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A Comparative Analysis of Dynamic Interactions between European and Indonesian Cocoa Markets during the 2008 Global Financial Crisis and the 2011 European Debt Crisis

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Abstract

This study empirically explores the dynamic interactions between the European and Indonesian cocoa markets during the 2008 global financial crisis (GFC) and the 2011 European debt crisis (EDC) using a battery of time series approaches of cointegration

and multivariate Granger causality. The study documented a long-run equilibrium between the European and Indonesian cocoa markets, implying a reciprocal relationship. However, an inefficient adjustment transmission in the Indonesian cocoa prices was recorded throughout the study. The US currency constantly influenced Indonesian cocoa prices, while cocoa markets were independent of fluctuations in world oil prices. Overall, the study recorded a different level of the speed of adjustment of short-run imbalances to long-run equilibrium in the domestic cocoa market across economic crises.

Keywords: cocoa market, CPI, exchange rate, oil price, economic crisis

JEL: C01, C23, O13

Introduction

Developing countries are the main exporters of cocoa beans to the global cocoa market (The United Nations Conference on Trade and Development – UNCTAD 2015). Developed countries, on the other hand, import cocoa beans as raw materials for their final manufactured products. As the third-largest cacao-producing country following Ivory Coast and Ghana, Indonesia supplies 15% (4.251 million tons) of cocoa beans to the total world cocoa market (UNCTAD 2017). In Indonesia, cocoa beans are one of the main agricultural commodities that significantly contribute to the national economy (Wyszkowska-Kuna 2019). The cacao plants are dominantly owned by farm households from Sulawesi Island (Hoffmann et al. 2020), while the production of cocoa is mainly done by smallholder farmers (87%), followed by state plantations (8%) and larger private estates (5%) (Yasa 2007).

During an escalating demand for cocoa beans in the global market, the margin price enjoyed by the cocoa smallholder farmers, as the main producers in Indonesia, is low compared to global cocoa prices (Ministry of Agriculture of the Republic of Indonesia 2020). The low level of welfare among cocoa smallholder farmers is a long-lasting unsettled issue. The low quality of non-fermented cocoa beans exported to foreign countries caused Indonesian cocoa prices to become cheaper (Witjaksono and Asmin 2016). Cocoa bean fermentation is one of the most essential ways to increase cocoa value added (Figueroa-Hernández et al. 2019). Nonetheless, with the increasing production of Indonesian cocoa and high global demand, Indonesia could continuously grasp the potential global market if the country were able to sustain a long-run equilibrium between domestic and global cocoa prices.

Indonesian cocoa has been instrumental in guaranteeing global food security (UNCTAD 2017). Thus, an imperative research topic is how stable cocoa production and price equilibrium can be ensured. Proper agricultural-related economic policies for the highest benefits of smallholder cocoa farmers should be designed by the government and stakeholders to make domestic cocoa more competitive in the international market (Mofya-Mukuka and Abdulai 2013; Olimpia and Stela 2017).

Recurring global economic turbulences often lead to domestic cocoa price volatility. Volatilities of world foodstuff prices jeopardize global food security, especially in underdeveloped and developing economies. The dynamics of the global market positioned the export of cocoa commodities to under-pressure foreign markets (Ivanic and Will 2014; Ying, Chang, and Lee 2014). The 2008 global financial crisis (GFC) and the 2011 European debt crisis (EDC) caused higher volatilities of cocoa and crude oil prices (Zhang, Ding, and Scheffel 2019), which then affected the global food price index (Kassim, Majid and Hamid 2011; Cabrera and Schulz 2016). At the start of 2016, the world cocoa bean price declined rapidly (International Cocoa Organization 2016). Since 2004, the global economic environment has been the major determinant of commodity market integration (Karim and Majid 2010; Yin and Han 2015). The market's ability to attain short- and long-run price equilibrium has different speeds of adjustments across economic crises, depending on their nature, intensities, duration, causes, and consequences.

With vast areas of land to potentially develop its cocoa farming business, Indonesia could act as the foremost raw material supplier for the international cocoa processing industry, despite the rather low margin price. The Indonesian government categorizes cocoa as the main commodity export that drives the national revenue from the foreign sector (Bank of Indonesia 2019), and it has been crucial in ensuring global food security (UNCTAD 2017). This cocoa industry is a small-scale business mostly located on Sulawesi Island (Hoffmann et al. 2020). Thus, studying and developing this sector from social, economic, and ecological perspectives become more imperative.

Previous studies showed that domestic cocoa prices become highly responsive to shocks in the global cocoa market (Fernández, Schmitt-Grohé, and Uribe 2017). There has been asymmetrical commodity price integration between domestic and global markets (Arnade, Cooke, and Gale 2017). This implies that a long-run equilibrium of the domestic cocoa market is highly dependent on the world cocoa market, which subsequently causes horizontal market integration. However, disequilibrium between the supply and demand of cocoa contributes to higher price volatility transmission (Ahrens, Pirschel, and Snower 2017). The transmission of cocoa prices can be seen through interactions between the global and the domestic markets (Bekkers et al. 2017; Ceballos et al. 2017). If the price of cocoa is overshadowed by an uncertain economic situation due to price fluctuation, it needs to be overcome through a proper trade policy design based on price estimation and the nature of long-run equilibrium.

Apart from pricing determinants, currency volatility also causes shocks to cocoa prices (Cozmanca and Manea 2010). The asymmetrical behavior of exchange rate volatility across countries impacts export expansion due to exchange rate risk (Volkov and Yuhn 2016; Buffie, Airaudo, and Zanna 2018), and economic turmoil is among the most considerable determinants that affect volatilities in exchange rates (Nedeljkovic and Urosevic 2012; Shah et al. 2019). Furthermore, the global crude oil price also plays a crucial role in influencing other commodity prices. Previous research provided strong empirical evidence of the effect of global oil price fluctuations on the prices

of agricultural commodities (Nazlioglu and Soytas 2012; Fowowe 2016). In the long run, the real oil price's elasticity of demand has a negative slope, particularly during peak production (Haugom, Mydland, and Pichler 2016).

Many previous researchers have explored the impacts of world oil prices and exchange rates on the agricultural commodities market. For instance, Wang, Wu, and Yang (2014) documented the significant influence of oil prices on selected agricultural commodity prices in the US economy using the Structural Vector Autoregression (SVAR) technique. Giordani, Rocha, and Ruta (2016) noted a significant association among the prices of 32 food products in 77 countries worldwide using the Two-Stage Least Square (2SLS) model. Using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) analysis, Ceballos et al. (2017) documented grain prices' transmission from the global to the domestic markets of 41 food products in 27 emerging economies.

Using the Auto-Regressive Distributed Lag (ARDL) model, Bahmani-Oskooee and Aftab (2018) found that changes in foreign exchange rates significantly influence the commodity price traded between Malaysia and China. Nazlioglu and Soytas (2012) documented connections between oil prices, exchange rate, and 24 global agricultural commodity prices using panel cointegration and dynamic causal relationship approaches. Volatility spillover was documented between the oil price and global prices of wheat, corn, soybeans, and sugar using impulse response functions and variance decompositions (Nazlioglu, Erdem, and Soytas 2013). Ultimately, in the context of the Indonesian economy, Arsyad and Yusuf (2008) simulated that a rise in oil price had caused cocoa exports to diminish between 1983 and 2002.

Previous research commonly assessed the relationship between oil prices and prices of agricultural commodities worldwide. Those studies did not specify the agricultural commodities or study periods following episodes of economic crises, although different economic crises have distinctive natures, durations, intensities, causes, and consequences. Additionally, although Indonesia is the third-largest world cocoa producer, previous research exploring the effects of world oil prices, exchange rate fluctuation, and the European cocoa market on cocoa-related-commodities in Indonesia has been scarce. Thus, this study identifies agricultural commodities, especially for Indonesian and European cocoa markets, to empirically investigate the conduct of the domestic cocoa market and its short- and long-run relationships. This study also considers the exchange rate, European consumer price indices of Germany and Russia, and the West Texas Intermediate (WTI) oil price in the analysis using the Vector Error Correction Model (VECM) and multivariate Granger causality approach. Finally, to provide meticulous empirical evidence of the influence of oil price changes on the domestic cocoa market across different economic phases, this study divides its analysis into periods of the 2008 GFC and the 2011 EDC.

The remainder of this study is structured in the following manners. Section 2 provides the data and empirical research framework. Section 3 discusses the findings and their implications. Finally, Section 4 concludes the study.

Empirical framework

Data

This research employs monthly secondary time-series data from January 2003 to December 2020. These data include Indonesian cocoa bean prices (COPID), the European cocoa bean prices on the London market (COPUK), the US real effective exchange rate (REERUS), the consumer price indices of Germany (CPIGE) and Russia (CPIRU), and the world price of West Texas Intermediate crude oil (OILP). The data for COPID is gathered from Statistics Indonesia (BPS – Statistics Indonesia 2004–2020), while COPUK is sourced from the International Cocoa Organization (ICCO). REERUS, CPIGE, CPIRU, and OILP are obtained from the International Monetary Fund (IMF).

Since the 2008 GFC and the 2011 EDC happened over the study period, the investigation for each economic crisis episode is conducted to offer meticulous empirical evidence of the effects of changes in the European cocoa market, exchange rate, consumer price indices of Germany and Russia, and world oil prices on Indonesia's cocoa commodity market across the two economic turmoil periods. The research then divides the data into the following three observational periods:

- Sub-sample 1: the 2008 GFC period – starting from January 2003 to May 2010 (89 observations);
- Sub-sample 2: the 2011 EDC period – spanning from June 2010 to December 2020 (127 observations).
- Full-sample: covering both Sub-sample 1 and Sub-sample 2 – spanning from January 2003 to December 2020 (216 observations).

Empirical model

The study incorporates representative and relevant variables into a Vector Auto-Regressive (VAR) equation system to answer the objectives of the research. Within the VAR framework, the endogenous variables influence each other (Nazlioglu and Soytas 2012; Wang, Wu, and Yang 2014; Dewanta 2019). Before estimating the VAR model, in the first step, the study needs to ensure data stationarity using unit root tests (Giuliodori and Rodriguez 2015) based on the following equations:

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

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

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

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

when $\phi = (\rho - 1)$ has a value of $\rho = 1$, then $\phi = 0$, implying Y has a unit root or non-stationarity. Δ in equation (4) shows the differentiation of Y. The differencing process, I(d), is taken to arrive at the stationarity so that $\phi \neq 0$ or $\rho < 1$ (Gujarati and Porter 2009).

The Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests are employed to ensure data stationarity. The study incorporates optimal lag-lengths and the truncation lag of q into the ADF and PP tests using the Final Prediction Error (FPE) criteria and the Newey-West approach, respectively.

In the second step, the study tests the cointegration among the variables using the Johansen tests. The time-series data is cointegrated if at a differentiated level, I(d), the data is stationary, showing the existence of a long-run equilibrium association among the endogenous variables. The error term (ϵ_t) has to be stationary, and its cointegration is tested using the following trace statistics:

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

Cointegration is also tested using the following Maximum-Eigen statistics:

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

The study will adopt the VECM technique to measure both short- and long-run relationships if the tests found cointegration. Referring to Asteriou and Hall (2011) and Wang, Wu, and Yang (2014), the following VECM equation is estimated:

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

where Z_t is the endogenous variable vector (i.e., COPID, COPUK, CPIGE, CPIRU, OILP, and REERUS) with an order of (n x m). A matrix β' from $\Pi = \alpha.\beta$' shows a cointegration vector and α indicates an error correction term (ECT) vector. Meanwhile, Γ is the matrix of the coefficient modifier in the short- and long-run, and p is the optimal lag-length.

In the third step, the study estimates the regression of endogenous variables across the 2008 GFC and the 2011 EDC using the following VECM equations:

$$D(COPID)_t = \alpha_1 + \beta_1 ECT\_COPID(-1) + \beta_{11}\sum_{i=1}^{p} D(COPID)_{t-i} + \beta_{12}\sum_{i=1}^{p} D(COPUK)_{t-i} + \beta_{13}\sum_{i=1}^{p} D(CPIGE)_{t-i} + \beta_{14}\sum_{i=1}^{p} D(CPIRU)_{t-i} + \beta_{15}\sum_{i=1}^{p} D(OILP)_{t-i} + \beta_{16}\sum_{i=1}^{p} D(REERUS)_{t-i} + \varepsilon_{t1} \quad (8)$$

$$D(COPUK)_t = \alpha_2 + \beta_2 ECT\_COPUK(-1) + \beta_{21}\sum_{i=1}^{p} D(COPUK)_{t-i} + \beta_{22}\sum_{i=1}^{p} D(COPID)_{t-i} + \beta_{23}\sum_{i=1}^{p} D(CPIGE)_{t-i} + \beta_{24}\sum_{i=1}^{p} D(CPIRU)_{t-i} + \beta_{25}\sum_{i=1}^{p} D(OILP)_{t-i} + \beta_{26}\sum_{i=1}^{p} D(REERUS)_{t-i} + \varepsilon_{t2} \quad (9)$$

$$D(CPIGE)_t = \alpha_3 + \beta_3 ECT\_CPIGE(-1) + \beta_{31}\sum_{i=1}^{p} D(CPIGE)_{t-i} + \beta_{32}\sum_{i=1}^{p} D(COPID)_{t-i} + \beta_{33}\sum_{i=1}^{p} D(COPUK)_{t-i} + \beta_{34}\sum_{i=1}^{p} D(CPIRU)_{t-i} + \beta_{35}\sum_{i=1}^{p} D(OILP)_{t-i} + \beta_{36}\sum_{i=1}^{p} D(REERUS)_{t-i} + \varepsilon_{t3} \quad (10)$$

$$D(CPIRU)_t = \alpha_4 + \beta_4 ECT\_CPIRU(-1) + \beta_{41}\sum_{i=1}^{p} D(CPIRU)_{t-i} + \beta_{42}\sum_{i=1}^{p} D(COPID)_{t-i} + \beta_{43}\sum_{i=1}^{p} D(COPUK)_{t-i} + \beta_{44}\sum_{i=1}^{p} D(CPIGE)_{t-i} + \beta_{45}\sum_{i=1}^{p} D(OILP)_{t-i} + \beta_{46}\sum_{i=1}^{p} D(REERUS)_{t-i} + \varepsilon_{t4} \quad (11)$$

$$D(OILP)_t = \alpha_5 + \beta_5 ECT\_OILP(-1) + \beta_{51}\sum_{i=1}^{p} D(OILP)_{t-i} + \beta_{52}\sum_{i=1}^{p} D(COPID)_{t-i} + \beta_{53}\sum_{i=1}^{p} D(COPUK)_{t-i} + \beta_{54}\sum_{i=1}^{p} D(CPIGE)_{t-i} + \beta_{55}\sum_{i=1}^{p} D(CPIRU)_{t-i} + \beta_{56}\sum_{i=1}^{p} D(REERUS)_{t-i} + \varepsilon_{t5} \quad (12)$$

$$D(REERUS)_t = \alpha_6 + \beta_6 ECT_{REERUS(-1)} + \beta_{61}\sum_{i=1}^{p} D(REERUS)_{t-i} + \beta_{62}\sum_{i=1}^{p} D(COPID)_{t-i} + \beta_{63}\sum_{i=1}^{p} D(COPUK)_{t-i} + \beta_{64}\sum_{i=1}^{p} D(CPIGE)_{t-i} + \beta_{65}\sum_{i=1}^{p} D(CPIRU)_{t-i} + \beta_{66}\sum_{i=1}^{p} D(OILP)_{t-i} + \varepsilon_{t6} \quad (13)$$

where *ECT* is the corrective adjustment in the VECM equation system. The significant negative value of *ECT* shows a gradual corrective adjustment from the short-run imbalance to the long-run equilibrium.

In the final step, the study measures dynamic causal relationships among variables using the multivariate Granger causality approach (Rahman and Kashem 2017). This approach provides useful information related to the size and direction of dynamic interactions (Asteriou and Hall 2011). The study identifies the presence of multivariate Granger causality using Wald test using the following multivariate Granger causality equation:

$$X_{(t)} = \sum_{i=1}^{p} A_i X(t-i) + \varepsilon(t) \quad (14)$$

where $X(t) \in R^{dx1}$ for t = 1,...,n, is a multivariate time series at optimal lag (p), and $\epsilon(t)$ is the Gaussian random vector, and A_i is a matrix for every i.

Findings and discussion

Descriptive statistics

The descriptive statistics provided in Table 1 presents a brief overview of preliminary information about the variables explored in the study. As illustrated in Table 1, the mean prices of the Indonesian cocoa beans (COPID), the European cocoa beans' price on London market (COPUK), consumer price index of Germany (CPIGE), consumer price index of Russia (CPIRU), the WTI oil price (OILP), and the US real effective exchange rate (REERUS) experienced a slight increase over the study period from January 2003 to December 2020. However, the highest values of COPID, COPUK, CPIGE, CPIRU, and REERUS were recorded in the Sub-sample 2 period (2010–6 to 2020–12). On the other hand, the highest value of OILP was recorded in the sub-sample 1 period (2003–1 to 2010–5). These findings show that, except for OILP, the other variables show an increasing trend.

Table 1. Descriptive statistics of the variables

Variable	COPID	COPUK	CPIGE	CPIRU	OILP	REERUS
Full-sample: The period of 2003–1 to 2020–12						
Mean	20996.3	1903.79	102.27	115.62	66.20	107.52
Maximum	36065	3134	114.29	191.15	133.93	122.59
Minimum	9235	1181	89.11	46.81	22.1	92.45
Std. Deviation	6692.9	469.32	7.41	44.93	23.96	7.89
Observations	216	216	216	216	216	216
Sub-sample 1: The 2008 GFC period (2003–1 to 2010–5)						
Mean	16305.17	1548.84	94.665	70.695	62.22	108.31
Maximum	29885	2528	100.01	99.13	133.93	122.46
Minimum	9235	1181	89.11	46.81	28.1	96.40
Std. Deviation	6212.9	371.56	3.55	15.95	24.13	6.29
Observations	89	89	89	89	89	89
Sub-sample 2: The 2011 EDC period (2010–6 to 2020–12)						
Mean	24272.13	2152.53	107.606	147.100	68.99	106.97
Maximum	36065	3134	114.29	191.15	110.04	122.59
Minimum	16575	1599	99.91	99.52	22.1	92.45
Std. Deviation	4797.9	357.8	3.92	29.03	23.53	8.83
Observations	127	127	127	127	127	127

Source: own calculation, processed by using the EViews statistical software.

Furthermore, the COPID, COPUK, and OILP were found to be more volatile during the Sub-sample 1 period, while the rest of the variables of CPIGE, CPIRU, and REERUS recorded higher volatility during the Sub-sample 2 period. The prices and exchange rate were highly sensitive to external factors, particularly during the EDC

period in 2011. The highest volatility was recorded from April to May 2011. Meanwhile, the IMF (International Monetary Fund 2019) reported that the WTI crude oil price achieved USD 110.04 per barrel in April 2011. Additionally, the OILP recorded a higher standard deviation in the 2008 GFC period (2003–2010). However, the average world oil price recorded the highest value of USD 68.99 per barrel in the 2011 EDC period (2010–2020). Geo-political, economic, and security pressures in the Middle Eastern region in mid–2015 caused higher volatility in global oil prices (Haugom, Mydland, and Pichler 2016).

Stationarity of data

Before estimating the dynamic causal relationships between the investigated variables, the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) unit root tests were conducted to ensure data stationarity. These tests have higher power while the time-series data exhibit non-linear behavior (Khraief et al. 2018). The findings of the ADF and PP unit root tests are provided in Table 2.

Table 2. Results of unit root tests

Variable	Level		First Difference	
	ADF	PP	ADF	PP
Full-sample: The period of 2003–1 to 2020–12				
COPID	0.8398	0.8186	0.0000***	0.0000***
COPUK	0.7384	0.7420	0.0000***	0.0000***
CPIGE	0.4945	0.1116	0.6383	0.0000***
CPIRU	0.8612	0.9077	0.0002***	0.0216***
OILP	0.2725	0.5135	0.0000***	0.0000***
REERUS	0.4395	0.7831	0.0000***	0.0000***
Sub-sample 1: The 2008 GFC period (2003–1 to 2010–5)				
COPID	0.6517	0.7257	0.0000***	0.0000***
COPUK	0.6580	0.8003	0.0000***	0.0000***
CPIGE	0.9733	0.9492	0.2411	0.0000***
CPIRU	0.9986	0.9996	0.0001***	0.0000***
OILP	0.1494	0.4032	0.0000***	0.0000***
REERUS	0.3927	0.5628	0.0000***	0.0000***
Sub-sample 2: The 2011 EDC period (2010–6 to 2020–12)				
COPID	0.7932	0.7858	0.0000***	0.0000***
COPUK	0.5369	0.5369	0.0000***	0.0000***
CPIGE	0.3937	0.1903	0.5973	0.0000***
CPIRU	0.8117	0.8970	0.0001***	0.0032***
OILP	0.1399	0.3150	0.0000***	0.0000***
REERUS	0.2241	0.3508	0.0000***	0.0000***

Note: *** shows significance at the 1% level. The figures show *p*-values.
Source: own calculation, processed using the EViews statistical software.

Table 2 illustrates the findings of the stationary tests of all variables using the *p*-value of the ADF and PP tests (Giuliodori and Rodriguez 2015). Through the process of data differentiation, *I*(1) for each sub-sample, the *p*-values of the PP test were all found to be significant at the 1% level. On the other hand, for the ADF test, only the CPIGE variable was non-stationary at the first difference for all periods, while the other variables recorded significance at the 1% level. Overall, the findings indicate that all variables in all sub-samples are stationary or contained no unit roots at the first difference, where $\phi \neq 0$ (Equation 4). These findings further show that agricultural cocoa commodities are very vulnerable to price volatility, market risk, and changes in other macroeconomic variables, both domestically and globally. Commodity market prices become more sensitive during episodes of economic turmoil (El-Khatib and Hatemi 2018), and speculation activities play a relatively large role in influencing the new price equilibrium (Bohl et al. 2019).

Johansen's cointegration test

After ensuring all variables are stationarity at a similar order of integration, *I*(1), the Johansen cointegration tests are then performed. The findings of the cointegration tests based on the trace and Maximum-Eigen statistics are reported in Table 3.

As observed from Table 3, the values of the trace and Maximum-Eigen statistics for all sub-periods are significant, at least at a 5% level. These findings show the existence of a long-run equilibrium among variables over the 2008 GFC, the 2011 EDC, and entire periods. These findings further imply that to predict the movements of domestic cocoa prices, one can refer to the movements of other variables in the equation system.

Table 3. The results of the Johansen cointegration tests

Null Hypothesis	Trace Statistic	Critical value	Prob.	Max-Eigen Statistic	Critical value	Prob.
Full-sample: The period of 2003–1 to 2020–12						
r = 0	495.173***	117.708	0.0000	122.189***	44.497	0.0000
r ≤ 1	372.983***	88.803	0.0000	106.341***	38.331	0.0000
r ≤ 2	266.642***	63.876	0.0000	85.578***	32.118	0.0000
r ≤ 3	181.063***	42.915	0.0000	78.313***	25.823	0.0000
r ≤ 4	102.750***	25.872	0.0000	58.431***	19.387	0.0000
r ≤ 5	44.318***	12.517	0.0000	44.318***	12.517	0.0000
Sub-sample 1: The 2008 GFC period (2003–1 to 2010–5)						
r = 0	207.771***	117.708	0.0000	56.852***	44.497	0.0015
r ≤ 1	150.919***	88.804	0.0000	40.781**	38.331	0.0256
r ≤ 2	110.148***	63.876	0.0000	34.829**	32.118	0.0227
r ≤ 3	75.318***	42.915	0.0000	30.585**	25.823	0.0109
r ≤ 4	44.724***	25.872	0.0001	26.234***	19.387	0.0043
r ≤ 5	18.490***	12.528	0.0045	18.49***	12.518	0.0045

Null Hypothesis	Trace Statistic	Critical value	Prob.	Max-Eigen Statistic	Critical value	Prob.
Sub-sample 2: The 2011 EDC period (2010–6 to 2020–12)						
r = 0	253.496***	117.708	0.0000	70.736***	44.497	0.0000
r ≤ 1	182.759***	88.803	0.0000	51.773***	38.331	0.0008
r ≤ 2	130.986***	63.876	0.0000	41.468***	32.118	0.0027
r ≤ 3	89.518***	42.915	0.0000	35.501***	25.823	0.0020
r ≤ 4	54.016***	25.872	0.0000	30.477***	19.387	0.0008
r ≤ 5	23.538***	12.517	0.0005	23.538***	12.517	0.0005

Note: *** and ** shows significance at the 1% and 5% levels, respectively.
Source: own calculation, processed using the EViews statistical software.

Having identified cointegration among the variables, the study could suitably adopt the VECM analysis to estimate the short- and long-run relations and among the investigated variables and their dynamic causal interactions.

The long-run impacts of European cocoa price, inflation, global oil prices, and exchange rate on the Indonesian cocoa price

Table 4 reports the findings of the long-run relationship between the European cocoa price (COPUK), the consumer price index of Germany (CPIGE), the consumer price index of Russia (CPIRU), the US real effective exchange rate (REERUS), world oil prices (OILP), and the Indonesian cocoa price (COPID) across three sub-samples of the study. As observed from Table 4, the study documented various sizes and directions of the long-run relationships among the variables. COPUK had a significant negative effect on COPID at the 1% level during the 2011 EDC and full-sample period, while a significant positive effect was recorded during the 2008 GFC period. In the long run, during the 2011 EDC and across the entire period, an increase in COPUK led to the decline of COPID. Meanwhile, during the 2008 GFC period, an increase in COPUK led to an increase in COPID.

Similarly, an increase in COPID caused COPUK to fall during the 2011 EDC and entire periods. On the other hand, during the 2008 GFC period, an increase in COPID also brought about an increase in COPUK. The negative bidirectional causalities during the 2011 EDC and across the entire period were due to the nature of the Indonesian cocoa commodities as the complement for other cocoa suppliers. However, during the 2008 GFC period, Indonesian cocoa commodities were viewed as substitutes for other cocoa suppliers. The relatively low price of cocoa beans led cocoa farmers to plant other agricultural products, such as corn, rubber, and palm oil (Permani 2013). Consequently, this caused the cocoa bean supply to decline in the long run and led to a rise in the prices of the domestic cocoa market.

Additionally, when the Indonesian cocoa prices increased, the inability of Indonesian cocoa beans to meet international standards due to their low quality (Dewanta 2019) drove consumers to demand more cocoa commodities from European countries due to their lower price and high quality. The European commodities market could sustain its high cocoa demand by selling its cocoa commodities at a competitive price in the long run. On the other hand, as the price of European cocoa rises, consumers buy more cocoa commodities from Indonesia because of their competitive price. Thus, in the long run, it is far easier for Indonesia to maintain the cocoa price at a lower level in the domestic market because of its low quality.

Table 4. Findings of the long-run relationship

Variable	COPID	COPUK	CPIGE	CPIRU	OILP	REERUS
Full-sample: The period of 2003–1 to 2020–12						
COPID	-	–11.923 [–7.989]***	–5590.227 [–9.680]***	416.278 [1.79234]*	131.839 [4.709]***	309.977 [3.366]**
COPUK	–0.083 [8.032]***	-	468.822 [9.766]***	–34.911 [–1.802]*	–11.056 [–4.709]***	–25.996 [–3.349]**
CPIGE	–0.0002 [5.902]***	0.002 [5.923]***	-	–0.074 [–1.799]*	–0.023 [–5.067]***	–0.055 [–3.346]**
CPIRU	0.002 [5.905]***	–0.028 [–5.908]***	–13.429 [–9.722]***	-	0.316 [4.720]***	0.744 [3.393]**
OILP	0.007 [5.902]***	–0.090 [–5.870]***	–42.401 [–10.413]***	3.157 [1.795]*	-	2.351 [3.590]**
REERUS	0.003 [5.951]***	–0.038 [–5.890]***	–18.034 [–9.704]***	1.342 [1.821]*	0.425 [5.066]***	-
Sub-sample 1: The 2008 GFC period (2003–1 to 2010–5)						
COPID	-	14.091 [1.821]**	28391.96 [6.705]***	–6194.064 [–4.260]***	–819.525 [–5.343]***	–2226.603 [–3.491]**
COPUK	0.071 [1.811]**	-	2014.913 [6.692]***	–439.579 [–4.251]***	–58.159 [–5.419]***	–158.017 [–3.584]**
CPIGE	3.52E–05 [1.320]	0.0005 [1.323]	-	–0.218 [–4.534]***	–0.029 [–6.603]***	–0.078 [–3.621]**
CPIRU	–0.0002 [1.321]	–0.002 [–1.326]	–4.584 [7.149]***	-	0.132 [5.433]***	0.359 [3.461]**
OILP	–0.001 [–1.325]	–0.017 [–1.351]	–34.644 [8.317]***	7.558 [4.340]***	-	2.717 [5.069]***
REERUS	–0.0005 [–1.335]	–0.006 [–1.377]	–12.751 [7.032]***	2.782 [4.263]***	0.368 [7.817]***	-
Sub-sample 2: The 2011 EDC period (2010–6 to 2020–12)						
COPID	-	–10.828 [–12.777]***	–562.374 [–1.720]*	267.463 [2.036] **	82.653 [4.261] ***	88.252 [1.646]
COPUK	–0.092 [–12.822]***	-	51.937 [1.74461]*	–24.701 [–2.056]**	–7.633 [–4.272]***	–8.150 [–1.634]
CPIGE	–0.002 [–9.244]***	0.019 [9.342]***	-	–0.475 [–2.056]**	–0.146 [–4.493]***	–0.156 [–1.632]

Variable	COPID	COPUK	CPIGE	CPIRU	OILP	REERUS
CPIRU	0.003 [9.229]***	−0.040 [−9.285]***	−2.102 [−1.733]*	-	0.309 [4.336]***	0.329 [1.666]
OILP	0.012 [9.229]***	−0.131 [−9.220] ***	−6.803 [−1.811]*	3.235 [2.073]**	-	1.067 [1.669]
REERUS	0.011 [9.321]***	−0.123 [−9.223] ***	−6.372 [−1.720]*	3.031 [2.082]**	0.936 [4.366] ***	-

Note: ***, **, and * show significance at the levels of 1%, 5%, and 10%, and [.] is the t-statistics.
Source: own calculation, processed using the EViews statistical software.

Furthermore, the study also found a significant negative effect of OILP and REERUS on COPID during the 2008 GFC period, at least at the 5% level. Meanwhile, during the 2011 EDC and full-sample period, OILP and REERUS significantly and positively impacted COPID, at least at the 5% level. However, during the 2011 EDC period, REERUS had an insignificant effect on COPID, while OILP recorded a significant positive effect. These findings showed that the different nature, duration, and causes of episodes of economic crises affected COPID differently.

Nearly 90% of cocoa beans in Indonesia are sold in the local market (Dewanta 2019). Accordingly, changes in the global oil price caused a more long-lasting effect on the Indonesian domestic market. A rise in oil price worldwide caused an increase in the production cost of derived cocoa products, such as cocoa liquor, cocoa powder, and cocoa butter. Consequently, this led to a decline in demand for the processed cocoa commodities by Indonesia's cocoa trading partners.

Since Indonesia exports the raw cocoa beans mainly to the neighboring countries of Malaysia and Singapore, which used them as inputs for their processed cocoa products (Dewanta 2019), these countries would reduce their cocoa demand from Indonesia in the long run. This practice, in turn, causes the price of Indonesian cocoa beans to plunge. The finding of the negative effect of REERUS on the Indonesian cocoa market during the 2008 GFC period is in line with previous research (Olaiya 2016; Verter 2016). An appreciation of the IDR (Indonesian Rupiah) causes the domestic cocoa price to become relatively more expensive and less competitive in the global market. Subsequently, the demand for cocoa and the price would fall in the long run. On the other hand, a relatively low level of IDR, compared to the foreign currency during the 2011 EDC period, caused an increase in the demand for Indonesian cocoa due to its high competitiveness.

COPID had a significant positive effect on OILP and REERUS at the 1% level during the 2011 EDC and full-sample periods. However, during the 2018 GFC period, COPID had an insignificant effect on OILP and REERUS. Indonesia only exported about 10% of cocoa beans, largely to the Asian market (92.46%), mainly to Malaysia (57.26%) and Singapore (31.88%). It also exported a negligible amount of cocoa beans to foreign countries, such as to North America (4.95%) and Europe (2.54%) (International Trade Centre 2020). Overall, the value of Indonesian cocoa exports reached only USD112 million in 2017. The tiny share of Indonesia's cocoa in the global market meant that OILP and REERUS had an insignificant effect on COPID during the 2018

GFC period. In addition, Indonesia's Ministry of Finance enacted a cocoa bean export tax, Regulation No. 67/PMK.011/2010, further lowering the export values of Indonesia to the world cocoa market (Permani, Vanzetti, and Setyoko 2011). However, during the entire period, Indonesian cocoa was still considered an important supplier to the global market.

Our study also documents the negative effect of the European cocoa price on the exchange rate, and vice versa. As the domestic currency appreciates, the local cocoa becomes less competitive in the global market. To foresee a lower demand for domestic cocoa beans due to its exorbitant prices, in the long run, the domestic cocoa price needs to be adjusted following price changes in the global cocoa market. Our findings are in line with Alori and Kutu (2019), who found that the exchange rate shocks affected the Nigerian cocoa exports to the world cocoa market. From a policymaker's perspective, these findings imply the importance of stabilizing the exchange rate to promote cocoa exports.

Overall, the nature of the long-run relationships between COPID and other variables was slightly different across the sub-samples due to the different nature, duration, and causes of the economic crises. During the 2008 GFC and the 2011 EDC crises, the impacts of the exchange rate were more dominant due to the higher volatility of the exchange rate during economic instability periods. For the full-sample period, the study recorded bidirectional long-run interactions between COPID and COPUK, COPID and REERUS, and COPUK and REERUS, while a unidirectional long-run interaction was documented from the OILP to COPID, OILP to COPUK, and OILP to REERUS. Thus, the world oil price played an essential role in influencing global economic stability. A rise in world oil prices caused the global cocoa beans prices to rise, the domestic currency to appreciate, and the domestic cocoa price to decline.

A long-run relationship between COPID and COPUK implies a horizontal integration of the Indonesian cocoa market with the global cocoa market (Arnade, Cooke, and Gale 2017). The low competitiveness of Indonesian cocoa beans in the global market due to the enactment of cocoa export duties and the low quality of non-fermented cocoa bean exports caused asymmetrical interactions between the domestic Indonesian and world cocoa markets (Witjaksono and Asmin 2016; Hasibuan and Sayekti 2018). Meanwhile, the establishment of a regional trade treaty among the cocoa producers reduced competition in the world cocoa market (Jambor, Gal, and Torok 2020). Generally, our findings also demonstrate the sensitivity of Indonesian net export, macroeconomic policies, and market flux to the changes in foreign currency of the USD. The fiscal and monetary policy interactions can explain the repercussion of exchange rate volatility (Shah et al. 2019).

Finally, an increase in price instability weakens the exchange rate (Volkov and Yuhn 2016; Nakatani 2018). Global crude oil prices failed to reach equilibrium level from short- to long-run. Haugom, Mydland, and Pichler (2016) believed that predicting future oil prices has a risk challenge. World oil prices oscillated during the 2008 GFC and the 2011 EDC crises period peaked in 2015. The connection between prices of agricultural commodities is non-neutral to the world oil price (Fowowe 2016; Syahril

et al. 2019). Geo-political, economic, and security tensions, particularly in the Middle East, contributed to higher volatility of world oil prices and macroeconomic instabilities (Evgenidis 2018).

Multivariate dynamic interactions among Indonesian and European cocoa markets, inflation, global oil price, and exchange rate

Finally, Table 5 illustrates the multivariate dynamic interactions among the variables. There is a long-run equilibrium between COPID and the COPUK, CPIGE, CPIRU, OILP, and REERUS variables, indicated by the negative significance of ECT for all sub-samples. These findings show that a short-run disequilibrium in the domestic cocoa market is adjusted to a long-run equilibrium with a speed of adjustments of –0.141 during the 2003–2020 (full-sample), –0.138 during the 2003–2011 (the 2008 GFC), and –0.573 during 2010–2020 (the 2011 EDC) periods. During the 2011 EDC period, the speed of adjustment was slightly faster than the other study periods, indicating a greater integration of the world cocoa market. It took about four weeks during the 2008 GFC and full-sample periods, and two weeks during the 2011 EDC period, for a short-run imbalance in the domestic cocoa price to be cleared and restored to long-run equilibrium. These findings further denote that the 2008 GFC hit the Indonesian economy hardest.

The 2008 GFC generated shocks to the global cocoa market (Bahmani-Oskooee and Aftab 2018; Dias, Silva, and Dionísio 2019). This adverse impact was marked by an increase in the fragility of the Indonesian cocoa market. Thus, hedging cocoa commodities is viewed as the paramount strategy to minimize the market risk due to price sensitivity to exchange rate fluctuations (El-Khatib and Hatemi 2018). Moreover, the Indonesian cocoa beans traded in the foreign cocoa markets are of low quality and non-fermented (Witjaksono and Asmin 2016) in the cocoa-derived products industry in Malaysia, Indonesian cocoa beans are commonly used as auxiliary raw material for the finest quality of cocoa beans from Ghana (Quarmine et al. 2012; Dewanta 2019). The Indonesian cocoa market was also adversely impacted by the 2011 EDC.

In terms of short-run association and multivariate Granger causal interaction, the study recorded bidirectional Granger causality between COPID and COPUK during the 2011 EDC. During the 2011 EDC, a unidirectional causality running from COPUK to COPID was documented. However, the study found that COPID was independent of COPUK over the entire study period. As the world's third-largest cocoa-producing country, Indonesia sold more than 85% of its cocoa beans in the domestic market, and only 15% was exported to the foreign market (Dewanta 2019). African countries are the major determinants of cocoa bean prices globally (Wessel and Quist-Wessel 2015). Thus, it is understandable that the foreign cocoa market has considerable influence on Indonesia's cocoa market.

Table 5. Multivariate dynamic interactions

Variable	COPID	COPUK	CPIGE	CPIRU	OILP	REERUS	ECT
Full-sample: The period of 2003–1 to 2020–12							
COPID	-	0.070	4.579**	1.942	0.109	0.341	–0.141
		(0.7904)	(0.0324)	(0.1634)	(0.7405)	(0.5587)	[–1.965]**
COPUK	0.074	-	6.094**	0.114	4.042**	0.051	–0.249
	(0.7856)		(0.0136)	(0.7351)	(0.0444)	(0.8200)	[–3.397]**
CPIGE	12.018***	31.807***	-	5.394**	1.484	4.140**	–0.854
	(0.0005)	(0.0000)		(0.0202)	(0.2231)	(0.0419)	[–8.624]**
CPIRU	1.077	0.124	2.614	-	4.309**	4.16**	–0.005
	(0.2994)	(0.7242)	(0.1059)		(0.0379)	(0.0413)	[–0.607]
OILP	0.0007	0.016	0.127	6.0002	-	0.994	0.009
	(0.9777)	(0.8979)	(0.7208)	(0.9937)		(0.3186	[0.251]
REERUS	1.714	2.734*	2.373	0.012	0.649	-	–0.059
	(0.1904)	(0.0982)	(0.1234)	(0.9095)	(0.4201)		[–2.052]**
Sub-sample 1: The 2008 GFC period (2003–1 to 2010–5)							
COPID	-	2.167	8.775**	4.245	11.043***	8.381**	–0.138
		(0.3385)	(0.0124)	(0.1197)	(0.004)	(0.0151)	[3.241]**
COPUK	10.827***	-	6.130**	4.960*	7.350**	1.515	–0.147
	(0.0045)		(0.0466)	(0.0837)	(0.0253)	(0.4687)	[–3.240]**
CPIGE	9.959***	0.749	-	3.978	6.570**	12.13***	–1.468
	(0.0069)	(0.6875)		(0.1368)	(0.0374)	(0.0023)	[–5.706]
CPIRU	3.859	7.430**	0.148	-	0.354	4.390	–0.176
	(0.1452)	(0.0243)	(0.9283)		(0.8375)	(0.1114)	[–2.555]**
OILP	4.419	2.060	0.233	1.824	-	1.499	0.041
	(0.1097)	(0.3568)	(0.8900)	(0.4016)		(0.4725)	[0.250]
REERUS	0.343	0.565	0.871	4.082	2.671	-	–0.177
	(0.8424)	(0.7536)	(0.6472)	(0.1299)	(0.2631)		[–1.626]
Sub-sample 2: The 2011 EDC period (2010–6 to 2020–12)							
COPID	-	2.778*	1.512	0.323	0.252	0.211	–0.573
		(0.0956)	(0.2188)	(0.5693)	(0.6156)	(0.6460)	[–3.284]**
COPUK	5.218**	-	2.887*	0.003	7.723***	0.134	–0.695
	(0.0224)		(0.0893)	(0.9498)	(0.0055)	(0.7141)	[–4.136]***
CPIGE	0.942	4.166**	-	0.446	0.039	0.132	–0.043
	(0.3319)	(0.0412)		(0.5039)	(0.8415)	(0.7161)	[–1.471]
CPIRU	2.162	0.513	0.436	-	1.085	7.339***	–0.009
	(0.1414)	(0.4736)	(0.5090)		(0.2974)	(0.0067)	[–0.628]
OILP	12.684***	12.458***	2.857*	0.775	-	0.021	–0.218
	(0.0004)	(0.0004)	(0.0910)	(0.3786)		(0.8861)	[–4.152]***
REERUS	0.107	0.033	0.138	3.22*	0.280	-	0.004
	(0.7430)	(0.8553)	(0.7100)	(0.0727)	(0.5962)		[0.224]

Note: ***, **, and * show significance at the levels of 1%, 5%, and 10%, respectively. Figures in (.) and [.] show probability value and t-statistics.
Source: own calculation, processed using the EViews statistical software.

As the third-largest producer of cocoa beans, Indonesia could play a greater role in shaping the world cocoa market (Hoang and Meyers 2015). However, the trend of Indonesian cocoa prices is to follow changes in the global market. About 70% of the market share of world cocoa beans comes from West African countries (Wessel and Quist-Wessel 2015), which are more competitive in the global cocoa market. Cocoa farming in both Indonesia and Africa is done mainly by smallholder farmers (Wessel and Quist-Wessel 2015; Hoffmann et al. 2020), but Indonesia has a negligible role in the world cocoa market.

REERUS had an asymmetrical influence in correcting short-run imbalances for COPID towards a long-run equilibrium during the 2008 GFC period; this finding similar to Volkov and Yuhn (2016). Meanwhile, the Indonesian domestic cocoa price was independent of REERUS during the EDC and full-sample periods. Over the 2008 GFC period, the economic crisis triggered exchange rate volatility (Nedeljkovic and Urosevic 2012; Majid, Sofyan and Rahmanda 2018; Sofyan, Majid, and Rahmanda 2019), and the IDR fell in value against the USD. Changes in commodity prices were more significant after 2008 (Zhang, Ding, and Scheffel 2019). However, trading activities could not offer maximum profits because of export restrictions and exchange rate risks, and the tax policy on cocoa bean exports introduced by the Indonesian government in April 2010 reduced its competitiveness in the global market (Hasibuan and Sayekti 2018).

Furthermore, the study found that COPUK was independent of REERUS during the 2008 GFC and 2011 EDC periods. These findings indicate that the European cocoa markets are mainly influenced by their regional currencies. However, the study found a unidirectional causal relationship running from COPUK to REERUS during the full-sample period, showing the critical role the European cocoa market plays in influencing REERUS. The higher volatility of the euro during the 2011 EDC period unfavorably affected the global cocoa market. Thus, forecasting cocoa price movements globally is quite challenging as it is influenced by numerous determinants (Haugom, Mydland, and Pichler 2016). The study found bidirectional causality between CPIGE and COPID during the 2008 GFC and full-sample periods, showing the interdependence of the domestic coca price on global price instability. However, Indonesia's domestic cocoa price is independent of the price instability in Russia due to the small trading volume between the two countries.

Finally, OILP is independent of COPID during the full-sample period. This fact is further supported by the insignificance of the ECT in the equation system. OILP changes have no effect on domestic cocoa prices. On the other hand, the study recorded a unidirectional causal effect running from OILP to COPID during the 2008 GFC period and from COPID to OILP during the 2011 EDC period. The world oil reached a maximum price of USD 133.93 (the 2008 GFC period) and USD 110.04 (the 2011 EDC period) per barrel. This oil price volatility is viewed as one of the sources of macroeconomic instability (Dahl, Oglend, and Yahya 2019). The prices of agricultural commodities of rubber and crude oil were symmetrical in the ASEAN market (Ramli et al. 2019).

Thus, the price transmission mechanism across the global commodities market was diverse, relying on nature and use value (Arnade, Cooke, and Gale 2017).

Overall, our study documented an increased integration trend between domestic and global cocoa markets across the episodes of global economic crisis. The existence of a short-run imbalance in the domestic cocoa market caused by various shocks from global economic instability was gradually and steadily corrected and adjusted towards a long-run equilibrium (Nazlioglu 2014; Ahrens, Pirschel, and Snower 2017). The global macroeconomic condition was the main determinant of the cocoa market integration globally (Yin and Han 2015).

Conclusions

This study explored dynamic interactions between the prices of Indonesian cocoa beans, the European cocoa market, the consumer price index, the world oil price, and exchange rates during the 2003–2020 period, comprising the 2008 global financial crisis and the 2011 European debt crisis. Adopting the VECM analysis, the study documented that a short-run imbalance in the Indonesian cocoa market due to shocks in the European cocoa market, the US real effective exchange rate, price stability in the Eurozone, and the world oil price had been gradually and steadily corrected moving towards its long-run equilibrium condition. The US currency volatility, global price instability, and world oil price fluctuations affected the Indonesian cocoa market in different ways, sizes, and causal directions. The different nature, duration, and causes of the 2008 GFC and 2011 EDC impacted the Indonesian cocoa prices in various ways.

Studying the nature of the interactions of global economic factors on the local cocoa prices is vital if a country intends to gain trade benefits (Ceballos et al. 2017). The relatively low competitiveness of Indonesia's cocoa beans in the global market should be viewed as a challenge that offers a huge opportunity if the country could manufacture high-quality fermented cocoa beans. The Indonesian cocoa market has a high potentiality to horizontally integrate with the global cocoa market. The domestic and global cocoa markets have been more interdependent both in the short- and long-term relationships.

The price adjustments in Indonesia's domestic cocoa market to shocks in the global cocoa market towards the long-run equilibrium were different across the 2008 GFC and 2011 EDC periods. The speed of adjustments in the global cocoa prices was faster than the adjustments in the domestic cocoa market. The domestic cocoa market tends to adapt the movements in the global markets with an asymmetrical pattern. On the other hand, Andrade and Zachariadis (2016) believe that an asymmetrical relationship exists if two or more markets are vertically integrated.

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Analiza porównawcza dynamicznych interakcji między europejskimi i indonezyjskimi rynkami kakao podczas światowego kryzysu finansowego w 2008 r. i europejskiego kryzysu zadłużenia w 2011 r.

Opracowanie przedstawia badanie empiryczne dynamicznych interakcji między europejskim i indonezyjskim rynkiem kakao podczas globalnego kryzysu finansowego w 2008 r. (GFC) i europejskiego kryzysu zadłużenia w 2011 r. (EDC). Badanie zrealizowano wykorzystując podejścia kointegracji i wieloczynnikowej przyczynowości Grangera w oparciu o zestaw szeregów czasowych. Badanie potwierdziło długoterminową równowagę między europejskim i indonezyjskim rynkiem kakao, sugerując istnienie wzajemnej relacji między nimi. Jednak w całym badaniu odnotowywano nieefektywną transmisję korekt cen kakao w Indonezji. Waluta amerykańska stale wpływała na indonezyjskie ceny kakao, podczas gdy rynki kakao były niezależne od wahań światowych cen ropy naftowej. Generalnie w badaniu odnotowano różny poziom szybkości dostosowywania się krótkookresowych nierównowag do długookresowej równowagi na krajowym rynku kakao w czasie kryzysów gospodarczych.

Słowa kluczowe: rynek kakao, CPI, kurs walutowy, cena ropy naftowej, kryzys gospodarczy

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