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The Effect of Global Prices of Crude Palm Oil, Marketing Margins and Palm Oil Plantations on the Environmental Destruction: An Application of Johansen Cointegration Approach

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ABSTRACT

As the most important factor in the world, palm oil is a crucial element that contributed to economic growth of a country. Besides as a role of the important vegetables oil, palm oil also gives a negative effect on environment through expanding the palm oil plantation. Therefore, this study aims to investigate the effect of global crude palm oil (CPO) price, marketing margins, and palm oil plantations on environmental destruction in the short-term and long-term. For examining the short-term and long-term effect, this study used Johansen Cointegration approach involving the bivariate causality with the Pirwise Granger Causality test and multivariate causality relationships with the Wald test. Also, we analyzed the responds of independent variables to dependent variable using impulse response (IRF) and variance decomposition (VD). This study used a monthly secondary data starting on 2008 to 2017 i.e. Environmental Quality Index, Global CPO price, Marketing margins and palm oil plantations. The data collected from 5 sources i.e. Central Bureau of Statistic (BPS), Food and Agriculture Organization (FAO), World Trade Organization, Central Bank of Indonesia (BI) and the Central Bank of Malaysia (BNM). The results of analysis shows that there is long-term relationship of global CPO price, marketing margins, and palm oil plantations on environmental quality index. For short run, this study found that global CPO price has a significant positive effect on environmental quality index. Meanwhile, the size of palm oil plantation and marketing margins have a significant negative effect on environmental quality index in Indonesia. Also, using the bivariate test, this study proves that there is one way causality relationship between the global CPO prices, marketing margins and size of oil palm area on environmental quality index. In addition, the global CPO prices and marketing margins fluctuations causing shock in environmental quality index.

Keywords: Global Crude Palm Oil Prices, Marketing Margin, Palm Oil Plantations, Environmental Quality Index
JEL Classifications: C01, C50, Q43, Q51

1. INTRODUCTION

Palm oil is the most important vegetable oil in the world (Cheng et al., 2017; Choong & Mckay, 2014). The increase its global crude palm oil (CPO) prices will increase the marketing margins of both entrepreneurs, and oil palm farmers consequently encourage the producer countries to increase their production by expanding plantations. These will be accompanied by increased productivity which leads to the declining of Indonesia environmental quality index. The development of oil palm plantation is a trigger for environmental damage, especially forest destruction (Jean et al., 2019; Saswattecha et al., 2017; Euler et al., 2016). Particularly with the shifting of fossil energy to renewable energy, the demand for palm oil continues to increase and is feared there will be a large-scale development of oil palm plantations that will have a negative impact on the environment (Silalertruksa et al., 2017;

Pacca and Bicalho, 2016; Sajjadi et al., 2016; Saswattecha et al., 2015; Kochaphum et al., 2013; Silalertruksa and Gheewala, 2012). The problem is the primary vegetable oil which is exploited to become biodiesel is also the palm oil. (Rincón et al., 2015); therefore, the negative impact of palm oil on the environment becomes the focus of consideration for consumer countries in discontinuing trade cooperation (Alfonso-Lizarazo et al., 2013).

The effect of oil palm development is not only negative, but also has a positive impact on the environment. Among the positives impact are the expansion of oil palm plantations is a solution in the region development (Villela et al., 2014) and the development of palm oil into renewable energy which is eco-friendlier (Prabu et al., 2018; Naylor and Higgins, 2018; Isa and Ganda, 2018; Hansen and Nygaard, 2014; Silalertruksa et al., 2012; Ong et al., 2011). Moreover, it is not an obstacle for the producer countries in responding to the negative issues of oil palm damaging the environment if they certify the roundtable on sustainable palm oil as a guide to environmental-based oil palm development (Tong, 2017; Ordway et al., 2017; Saswattecha et al., 2015). Indeed, there are concerns that the certified oil palm plantations are owned by large companies while there are still very few farmer-owned plantations that have been certified (Azhar et al., 2017). Therefore, it is necessary to understand the socio-ecological background of small-farmer to design a holistic certification scheme that will succeed in preserving biodiversity in the landscape of agricultural production without ignoring the condition of small farmers (Saadun et al., 2018).

An empirical study about the impact of the oil palm area development on environmental damage has been widely conducted (Susanti and Maryudi, 2016). There is a study in Thailand that shows the increase of palm oil production negatively affected environmental damage (Saswattecha et al., 2017), then, Wicke et al., (2011) are conducted a study Indonesia and Malaysia for 30 years that shows oil palm development reduced forest land. Also, the study conducted by Abdul-Manan (2017) shows that the development of renewable energy from palm oil drives demand higher which ultimately also triggers the development of oil palm areas. It is feared to increase the price of global agricultural commodities and endanger food security, especially in vulnerable countries (Taghizadeh-Hesary et al., 2019; Gomes et al., 2018). From the existing empirical studies, we have not seen the short-term, and long-term equilibrium and the relationship of bivariate and multivariate causality between the variables studied, as well as seeing the shock environmental index variable which is responded to by global CPO price volatility and marketing margins.

Regarding the differences in the results of the previous researches, this study will focus on analyzing how volatility in global CPO prices, marketing margins and the size of Indonesian oil palm plantations on Indonesia's environmental quality index in the short and long-term periods. Furthermore, this study also looks at the relationship of bivariate and multivariate causality among the environmental quality index and the volatility of global CPO prices, marketing margins, and the size oil palm plantations. Additionally, this study will be looking at shocks in the volatility of global CPO prices, marketing margins and the area of oil palm plantations that are impacted the environmental quality index.

2. LITERATURE REVIEW

Indonesia, as a country with the widest oil palm plantation in the world, is certainly experiencing severe deforestation and environmental damage. The development of oil palm in Indonesia in recent decades had a significant negative impact on the environment (Susanti and Maryudi, 2016). According to Saswattecha et al. (2017), in Thailand case, from the palm oil production point of view, has a considerable impact on the environment. This study sees the effects of changing land use on the ecosystem and the environmental impact of oil palm plantations and palm oil factories. The BAU scenario shows that environmental impacts can double without additional enhancement options to palm oil development. The CP scenario shows that the current plans to increase palm oil production will greatly increase environmental impacts. Only implementing cost-effective options, as in the GRT scenario, is also not enough to avoid the increasing environmental impacts, if the palm oil exports increase faster than currently estimated. The GRN scenario which assumes the application of effective options, regardless of the cost, shows it will greatly reduce the environmental impact.

According to Wicke et al. (2011), that examines the case of the world's largest oil palm country, Indonesia and Malaysia, for 30 years in oil palm development. The result shows Indonesia's loss the forest cover of 40 million ha and 30% reduction of forest area. Malaysia has a smaller loss of forest cover, about 5 million ha or 20% reduction in the forest area. The development of renewable energy from palm oil drives demand which eventually triggers the enlargement of oil palm areas (Abdul-Manan, 2017); moreover, it is also concerned that it will increase the prices for global agricultural commodities and endanger food security, especially in vulnerable countries (Taghizadeh-Hesary et al., 2019; Gomes et al., 2018).

To maintain the environmental quality index, the government, the private sector, and the public will continue to explore and utilize natural resources for efficient economic development while maintaining environmental balance (Kemenlkh, 2016). This is a concern to keep the environmental quality index increasing. The decrease in the environmental quality index is exemplified by the occurrence of damage or pollution of water, air and forest area (BPS, 2017).

Environmental quality index (EQI) is a national environmental management performance index. This is the concept of the environmental performance index (EPI) which the criteria include water quality, air quality, and the quality of land cover (Kemenlkh, 2016). Furthermore, the conditions and quality of the environment can be seen from three essential things: (1) Physical conditions of the atmosphere, climate, weather, water characteristics, geology, geography, and soil; (2) Land cover, ecosystems, and diversity; (3) Quality of the environment, in the form of air quality, fresh water and sea water (BPS, 2017).

From the previous empirical studies, the finding shows that land development, increasing production and development of palm oil as renewable energy sources encourage environmental damage. Whereas this study will add to the independent variable of global CPO price volatility and palm oil marketing margins. Moreover, in responding to less comprehensive findings and to provide the latest empirical study, this study looks at the short-term and long-term balance and causality relationship between the variables studied.

3. DATA AND EMPIRICAL MODELS

This study uses secondary data was collected from Bank Indonesia, the Central Bureau of Statistics of Indonesia, World Trade Organization and Food and Agriculture Organization. The time series data with the monthly period from January 2008 to December 2017 used. The number of observations is 120 months and already meet the requirement of time series data (Narayan and Narayan, 2005). The analysis model of this study is vector error correction model (VECM) to see short-term and long-term equilibrium relationships (Kassim and Majid, 2015; Pal and Mitra, 2017; Abdul et al., 2011). This model analyzes the relationship balance with cointegration test approach (Johansen Cointegration Test) and analyzes the relationship of bivariate causality with the Pairwise Granger Causality Tests approach and multivariate causality relationships with the Wald Tests approach. Moreover, it will analyze the shocks on the value of the independent variable which is related to the dependent variable using Impulse Response; and examine how the contributions of the independent variables in explaining joint contributions using Variance Decomposition.

The study begins with testing the stationarity of data using Augmented Dickey-Fuller (ADF), Philips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) at the same degree (level or deferent) to obtain stationary data, i.e. data whose variants are not too large and have a tendency to approach the average value (Ender, 1995). Then after the data is stationary, it is necessary to do a model stability test to prove that the model is good. A good stability model will give the estimation test an unbiased result. The stability test is conducted through the VAR system. The results of the model stability test explained in two forms, namely: Tabulation and graph forms. The tabulation form describes the modulus values, and the graph form describes points distributed in a circle. The modulus value with an average value smaller than one illustrates that the model is stable; meanwhile, the inverse root of AR characteristic polynomial graph describes the stable model by the dispersion of points in a circle. After the model stability test is carried out with accordance results, the lag length test can be carried out.

Once the model is stable, we can continue to determine the optimal lag length which is the response period of a variable to its past variable and other endogenous variables. In this study, to determine optimal lag length is used several criteria; likelihood ratio (LR), final prediction error (FPE), Akaike information criterion (AIC), Schwartz information criterion (SIC), and Hannan-Quinn information criterion (HQ) (Nizar, 2012). The optimal lag length is determined using these criteria and takes into account the criteria that have the smallest value (which has the most asterisk) among the various lags proposed by VAR model.

After a lag length test, the cointegration test is then carried out. The cointegration test approach in this study is the Johansen cointegration method. Johansen's cointegration test can be analyzed through VAR with p order (Ajija et al., 2011).

The method to analyze the relationship between causality of observed intervariable is the Granger causality test. In this study, the Granger causality test is used to look at the direction of the causality relationship of environmental quality index, marketing margins, volatility in global CPO prices and the size of Indonesian oil palm plantations. Analysis of causality between independent variables and dependent variables use the VECM model with the Granger Causality approach. It will show the bivariate causality relationship while looking at multivariate causality using the Wald tests approach.

According to Ajija et al. (2011), if the VAR model time series data is proven to have a cointegration relationship, the VECM model can be used to determine the short-term behavior of a variable against the term value length. VECM is also used to calculate short-term relationships between variables through standard coefficients and estimate long-term relationships using residual lags from cointegrated regression. This study uses the equation as follows:

$$EQI = f(MMC, CPV, APO) \tag{1}$$

$$EQI_t = \alpha_0 + \alpha_1 MMC_t + \alpha_2 CPV_t + \alpha_3 APO_t + \varepsilon_t \tag{2}$$

The environmental quality index represented by *EQI*, *MMC* is the CPO marketing margins, *CPV* is the volatility of global CPO prices, *APO* is the area size of oil palm plantations, and is the error term. Further, for applying the VECM, the below equations is presented:

$$\Delta EQI_t = \alpha_0 + \alpha_1 \sum_{i=1}^{n} MMC_{t-1} + \alpha_2 \sum_{i=1}^{n} CPV_{t-1} + \alpha_3 \sum_{i=1}^{n} APO_{t-1} + ECT(1)_{t-1} \tag{3}$$

Table 1: Unit roots test result for environmental quality index (Model 3)

Variable	Level			First difference		
	ADF	PP	KPSS	ADF	PP	KPSS
EQI	0.3584	0.6549	0.2523	0.4169	0.1215	0.0459**
MMC^	0.1370	0.3069	0.1340	0.0000***	0.0000***	0.0769*
CPV^	0.1751	0.3401	0.1340	0.0000***	0.0000***	0.0464**
APO	0.1691	0.8053	0.1323	0.2914	0.2188	0.0852*

$$\Delta MMC_t = \alpha_0 + \alpha_1 \sum\nolimits_{i=1}^{n} EQI_{t-1} + \alpha_2 \sum\nolimits_{i=1}^{n} CPV_{t-1} + \alpha_3 \sum\nolimits_{i=1}^{n} APO_{t-1} + ECT(2)_{t-1} \quad (4)$$

$$\Delta CPV_t = \alpha_0 + \alpha_1 \sum\nolimits_{i=1}^{n} EQI_{t-1} + \alpha_2 \sum\nolimits_{i=1}^{n} MMC_{t-1} + \alpha_3 \sum\nolimits_{i=1}^{n} APO_{t-1} + ECT(3)_{t-1} \quad (5)$$

$$\Delta APO_t = \alpha_0 + \alpha_1 \sum\nolimits_{i=1}^{n} EQI_{t-1} + \alpha_2 \sum\nolimits_{i=1}^{n} MMC_{t-1} + \alpha_3 \sum\nolimits_{i=1}^{n} CPV_{t-1} + ECT(4)_{t-1} \quad (6)$$

As reinforcement for the bivariate and multivariate causality result in this study, an impulse response function (IRF) analysis is needed to see the shock of independent variables responded by the dependent variable. This is in line with the study conducted by Machpudin (2013) and Nasution (2015).

Estimating the *IRF* is to see the shock of the independent variable which is responded by the dependent variable. However, according to Majid and Mahrizal (2016) IRF measures the percentage of estimated variable errors which is explained by other variables, or in other words, the relative impact of one variable has on other variables. Whereas according to Khaliq (2015), variance decomposition (VD) is used to see the estimated error variance of a variable, which means to find how much the difference between the variance before and after the shock. Therefore, it can be concluded that the variance decomposition analysis is to determine the contribution of independent variables in explaining the dependent variable in the event of a shock.

4. RESULT AND DISCUSSION

4.1. Stationary Testing

The testing in this study begins with the unit root test to ensure that all the data in a stationary condition (Richi and Napitupulu, 2012). The unit root test in this study is Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Philips-Schmidt Shin (KPSS). All of the root test of this study performed by limiting the significance level to 1-10%. The unit root test results as seen in Table 1.

The result of root unit test using Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Philips-Schmidt Shin (KPSS) methods shows the Environmental Quality Index (EQI), marketing margin (MMC), volatility of global CPO prices (CPV) and the size of oil palm plantations are not stationary at level or I (0), so we do the first difference or I (1) in the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods whit the Environmental Quality Index (EQI) and the area size of oil palm plantations (APO) are not stationary. Furthermore, the unit root test using the Kwiatkowski-Philips-Schmidt Shin method (KPSS) shows the stationary of environmental quality index (EQI) and stationary CPO price volatility (CPV) at 5% alpha and marketing margin (MMC) and stationary oil palm plantation area (APO) at 10% alpha.

4.2. Determining Lag Length

Having testing the stationary data, the optimal lag length can be determined. Determining the optimum lag is one of the crucial steps in estimating VAR (Nugroho, 2012). The optimal lag length test aims to eliminate the problem of autocorrelation in the VAR system. This study uses likelihood ratio (LR), final prediction error (FPE), Akaike information criterion (AIC), Schwartz information criterion (SIC) and Hannan-Quinn information criterion (HQ) methods to determine the optimum lag length (Poetry and Sanrego, 2011).

Table 2: Criteria of length lagged variable environmental quality index (Model 1)

Lag	LR	FPE	AIC	SC	HQ
0	NA	1.31e+12	39.25609	39.35373	39.29570
1	345.3176*	6.75e+10*	36.28667*	36.77487*	36.48472*
2	22.84136	7.21e+10	36.35102	37.22979	36.70751
3	19.03011	7.94e+10	36.44512	37.71445	36.96005
4	24.10133	8.24e+10	36.47701	38.13691	37.15038
5	15.22087	9.37e+10	36.59618	38.64664	37.42799
6	19.12355	1.01e+11	36.66210	39.10312	37.65235
7	8.858763	1.24e+11	36.84236	39.67394	37.99105
8	12.66636	1.44e+11	36.96826	40.19040	38.27538

LR: Likelihood ratio, FPE: Final prediction error, AIC: Akaike information criterion, HQ: Hannan-quinn information criterion

Table 2 shows that in the third model with the criteria LR, FPE, AIC, SC and HQ on order 1 and automatically using the optimum lag which is lag 1. It means that all variables used in the third equation affect each variable in the same period but interrelated until one previous period. Then after the lag results from models 1, 2 and three are obtained, it can be forwarded to the following test, the cointegration test.

4.3. Cointegration Test

Cointegration test is to see the long-term equilibrium relationship between the non-stationary variables but has a fixed linear combination (Dirga et al., 2016). In this study, cointegration tests were carried out using the Johansen's cointegration method and the requirement for this test is the variables that will be tested should be the stationary variables in the same degree.

Table 3: Johansen cointegration test result

Trace				Maximum eigenvalue		
Ho	Trace statistic	Critical value	Probe**	Max-eig statistic	Critical value	Prob
r=0*	73.20638	47.85613	0.00000	32.43741	27.58434	0.01100
r≤1*	40.76898	29.79707	0.00190	21.62034	21.13162	0.04270
r≤2*	19.14864	15.49471	0.01340	12.82639	14.26460	0.08330
r≤3*	6.322249	3.841466	0.01190	6.322249	3.841466	0.01190

*is cointegrated

Table 3 shows that the model 1, 2 and 3 are cointegrated. The trace statistic value proves it and the maximum eigenvalue that greater than the critical value. This can be interpreted that the three models have a long-term equilibrium. Following the results of the cointegration test obtained, it can be concluded that the model 1, 2 and 3 are appropriate to use in the VECM model.

4.4. The Short and Long-terms Effect of Global CPO Prices, CPO Marketing Margin, Size of Palm Oil Plantation and Environmental Destruction

The results of the VECM estimation in short-term period shows that ECT is significant in value a 1%. It means that equation (19) is a valid model describing short-term dynamics. Later, there is an assumption of significant error correction parameter which verifies the adjustment mechanism from short-term to long-term period. The amount of adjustment from short-term to long-term period is 0.0208 which means the period required to return to equilibrium is 0.024 months or about 0.624 days or 14.98 h (assuming the amount in 1 month is 30 days).

According to Table 4, in the short-term period, the Environmental Quality Index in the previous period has a positive effect on the environmental quality index. The increase of environmental quality index by 1% in the previous period, will increase the environmental quality index for 0.7633%. Also, the global CPO price volatility variable in the previous period has a positive effect on environmental quality index. The increase of global CPO price in the previous period by the US $ 1 per metric ton, will increase the environmental quality index by 0.0005%. However, the size of the oil palm area has a significant negative effect on the environmental quality index. The increase of the area size by 1000 hectares, will reduce the environmental quality index by 1.90E-06. It means that increasing the expansion of oil palm plantations has resulted in forest destruction, land clearing by burning, increasing air pollution and disposal of oil palm waste to irrigation, increasing water pollution, thereby reducing the environmental quality index.

Table 4: The result of short-term estimation of environmental quality index (Model 3)

Variable	Coefficient	T- Statistics
EQI(−1)	0.763263***	17.1852
MMC^(−1)	8.23E-05	0.19957
CPV^(−1)	0.000490**	3.02165
APO(−1)	−1.90E-06*	−2.48369
ECT−EQI	−0.020837**	−4.82543

***,**,* Sig. at the level 1%, 5%, and 10%

Table 5: The long-term estimation result of the environmental quality index

Variable	Coefficient	T- statistics
MMC^	−0.016122*	−2.17165
CPV^	0.010635***	4.57641
APO	6.12E-07	2.11295

***,**,* Sig. at the level 1%, 5%, and 10%

In the long-term period, it indicates that between the variables of the environmental quality index, marketing margins, volatility in global CPO prices and the size of Indonesian oil palm plantations having a long-term equilibrium. It shows in the value of ECT_EQI value is negative and significant. The following are the results of long-term coefficient estimation.

Table 5 shows the long-term period Indonesia’s oil palm marketing margin has a significant negative effect on Indonesia’s environmental quality index. The increase in Indonesia’s palm oil marketing margin by IDR 1 per kilogram of CPO will reduce the environmental quality index by 0.0161%. In contrast to the volatility of global CPO prices, it has a positive effect on the environmental quality index. The increase the volatility of global CPO prices by the US $ 1 per metric ton, will increase Indonesia’s environmental quality index by 0.0106%. Positive influence by the long-term volatility of global CPO prices on the environmental quality index because Indonesian plantations have begun to be environmentally friendly and productivity levels have begun to increase following other producer countries (Agriculture, 2016). Moreover, many oil palm plantations are less well-maintained. Therefore it grows into a forest again.

The environmental quality index is an illustration of the efforts made by the government, the private sector and the public in exploring and utilizing natural resources for the efficient economic development while maintaining environmental balance (Kemenlkh, 2016). It is a concern to keep increasing the environmental quality index. The decreasing of the environmental quality index is an illustration of the occurrence of damage or pollution of water/air and forest area (BPS, 2017).

4.5. Bivariate Causality Relationship

The results of the bivariate causality test (Granger causality) illustrates that by using a 10% probability rate, the volatility of global CPO prices (CPV) have causality 1 with the Indonesian environmental quality index (EQI). It means that changes in global CPO prices will tend to increase production by expanding the area of oil palm plantations (Jean et al., 2019; Saswattecha et al., 2017; Susanti and Maryudi, 2016). The expansion of oil palm plantations decreases the environmental quality index and ultimately damages Indonesia’s environment (Table 6).

Table 6: The result of bivariate causality for environmental quality index

Hypotheses	F-statistic	Prob	Null hypothesis	F-statistic	Prob
MMC≠EQI	0.12357	0.8839	CPV=MMC	2.57251	0.0808
EQI≠MMC	0.02309	0.9772	MMC≠CPV	0.22339	0.8002
CPV=EQI	2.89395	0.0595	APO=MC	3.60894	0.0303
EQI≠CPV	1.42650	0.2445	MMC≠APO	0.80680	0.4489
APO≠EQI	0.61773	0.5410	APO≠CPV	0.09286	0.9114
EQI≠APO	0.05462	0.9469	CPV≠PO	0.35256	0.7037

= Has significant relation and ≠ no significant relation

Global CPO price volatility has a one-way causality relationship with marketing margins. It indicates that changes in global CPO price will affect changes in marketing margins. The response to the increase of global CPO prices volatility has pushed the price of Indonesian CPO exports and has an impact on the price of fresh palm oil fruit bunches (FFB). However, the problem is the increased price of Indonesian CPO exports, is not directly responded by the increase of FFB price. If there is an increased price of CPO exports, exporters do not directly increase the FFN price so the marketing margin which is gained by the exporter increases and vice versa. The size of oil palm plantations has a one-way causality relationship with marketing margins. It indicates that the expansion of oil palm plantation in the medium-term period will encourage an increase in CPO production.

4.6. Multivariate Causality Relations

The results of the multivariate causality test show that the size of oil palm plantations has a two-way causality relationship with marketing margins. It means that the size of oil palm is affected the marketing margin, and vice versa marketing margin affect the size of the oil palm area. The expansion of oil palm plantations is driving the production increase. The increase in production which is not offset by demand causes the prices lower. The lower prices cause the marketing margins obtained by exporters lower and affect the decline of the marketing margins the businessmen and oil palm farmers. The size of palm oil plantations has a one-way causality relationship with marketing margins. It indicates that the expansion of oil palm plantation is in the medium and long-term will increase CPO production (Table 7).

Table 7: The result of multivariate causality for environmental quality index

Variable	F-statistics				T-Statistics
	EQI	MMC^	CPV^	APO	
EQI	-	0.4441 (0.6425)	4.3357** (0.0154)	2.1708 (0.1190)	−0.0241*** (0.0002)
MMC^	0.4541 (0.6362)	-	0.7841 (0.4591)	4.4346 (0.0141)	−0.1214*** (0.0014)
CPV^	0.5109 (0.6014)	0.1522 (0.8590)	-	1.1925 (0.3074)	−0.0461* (0.0878)
APO	1.7578 (0.1773)	3.4266** (0.0360)	1.7578 (0.1773)	-	−0.0006 (0.2351)

***,**,* Sig. at the level 1%, 5%, and 10%

4.7. The Shocks of Global CPO Price, Marketing Margin and Size of Palm Oil Plantations on Environmental Quality Index

4.7.1. Impulse response

Figure 1 shows the impact of Indonesia Environmental Quality Index changes in a standard deviation concerning the marketing margins changes, using a 20-month of horizon time. In the 1st month, the environmental quality index has not affected the shock of marketing margin in a standard deviation. Then from the first period to the fourth period, the environmental quality index responds positively and also reaches equilibrium. Afterward, from the fourth period and so on the environmental quality index respond positively to marketing margins until it reaches the equilibrium.

Furthermore, the change of the Indonesian environmental quality index variable in a standard deviation on the changes of global CPO price volatility, using a 20-month time horizon, show, in the 1st month, the environmental quality index is not affected by the shock of global CPO price volatility in a standard deviation. Then from the first period onwards, the environmental quality index responds positively to the volatility of global CPO prices until it reaches equilibrium. Changes in Indonesia's environmental quality index amounted to a standard deviation of changes in the size of Indonesian oil palm plantations, using a 20-month time horizon, show, in the middle of the first period, the environmental quality index is not affected by the shock of Indonesia's oil palm plantation area by a standard deviation. Then from the middle of the first period

Figure 1: Impulse response function of environmental quality index

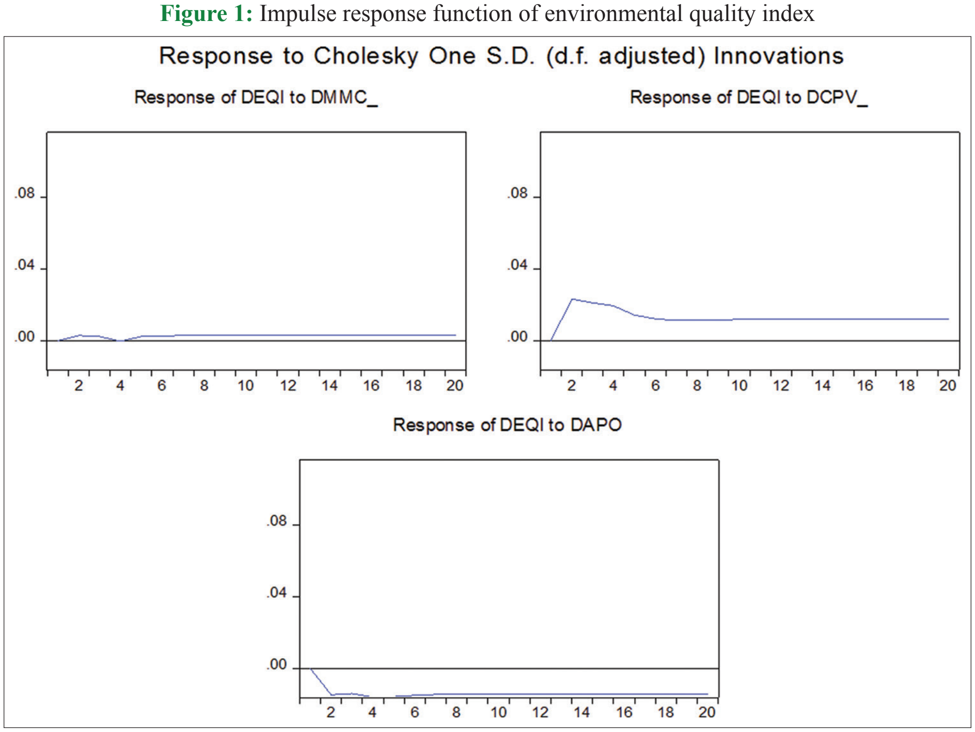

Table 8: Results of the variance decomposition for environmental quality index

Variable	EQI		MMC		CPV		APO	
EQI	(2)	97.02	(4)	0.68	(10)	9.82	(10)	0.03
MMC	(4)	0.03	(1)	99.98	(10)	4.70	(10)	1.05
CPV	(4)	2.83	(10)	7.16	(1)	96.69	(10)	6.49
APO	(10)	1.49	(10)	5.46	(10)	0.20	(1)	97.34

( ) = period with the highest value

onwards, the environmental quality index responds negatively to the size of Indonesian oil palm plantations until it reaches equilibrium.

4.7.2. Variance decomposition

Indonesia's environmental quality index itself explains Table 8 shows in the first period, Indonesia's environmental quality index by 100%. In the marketing margin variable shock, the environmental quality index variable explains itself by 97.02%. Whereas what is explained by MMC variables is 0.03%, CPV 2.83%, and APO 1.49%. It means that the environmental quality index variables itself predominantly explain the shock in marketing margins. Changes in Indonesian CPO production can explain the shock on marketing margins which is bigger than the global CPO price variable, 2.83%. It illustrates that there is a relationship between global CPO price and environmental quality index as explained in bivariate causality, multivariate causality, and impulse response function.

Furthermore, when there is a shock to the marketing margin, the contribution of the variable itself is more dominant, 99.98%; whereas, the EQI, CPV and APO variables describe 0.68%, 7.16%, and 5.46% respectively. Global CPO price variable and the area size is greater than the environmental quality index variable in explaining the shock of marketing margin. Similarly, when there is a shock in the area size, the contribution of the variable itself is more dominant at 97.34%; whereas, the EQI, MMC and CPV variables describe 0.03%, 1.05%, and 6.49% respectively. The global CPO price variable gives great contributions to explain the size of the Indonesia palm oil plantation variable. This means the response rate of global CPO prices is more pushing the shock towards the development of oil palm area.

5. CONCLUSION

The equilibrium in the short-term the environmental quality index and the global CPO price at one previous period has a positive influence on the environmental quality index, while the size of oil palm plantations on the previous period negatively affect the environmental quality index. Then in the long-term period, the marketing margin of Indonesian palm oil has a significant negative effect on Indonesia's environmental quality index, while the global CPO price has a positive effect on Indonesia's environmental quality index. (ii) The results of the bivariate causality test prove there is a one-way causality relationship between the environmental quality index and global CPO prices. Furthermore, the global CPO price and the land size have a one-way causality relationship with marketing margins.

The multivariate causality test results show the size of oil palm plantations has a two-way causality relationship with marketing margins. It means that the size of the oil palm area influences the marketing margin and conversely marketing margin affects the size of the oil palm area. The expansion of oil palm plantations is driving the production increase. The increase in production which is not matched with the demand causes the price decreases. The lower price reduces the marketing margin of the exporter, and it decreases the marketing margins of the entrepreneurs and the smallholders. The size of oil palm plantations has a one-way causality relationship with marketing margins. It indicates the expansion of oil palm plantation in the medium-term will encourage an increase in CPO production. (iii) The impulse response function and variance decomposition result explain that the environmental quality index shock gives a fluctuating response to changes in marketing margins. However, the always positive response is given by the environmental quality index in response to changes of global CPO prices variable while the changes of the size oil palm area is negatively responded by the environmental quality index.

The impact of environmental damage from the development of oil palm plantations is difficult to avoid, but it is minimized by environmentally friendly land clearing, natural use of pesticides and fertilizers, increased productivity with land intensification programs, and so forth. The government needs to manage the granting land permit to large oil palm plantation entrepreneurs who are more responsive and consistent in implementing environmental-based farming practices. Moreover, the Government also needs to encourage the development of smallholder oil palm plantations in the framework of developing people's economy. The oil palm entrepreneurs are not only using the benefits they get for technology development, but also provides a share of benefits as compensation to the community in the form of CSR funds. In this case the government as a policy actor must issue the regulations.

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