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The Spillover Effect of Shocks of Fundamental Factors and Speculative Activity on Prices Volatility of World Vegetable Oil

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ABSTRACT

This study is aimed to precisely measure the persistence and the spillover effect of shocks of fundamental factors and speculative activity on the volatility of world vegetable oil prices. This study is analyzed using GARCH and VAR Model substantially continued by Generalized Impulse Response Function and Forecast Error Variance Decomposition. This study uses monthly secondary data from January 2004 to June 2017. The main findings of this study indicate that there are the persistence of volatility in prices of palm oil, soybean oil and rapeseed oil and bidirectional volatility spillovers between vegetable oils. The study also finds the volatility of palm oil prices to become the largest transmitter of volatility in the prices of other vegetable oils. In the long term, it shows the magnitude of the effect of demand shocks especially GDP growth and speculative in relation hedging activity on reducing the prices volatility of vegetable oil.

Keywords: Price, Shock, Speculative, Vegetable Oil, Volatility
JEL Classifications: E30, F17, F40, Q02, Q17

1. INTRODUCTION

The pattern of trade in world vegetable oils has transformed over the past decade. The condition of vegetable oils market has also been more competitive as the share of palm oil in production and consumption in the world market has increased, making palm oil as the leader in the market for soybean, rapeseed and sunflower oils (Brummer et al., 2015). The development for diversification used of vegetable oils both for food and as raw materials for renewable energy (biofuels) has made the markets for vegetable oils more integrated globally, and as a result, there has been an increasing interdependence and volatility of vegetable oil prices (Priyati and Tyers, 2016).

Price volatility among vegetable oils products is different and has very complex dynamic structures accompanied by high levels of spillover when there is an increase in price volatility (Brummer et al., 2016). In the context of market integration, the phenomenon of shocks that occur in a market can be easily and quickly transmitted to other markets through trade relations and information flows. Efforts to understand the price volatility spillover that occur are essential as the market for vegetable oil is increasingly integrated. The initiative has been necessary because high price transmission is not necessarily marked as providing secondary effects or price shocks. However, increasing volatility results in the emergence of higher risks and uncertainties in the future (Trujillo-Barrera et al., 2012). When the leverage effect is detected, the negative shock effect will be higher than the impact of the positive shock in increasing price volatility (Black, 1976).

Price volatility is not a problem if the market could adjust quickly to any changes in supply and demand. However, extreme reactions to high volatility in the short term may not only represent market adjustments but could also lead to acts of speculation. Market signals become unclear due to speculative behavior so that it is difficult to distinguish the effects of fundamental factors on price volatility.

As the volatility of vegetable oil prices has increased, it has become a challenge to identify determinants of price volatility. The idea that the role of fundamental market factors such as supply and demand shocks of vegetable oil and macroeconomic factors are not the main factors determining the volatility of vegetable oil prices has reappeared recently. Tadesse et al. (2014) through their study have shown that fundamental elements could not sufficiently explain extreme volatility and surges in food prices in the 2007-2008 and 2010-2011 periods. The sentiment factors of speculator in the commodity futures market are believed to provide new dynamics in the vegetable oil market, which has a significant influence on the volatility of world vegetable oil prices. The study of Boonyanuphong and Sriboonchitta (2014) found that the role of financialization in commodity markets was the main factor that explained the latest surge in commodity prices. This condition was marked by the growth of the market for agricultural commodity derivatives on the market up to 29% during the period 2005-2010. Tadesse et al. (2014) found speculative behavior driven by price expectations played as a very important factor in volatility, especially in the food commodity futures market (Martin et al., 2017; De Schutter, 2010). The increase in trading activity in the futures exchange tends to push the movement of agricultural commodity prices away from the market fundamental factors (Masters and White, 2008; Boonyanuphong and Sriboonchitta, 2014). Other factors such as the development of biofuel production are also driving the increase in the volatility of world vegetable oil prices (Mitchel, 2008; Headey, 2011; Brummer et al., 2015).

According to the facts previously mentioned, this study aims to analyze the level of persistence and measure the spillover effect of fundamental factors and speculative activities on the volatility of world vegetable oil prices. Increasing price volatility could cause uncertainty in the market, and affect the economy, social and political countries of exporters and importers of vegetable oils. Meanwhile, for producers and market actors, high uncertainty can lead to higher risk management costs and adjustment costs that affect market prices and investment decisions (Bernhard, 2017). Therefore, it is necessary to understand the volatility of spillovers, specifically for policymakers who will design the policies.

2. LITERATURE REVIEW

The volatility of agricultural commodity prices has become the concern of policymakers and economists. Volatility is a measure of price variability around its trend that indicates the direction and how quickly prices change over time (Prakash, 2011; Tadesse et al., 2014). Most agricultural commodity markets are characterized by high levels of volatility accompanied by rollercoasters behaviors (Roache, 2010). In fact, the average price volatility does not differ significantly between the 1970 s and the late 2000 s, but the nature of volatility and its causes are different (Tadesse et al., 2014). Various studies mention the fundamental factors of markets as the main cause for rising in price volatility. The first factor causing an increase in volatility in agricultural commodity prices is the occurrence of supply and demand shocks that depend on climate change, weather, market conditions, business cycles and geopolitical situations (Lahiani et al., 2013; Huchet-Bourdon, 2011; Brummer et al., 2016). Another factor includes macroeconomic factors such as interest rates and money supply, trade policy, unpredictable market information and the spillover of the biofuel market to the food market (Brummer at al., 2016). The indicators of macroeconomic and oil prices are identified as important factors in price volatility (Enciso et al., 2016).

The innovation of biofuels and the financialization of commodity futures markets is the most controversial issue as a cause of increased food price volatility. Demand on biofuel as a source of new demand for agricultural commodities contributes to price volatility (Mitchell, 2008, Headey 2011). Michael Masters is a hedge fund manager leading of the claim that the spikes in commodity futures prices in 2007-2008 were mainly driven by long-only index investment. Master suggests that index investment make massive buying pressure, which in turn led to a bubble in commodity prices (Master and White, 2008). Discussing several empirical also justify that investments of agricultural futures exchange are one of the factors contributing to the permanent increase in food price volatility (Gilbert 2010, Robles et al., 2009; Boonyanuphong and Sriboonchitta, 2014). Manera et al. (2013) used GARCH models and found that speculation significantly affected the volatility of returns. Manera et al. (2013) further explained that short term speculation would cause a positive impact while long term speculation generally gave an negative effect significant on volatility for energy products (such as crude oil, heating oil, gasoline, and natural gas) and non-energy commodities such as cocoa, coffee, corn, oats, soybean oil, soybeans, and wheat over the period of 1986-2011.

However, some empirical literature were failed to find the evidence for the Masters' hypothesis (Gilbert and Morgan, 2010; Irwin et al., 2009). Some studies found the influence of index traders. Irwin and Sanders (2012) conclude that index trading is unrelated to the recent price peaks. This is similar to the study of Miffre and Brooks (2013) that investigated the role of long-short speculators and found the speculators have no significant impact on volatility or cross-market correlation on metals, energy futures, livestock futures, and agricultural futures markets. This result supported by Bohl and Stephan (2013) who mentioned that the financialization of commodity futures markets does not increase the volatility of spot returns. According to the several empirical studies, the impact of speculative activity are inconclusive to volatility.

The effect of spillover volatility among agricultural commodities also increases along with the development of biofuels and the existence of a substitution relationship between products and the financialization of commodity futures markets. Volatility spillover refers to a situation where the historical volatility of a particular market does not only affect its volatility at the moment but also has an impact on price volatility in the relevant market (Musunuru, 2014; Trujillo-Barrera et al., 2012). Several empirical studies show the existence of price volatility spillover in agricultural commodities in interrelated markets. The study of Apergis and Rezitis (2003) showed there are additional effects of their volatility and macroeconomic volatility which have a significant impact on food price volatility. Lahiani et al. (2013) found significant spillover effects in the markets for wheat, cotton, sugar, and corn. Trujillo-Barrera et al. (2012) showed a considerable volatility spillover from the crude oil market to the corn market which explained the magnitude of dependencies between markets triggered by ethanol production. Balcombe (2011) comprehensively showed that the volatility in a commodity could be a result of spillovers from other agricultural products, oil prices, and exchange rate volatility, stock and productivity levels that had a downward impact on volatility.

However, there are only a few studies that comprehensively discuss the determinants of volatility and the impacts of spillover volatility and shocks among major vegetable oils (except Brummer et al., 2015). Some results of the study concluded that there was an increase in the spillover volatility of vegetable oil prices after the global crisis (Sy et al., 2015; Namini and Hudson, 2017) with palm oil and soybean oil being the market leader for rapeseed oil and sunflower oil (Brummer et al., 2015). The study of Rahman et al. (2007) and Songsiengchai et al. (2018) also clarified the existence of uncertainty and spillover volatility between domestic palm oil prices and world vegetable oil prices. The primary determinant factors of volatility in vegetable oil prices include exchange rate volatility and oil price volatility (Brummer et al., 2015; Namini and Hudson, 2017). Khin et al. (2014) also mentioned the increasing stock and production as other factors that contribute to the high volatility of palm oil prices.

3. RESEARCH METHODS

The data used in this study are monthly time series data from January 2004 to June 2017. The data used comes from Oil World, United States Department of Agriculture, Commodity Future Trading Commission, Benhard Malaysia Derivatives, International Monetary Fund (IMF), and The FED, Federal Reserve Bank of St Louis.

The volatility of vegetable oil prices is analyzed using the GARCH model. As the first step, the stationary test using Augmented Dickey-Fuller (ADF) is required to identify the stationary of the data. The next step is to determine the best ARIMA model as the mean model in the GARCH model. The best GARCH model is selected based on the smallest Akaike Information Criterion (AIC) value, and it does not contain the ARCH (Lagrange Multiplier Test) effect. The GARCH (l, k) model used in this study is based on Bollerslev (1986) and can be formulated as follows:

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \quad (1)$$

σ_t^2 = Conditional variance
ω=Mean conditional variance
ε_{t-i}^2 = Lag squared residual
σ_{t-j}^2 = Lag conditional variance

The spillover effect of shocks from fundamental factors and speculative activity to the volatility of vegetable oil prices is analyzed further using the VAR-based on the estimation results from GARCH (p,q) model. Similar to the previous analysis, the first step in this analysis is to test the stationary of the data. Afterward, it is required to identify the optimal lag based on the smallest value of the AIC and Schwarz Information Criterion (SC). The smaller the value of the criteria, the expected value generated by a model will be closer to reality. The stability test is then carried out to determine whether the VAR model estimated has stability. The VAR system is stable when the roots of characteristic polynomial values have modulus values less than one and all are located in unit circles. The stability test is necessary since it will affect the stability of the results of the Generalized Impulse Response Function (GIRF) and Forecast Error Variance Decomposition (FEVD). The VAR model in this study could be written as follows:

$$\begin{aligned}\sigma VO_t = \beta_o &+ \sum_{i=1}^{p}\beta_1\sigma VO_{t-i} + \sum_{i=1}^{p}\beta_2 SVO_{t-i} + \sum_{i=1}^{p}\beta_3 PVO_{t-i} + \\ &\sum_{i=1}^{p}\beta_4 XCPO_{t-i} + \sum_{i=1}^{p}\beta_5 XSBO_{t-i} + \sum_{i=1}^{p}\beta_6\sigma CO_{t-i} + \\ &\sum_{i=1}^{p}\beta_7 BIO_{t-i} + \sum_{i=1}^{p}\beta_8 ELNO_{t-i} + \sum_{i=1}^{p}\beta_9 GGDP_{t-i} + \\ &\sum_{i=1}^{p}\beta_{10} CPI_{t-i} + \sum_{i=1}^{p}\beta_{11} USDSP_{t-i} + \sum_{i=1}^{p}\beta_{12} FCPO_{t-i} + \\ &\sum_{i=1}^{p}\beta_{13} FSBO_{t-i} + \sum_{i=1}^{p}\beta_{14} IR_{t-i} + \varepsilon_{it}\end{aligned}$$

σVO_t=The volatility of vegetable oil prices includes palm oil (Indonesia (CPOI), Malaysia (CPOM), Rotterdam (CPOR)), USA's soybean oil (SBO), Rotterdam's Rapeseed oil (RPO) and USA's sunflower oil (SFO) in the period of t
σVO_{t-i}= The volatility of world vegetable oil prices in the period of t-i
SVO_{t-i}= The increasing stocks of world vegetable oil in the period of t-i
PVO_{t-i}= The increasing production of world vegetable oils in the periods of t-i
$XCPO_{t-i}$= The increasing export of world palm oil in the period of t-i
$XSBO_{t-i}$=The increasing export of world soybean oil in the period of t-i
σCO_{t-i}= The volatility of world crude oil prices in the period of t-i
BIO_{t-i}= The growth of biodiesel production in the period of t-i
$ELNO_{t-i}$= The Elnino index in the period of t-i
$GGDP_{t-i}$=The growth of GDP of G20 countries in the period of t-i
CPI_{t-i}= The growth of CPI in the urban level in the period of t-i
USD_{t-i}= The growth of the USA Dollar Index in the period of t-i
$FCPO_{t-i}$= The speculator Index for Palm Oil in the period of t-i
$FSBO_{t-i}$= The speculator Index for Soybean Oil in the period of t-i
IR_{t-i}= The growth of interest rate of USA Treasury Bill in the period of t-i

ε_{it}= Error and i= 1,2…,k
i= The length of lag and i=1,2,…k

The GIRF is conducted to identify the effects of shocks by analyzing the positive or negative responsiveness of price volatility of vegetable oils. The GIRF could also use to understand the impact of shocks of fundamental factors and increase speculative activity in the futures market. Meanwhile, a FEVD analysis is useful to explain the contribution of every shock of vegetable oil price volatility as well as fundamental factors and speculators measured over the next 15 periods.

4. RESULTS AND DISCUSSION

4.1. Development of Production, Consumption, Import, Export and Ending Stocks of Vegetable Oil

Palm oil, soybean oil, rapeseed oil, and sunflower oil are the four main oils produced and consumed and traded in the vegetable oil market (Purba et al., 2018). In 2008-2017, the volume of production, imports, exports, consumption and ending stocks of major vegetable oils had a steady increase from year to year. The increasing production of vegetable oil is caused by the rising global demand along with the expanding world population, especially India and China (Mielke, 2015). Table 1 illustrates the growth of production of world vegetable oil which is higher compared to its consumption in the period 2008-2017 specifically for palm oil and soybeans. On the contrary, the growth of consumption of rapeseed oil and sunflower oil groups is higher than its production.

Meanwhile, the exports and imports of rapeseed oil and sunflower oil are quite higher compared to palm oil. The growth of soybean oil exports and imports are the lowest compared to other vegetable oils. These growths of production and consumption as well as exports and imports could lead to increasingly intense competition between vegetable oils, and these could lead to rising fluctuations in vegetable oil prices. The four vegetable oils are mutually substituted, and thus, the price of a vegetable oil commodity will influence other products (Buyung et al., 2017). Therefore, an increase in the price of one of the vegetable oil commodities will substantially raise the demand for other vegetable oils.

4.2. The Price Volatility Analysis of Vegetable Oils

The estimation results in Table 2 show that the GARCH (1,1) model is the best model of vegetable oil price volatility. GARCH (1,1) is chosen since it has the minimum AIC value, maximum Log likelihood value, and it does not have autocorrelation (Ljung Box Test) and heteroscedasticity (ARCH Effect). According to Cermak et al. (2017), the GARCH (1,1) model has the ability to capture the main characteristics of commodity markets, especially the leptokurtic distribution and the volatility of clustering. This is supported by the study of Hassanov and Shitan (2014) who also used GARCH (1,1) to describe the dynamics of the volatility of palm oil prices.

According to Table 2, the value of the ARCH (α) parameter estimated is positive. This means the information about volatility from the previous period could explain the current volatility. The results of this study also show that vegetable oil prices respond significantly to any new information. Rapid changes in the volatility of vegetable oil prices based on new information could be considered an indication of the efficient dissemination of information on the vegetable oil market. The ARCH parameter value for the price of rapeseed oil and palm oil in Malaysian are higher compared to those of soybean oil and sunflower oil. These results indicate the volatility of prices of rapeseed oil and palm oil

Table 1: Development of production, consumption, import, export and ending stocks of vegetable oil

Vegetable oil	Volume (000 ton)										Growth (%)
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2008-2017
Palm oil											
Production	43.43	45.27	45.83	50.82	53.88	56.47	59.93	62.94	59.24	67.92	5.09
Import	33.74	36.28	37.20	38.66	41.38	44.15	44.39	47.82	44.05	49.18	4.28
Export	33.75	36.23	36.52	39.11	40.81	43.94	44.44	48.27	43.91	49.48	4.34
Consumption	42.41	45.39	46.41	48.79	52.40	57.75	59.28	60.84	62.76	65.41	4.93
Ending stock	7.18	7.16	7.38	9.61	11.78	10.68	11.79	13.46	10.08	12.28	6.15
Soybean oil											
Production	36.84	36.10	40.23	41.54	41.81	42.79	45.17	49.24	51.98	53.94	4.33
Import	10.73	9.25	9.87	9.50	9.25	9.46	9.87	12.24	12.14	11.45	0.73
Export	10.09	9.31	10.19	9.32	9.34	9.63	9.83	12.59	12.08	11.26	1.22
Consumption	37.84	35.86	39.17	42.09	41.67	42.96	45.30	47.95	52.21	53.87	4.00
Ending stock	4.03	4.22	4.93	4.55	4.61	4.29	4.27	5.22	5.04	5.31	3.11
Rapeseed oil											
Production	19.97	21.74	23.96	24.10	24.83	25.50	27.00	26.21	25.31	25.32	2.67
Import	2.37	2.67	3.33	3.71	4.12	4.17	3.99	4.14	4.43	4.50	7.38
Export	2.36	2.58	3.44	3.74	4.08	4.14	4.02	4.22	4.37	4.57	7.61
Consumption	19.82	21.17	23.59	24.10	24.20	24.51	26.27	26.83	26.96	26.11	3.11
Ending stock	1.41	2.21	2.46	2.66	3.35	4.99	6.77	6.07	4.47	3.61	11.02
Sunflower oil											
Production	10.88	13.05	12.51	13.06	15.05	13.96	16.21	15.27	16.51	19.01	6.39
Import	3.88	5.14	4.83	5.42	7.35	6.45	8.17	7.45	8.82	10.56	11.76
Export	4.07	5.18	4.77	5.46	7.31	6.60	8.10	7.51	8.98	10.54	11.15
Consumption	10.53	12.62	12.79	12.85	14.57	14.12	16.04	15.16	16.28	18.58	6.52
Ending stock	1.35	1.78	1.59	1.85	2.40	2.09	2.35	2.48	2.55	3.00	9.26

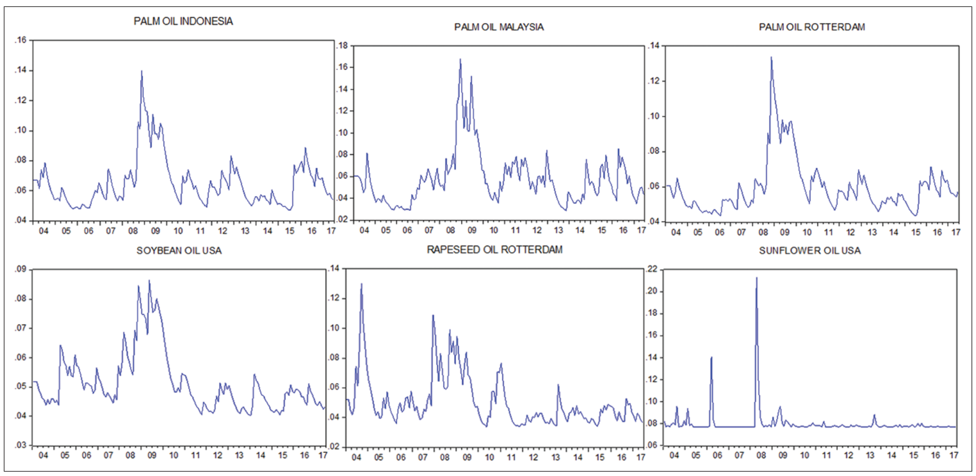
Source: Oil world (various years, processed)

Table 2: The estimation results of price volatility model of vegetable oils

Model	CPOI	CPOM	CPOR	SBO	RPO	SFO
ARMA (p, q)	(3,2)	(3,3)	(3,2)	(3,3)	(1,2)	(1,1)
GARCH (l, k)	(1,1)	(1,1)	(1,1)	(1,1)	(1,1)	(1,1)
Omega	0.0005	0.0003	0.0004	0.0002	0.0004	0.0059
	[0.0864]	[0.1503]	[0.2165]	[0.2381]	[0.0332]	[0.0388]
Alpha1	0.1520*	0.2003*	0.1344*	0.1006	0.2696*	0.0917*
	[0.0311]	[0.0076]	[0.0526]	[0.1283]	[0.0316]	[0.0920]
Beta1	0.7228*	0.7248*	0.7710*	0.8126*	0.6056*	0.0000
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[1.0000]
AIC	−2.5511	−2.8425	−2.7434	−3.0199	−3.1142	−2.1505
Log likelihood	216.6427	241.2395	232.2179	255.6123	260.2538	181.1868
Ljung-box	0.4148	0.3209	0.3923	0.2411	0.4606	0.8920
LM test	0.8438	0.7312	0.8303	0.5809	0.6865	0.8585
Persistence	0.8748	0.9250	0.9054	0.9132	0.8752	0.0917
Length (month)	5.1	8.8	6.9	7.6	5.2	0.3

Source: Processed data, *significant at 10% level; […]=Probability

Figure 1: Conditional volatility of world vegetable oil on January 2004-June 2017



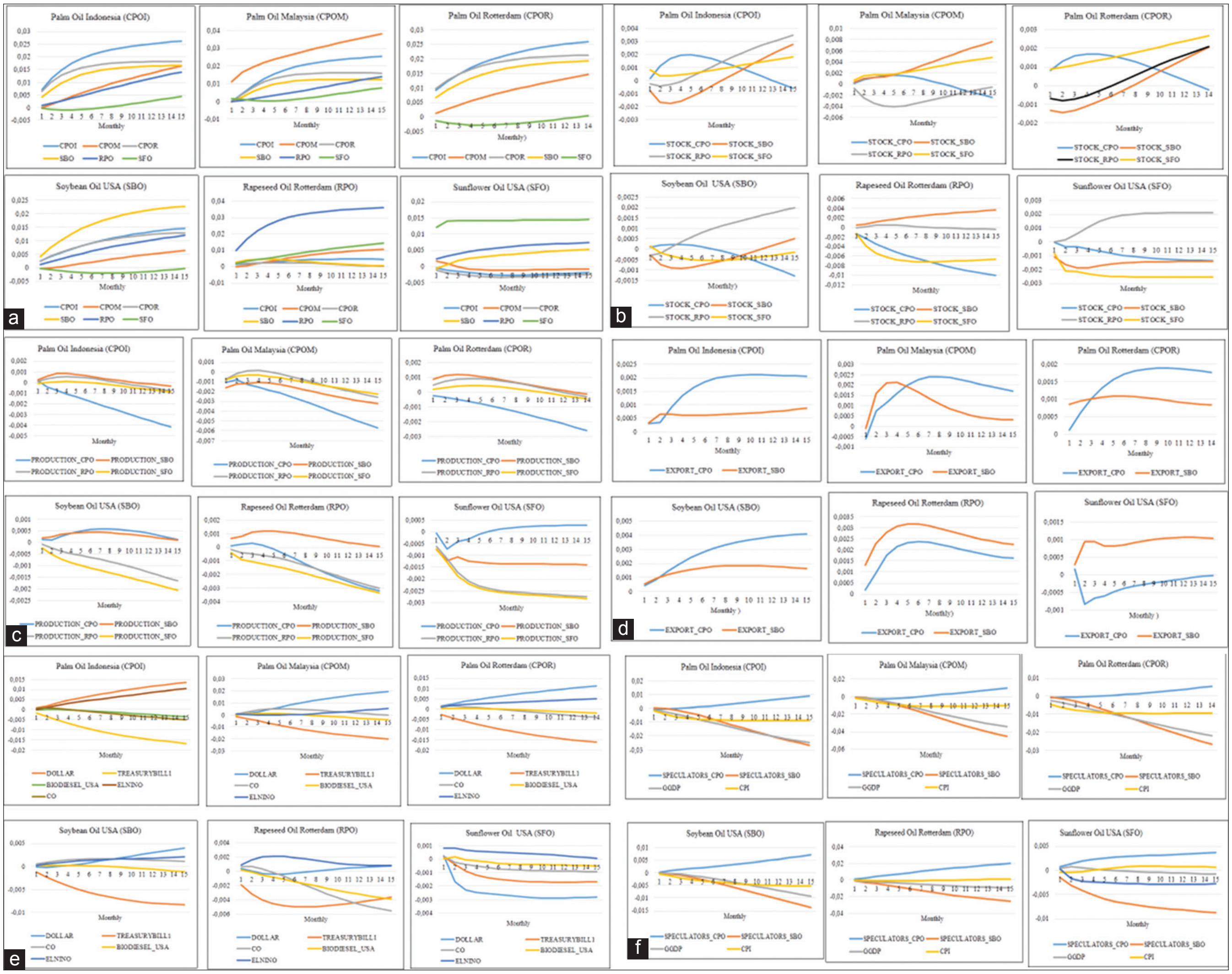
are more sensitive and vulnerable to news shocks in the previous period. The low ARCH coefficient value means when the market has a rising stock condition, it will only influence volatility in the future with relatively small. The GARCH (β) coefficient is significantly positive with high value indicates the current volatility is affected by past fluctuations and has a high level of variability (time-varying). The volatility of agricultural products varies from one market to another since its related to the elasticity of supply and demand and also its sensitivity to speculations made to predict the future price.

The volatility of vegetable oil prices is persistent. The persistence of volatility is indicated by $\alpha + \beta \leq 1$. The sum of α and β less than one also shows the near long memory. In other words, any shocks will cause permanent changes in the long run. The persistence of volatility because of shocks could last from 5 to 9 months. The price volatility of sunflower oil is less persistent, and it will last between 0.09 and 0.3 months. Indonesia's palm oil price volatility has relatively lower persistence in 5 months compared to the volatility of palm oil prices from Malaysian and Rotterdam as well as soybean oil. This study supports the findings of Busse et al. (2010) which showed the prices of rapeseed oil and soybean oil that had a high sensitivity to shocks and persistence, and thus, those commodities were vulnerable to high risk due to excessive reactions in the volatile phase. High persistence indicates the shocks that will last for a long time. The persistence of volatility will cause difficulties in obtaining the right price signal from fundamental factors. The problems in finding the right price signal could enhance the speculative actions. As a result, it could cause the higher costs to manage risks for production activities, difficulties in the process of obtaining the right prices and ultimately could affect food costs in domestic and world markets (Trujillo-Barrera et al., 2012).

The volatility of vegetable oil prices is presented in Figure 1. Figure 1 illustrates the various movements in the price volatility of vegetable oils. First, there is a similar pattern occurred every year when there is an increase in the production and stocks for all groups of vegetable oils. Second, in 2008, the volatility movement is higher than the previous price volatility. In mid-2008, the overall volatility of vegetable oil prices is very high. As can be seen from Figure 1, higher volatility periods began in 2006. In this case, the increasing price volatility of vegetable oil market is aligned with the increase in crude oil prices which drive demand for raw materials for biofuels based on rapeseed, soybean, sunflower and palm oil groups.

The volatility has reached its maximum height between 2007 and 2008. It is rational since the 2008-2009 period was characterized by the global financial crisis in the market and a period of high

Figure 2: Results of generalized impulse response function on price volatility vegetable oil, (a) Response volatility between vegetable oil market, (b) response volatility to increasing stock (c) response volatility to increasing production, (d) response volatility to increasing palm oil and soybean oil export, (e) response volatility to dollar to index, biodiesel production, volatility crude oil, treasury bill, index elnino, (f) response volatility to speculative activity, growth GDP and CPI



volatility. This phenomenon eventually led to the highest volatility in vegetable oil prices in history. Recovery of financial and commodity markets occurred in the second half of 2009 which was marked by a decline in volatility during this period. At the same time, quantitative easing began in the United States and other countries (Klotz et al., 2014). At the end of 2015, there was also an increase in volatility because of shock from Elnino weather, resulting in a reduction in the supply of palm oil and causing volatility in the prices of vegetable oils, especially palm oil. Hence, the impact of disruption to volatility differs among the vegetable oil markets. Volatility indicates the magnitude of the risks and uncertainties faced by the vegetable oil market, especially the palm oil market. Therefore, it is necessary to observe fluctuations of vegetable oil prices and its shocks and further analyze factors that influence the persistent volatility of vegetable oil prices.

4.3. The Impact of Fundamental Factors and Speculation Shocks to Price Volatility of Vegetable Oils

According to the estimation results of the ADF test, all variables used in the model are stationary at the level. After the stability model has been tested, the VAR model is used in the GIRF and FEVD tests in Figures 2 and 3. The results of the GIRF analysis, as shown in Figure 2a, show there are bidirectional spillovers of price volatility in the vegetable oil market with positive effects that tend to increase in the long run. The results of this study have justified the role of shocks in the palm oil market. The shocks will immediately be responded and affect the volatility of the price of soybean oil, rapeseed oil and sunflower oil. The results of this study are similar to Brummer et al. (2015) who found the spillover effect of price volatility from palm oil and soybean oil to rapeseed oil. Rahman et al. (2007) also proved that there was volatility spillover between domestic palm oil prices and world vegetable oil prices. However, in the short-term, the shocks of price volatility of Malaysian palm oil and sunflower oil are responded negatively by the volatility of prices of Indonesian and Rotterdam palm oil and soybean oil.

Meanwhile, rapeseed oil only reacts negatively to the shock of volatility in Malaysian palm oil prices. The volatility of Malaysian palm oil prices responds negatively to the shock of volatility in the prices of Indonesian and Rotterdam palm oil, soybeans, rapeseeds oils, and responds positively to the shock of price volatility of sunflower oil in the short term. Sunflower oil has a slightly different response compared to other vegetable oils. In the short-run, the volatility of sunflower oil responds positively to the shock of volatility in prices of Malaysian palm oil and rapeseed oil and responds oppositely to the shock of volatility in Indonesian and Rotterdam palm oil prices. In the long-run, the volatility of sunflower oil prices responds negatively to palm oil prices' shocks but responds positively to volatility in the prices of soybean oil and rapeseed oil.

The shock of increasing world palm oil stocks has a positive effect on the volatility of palm oil and soybean prices. On the other hand, the shocks have a negative impact on rapeseed and sunflower oils in the short term in Figure 2b. The results are different from the findings of Pietola et al. (2010) who found a significant negative relationship between price volatility and increased stock in the case of US wheat in the short term. Overall, in the long-run, the shocks because of the increasing palm oil stocks will be responded negatively by all groups of vegetable oils. These results imply that an increase in palm oil stocks can reduce the volatility of prices in vegetable oils. The rthe ising stock of soybean, rapeseed and sunflower oils, in the long run, will increase the price volatility of its substitute products. These results confirm the study of Stigler and Prakash (2011), Pietola et al. (2010), and Wright (2011) which stated that the decline in stocks in the long-run would increase price volatility. The inverse relationships between stocks and volatility happen since the price volatility of storable commodities occurs when the prices are high.

In the long run, the shock of increasing vegetable oil production also has a negative impact on the volatility of vegetable oils except for the volatility of sunflower oil prices in Figure 2c. The shock of an increase in world exports of palm oil and soybean oil will positively affect or increase the volatility of all vegetable oil prices both in the short-run or in the long-term in Figure 2d. In the case of palm oil, Rahman et al. (2007) justified the relationships between the increase in palm oil exports and price volatility. The increasing palm oil exports would increase domestic prices which subsequently led to the rise in price volatility (Rahman et al., 2007).

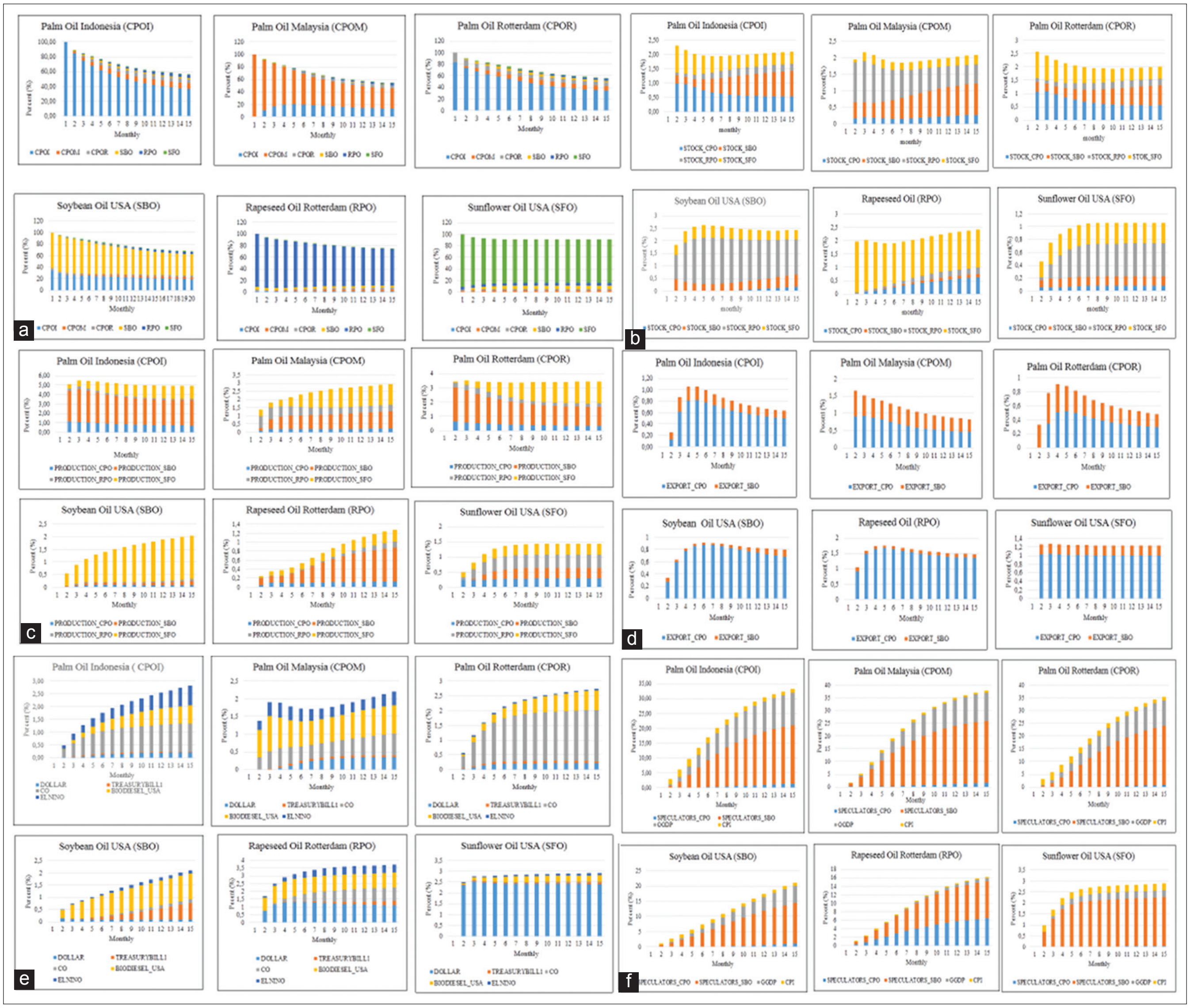
The shocks in the volatility of crude oil prices will be responded negatively in the short-term and positively in the long run except for the volatility of soybean oil prices. Similar results have been found by Balcombe (2011), Alom et al. (2010), Rude and An (2015) who showed a positive spillover effect from the crude oil market to the food market. Nazlioglu et al. (2013) further justified the transmission of volatility between crude oil prices and agricultural commodities, ultimately in the post-crisis period. The effect of volatility spillover increases from the crude oil market to biofuel markets such as rapeseed and soybeans (Kristoufek et al., 2012). The study of Peri and Baldi (2010) also added that there was a cointegration relationship between the prices of rapeseed oil and biodiesel and there was no cointegration relationship between crude oil and soybean oil as well as sunflower oil. This is similar to the study of Chang and Su (2010). According to the study, the substitution effects could be seen clearly in the periods of high crude oil prices where the spillover effects happened from crude oil prices to corn and soybeans in the futures market.

The interdependence relationship between the agricultural and energy markets is increasing along with the emergence of bioenergy-related policies. Zhang et al. (2009) and Serra et al. (2011) had found the evidence of price volatility interactions between the food market and biofuels. The study has supported the results of this study which illustrate the negative response of volatility of all vegetable oil prices because of the increase in biodiesel production. The policies related to bioenergy such as biofuels strengthen the relationship between the energy and agricultural market. Biodiesel policies in the EU (Busse et al., 2012) and bioethanol policies in the USA and Brazil have made the price formation process between the energy and agricultural market interrelated in complex ways and often depend on the regime. However, Timmer (2010) reminds that in a long-term perspective, the policy of developing biofuels will increase the price volatility of the related commodities if the policy instruments used are not flexible. Meanwhile, the shocks because of el-Nino will positively influence the volatility of vegetable oil prices and will be stable in the long-run. The results are different to the study of Ubilava and Holt (2013) that found an adverse effect of el-Nino on the volatility of soybean prices, while the la- nina had an opposite effect to the price volatility.

GDP and CPI growth as the proxy of global demand growth variable has been shown to reduce the volatility of vegetable oil prices which are characterized by negative responses in the long-term. This is supported by the study of Tadesse et al. (2014) that found the greater marginal effect of GDP growth on food price volatility compared to the impact of speculation and supply shocks. Roache (2010) also found that an increase in US inflation would be followed by a decrease in the price volatility of palm oil, rice, soybeans, and wheat. Meanwhile, the effect of the appreciation of the US Dollar exchange rate will increase the volatility of prices of palm oil and rapeseed oil. The study of Brummer et al. (2015) also showed that the volatility of the US dollar had a positive impact on the price volatility of palm oil, sunflower oil, and soybean oil. Roache (2010) mentioned the exchange rate as a determining factor in increasing food price volatility since the 1990s. In opposite, the shock of changes in US Treasury interest rates has been negatively responded by the vegetable oil group in the long-run. Hayo et al. (2011) further explain that the impact of US monetary policy such as changes in interest rates will reduce the price volatility of agricultural commodities. Karali and Power (2013) described that in the long-run, the interest rate had a negative impact on price volatility in the US commodity futures market for corn and crude oil, and the more significant negative effect specifically occurred on crude oil.

The speculator activity in hedging the futures market for soybean oil influences negatively the volatility of all vegetable oil prices in the long-run. The results of this study are supported by Brunetti et al. (2016). According to the study, the speculators did not cause price changes but instead reduced market volatility and increased market liquidity. Speculative activity concerning hedging activity can contain information about changes in futures volatility (Martin

Figure 3: Results of forecast error variance decomposition on price volatility vegetable oil, (a) Forecast error variance decomposition volatility between vegetable oil, (b) Forecast error variance decomposition volatility to increasing stock (c) Forecast error variance decomposition volatility to increasing production, (d) Forecast error variance decomposition volatility to increasing export, (e) Forecast error variance decomposition volatility to index dollar, cude oil volatility, treasury, biodiesel production and index elinino, (f) Forecast error variance decomposition volatility to speculative activity, growth GDP and CPI



et al., 2017). The negative impact of financialization as a proxy variable of speculation to price volatility is similar to the results of many studies on the same topics. There has been an increasing number of references that justified the ability of financialization in reducing volatility, and it subsequently gave stabilization impact on speculative activities (Brummer et al., 2016), especially when commodities have become financial assets attracting diverse types of speculators (Kim, 2015). Nevertheless, the speculation ratio in the futures market for palm oil influences the volatility of all vegetable oil positively. In line with the results of Manera et al. (2013) and Martin et al. (2017) which shows that the positive influence of the speculation ratio on the agricultural's future market in the US and China.

The estimation results of FEVD could be seen in Figure 3. Figure 3a illustrates the contribution of the volatility of the commodities itself and the relationships of volatility between vegetable oil commodities. The illustration has explained the variations of volatility in the short-term. The study emphasizes the vital role of palm oil price volatility in explaining the volatility of vegetable oil prices. The volatility of Indonesia's palm oil prices contributed significantly to the volatility of Malaysian's and Rotterdam's palm oil prices as well as soybean. The results are in accordance with the findings of Brummer et al. (2015) that the volatility of palm oil prices had the most significant impact on price volatility in other vegetable oil markets.

Fundamental factors such as increasing stock, production and exports have less contribution to the volatility of vegetable oil prices in Figure 3b and c. Tadesse et al., (2014) also found that the stock-to-use ratio was not significant in explaining food price volatility. However, increasing soybean oil production contributes significantly to the volatility of Indonesian palm oil prices. This indicates the considerable influence of the market for soybean oil on the volatility of Indonesian palm oil prices. Rude and An (2015) showed that stock management practices could act as a tool to minimize price volatility. The contribution of el-Nino shocks is higher to the volatility of palm oil prices than other vegetable oils. Rude and An (2015) have similar results that justified the increasing price volatility because of weather events, especially for wheat and rice.

The volatility of crude oil prices has less influence on the volatility of vegetable oil prices in Figure 3e. This is supported by the study of Namini and Hudson (2017) that proved the insignificant effect of the volatility of crude oil prices to the price of agricultural commodities in the post-crisis period. Meanwhile, Busse et al. (2010) explained the response of rapeseed prices to the price of crude oil, and thus, it became an indication of spillover because of investor behavior in the crude oil market. The behavior might be mainly influenced by expectations about the biodiesel production policy. Crude oil prices determine the profitability of biofuels. Any increase (or decrease) in crude oil prices will increase (decrease) the competitiveness of biofuels leading to an increase (decrease) in demand for rapeseed as the primary biofuel input. Therefore, there is a spillover effect from the price volatility of crude oil to the volatility of rapeseed prices because prices will adjust to any changes of expectations in crude oil prices.

Meanwhile, the increasing production of biodiesel still contributes less to the volatility of vegetable oil prices. However, Busse et al. (2012) found the strong influence of biodiesel prices on the formation of rapeseed oil prices. The unsteady relationship between biodiesel and palm oil has proved that the palm oil boom is more driven by demand from the food market than the energy market (Sanders et al., 2014).

The increase in the CPI and US Treasury interest rate index also has a small contribution in explaining the volatility of vegetable oil prices. This is similar to the findings of Namini and Hudson (2017). According to them, the inflation rate would affect the variation in prices of agricultural commodities in the short term. The appreciation of the US dollar does not influence much the volatility of vegetable oils. The same results are also shown by Namini and Hudson (2017). According to the study of Namini and Hudson (2017), the volatility of the US dollar did not affect the volatility of agricultural prices. In the long run, the contribution of GDP growth as a proxy for demand has a considerable contribution to the volatility of vegetable oil prices. The increase in demand for food in developed and emerging countries is considered as the main driver of food price volatility (Mcphail, 2012). This study also supports the study of Tadesse et al. (2014) that explained the higher impact of demand-side shocks (the growth of oil price and GDP) to price volatility compared to the market side and supply shocks. Apergis and Rezitis (2003) also affirmed the idea by finding the strong influence of demand factors to the volatility of output prices compared to the cost factors.

The speculative activity either for soybean oil or palm oil can explain the volatility of vegetable oil from the start of the second period and continue to increase until the end of the period (15 periods) in Figure 3f. The activities of soybean oil speculator can explain 19-24% of the volatility of palm oil, while 14.5%, 8.73%, and 2.22% respectively for the price volatility of soybean, rapeseeds and sunflowers oils in 15 periods. On the other hand, the role of speculator activities in palm oil market only contributes small in the range of 1-2%, and it explains the price volatility of palm, soybeans and sunflowers oils until 15 periods. The contribution of increasing activities of speculator until 6.46% in the palm oil market could explain the variability in the volatility of rapeseed prices. The results have been supported by the study of McPhail et al. (2012) that confirmed the activity of speculator as the significant factor in increasing the variation in corn prices. Commodities traded in thin market are a leading indicator of the more prominent role of speculation in influencing the prices of wheat, rice, corn, and soybeans. The impact of speculative trading on thin markets could produce wrong trends that cause a higher price on the consumer side (Robles et al., 2009).

5. CONCLUSION

This study aims to analyze the persistence and spillover effect of shocks of fundamental factors and speculators on the volatility of vegetable oil prices. The findings show that the GARCH (1,1) model is the best model in predicting the volatility of vegetable oil prices in the short term. The price of vegetable oil is volatile and persistent in the long run, especially for the group of palm oil, soybeans and rapeseed. Other findings indicate that the volatility of spillover between vegetable oils is unidirectional and has a positive effect that is increasing in the long term. The results of the analysis have proven that demand and supply shocks, as well as speculation, are essential factors in explaining the volatility of vegetable oil prices. Fundamental factors such as increased stock, production and exports contribute weakly to explaining the volatility of vegetable oil prices. However, increasing soybean oil production adds significantly to the volatility of Indonesian palm oil prices. In the long run, GDP growth as a proxy for demand contributes considerably to reducing the volatility of vegetable oil prices. Meanwhile, the contribution of speculator activities in soybean oil and palm oil can explain the volatility of vegetable oils from the second period and continue to increase until the end of the period. However, the speculator activities have less contribution in the palm oil market compared to other vegetable oil markets.

Therefore, it is recommended to have risk management (hedging) in futures trading activities and maintain stock capacity as part of the strategy in the trade of vegetable oil and the development of biodiesel to reduce the price volatility. It is crucial for Indonesia and Malaysia as the largest producers and exporters of palm oil in the world vegetable oil market to increase the competitiveness of palm oil management from upstream to downstream by strengthening the industry and market for oleochemical, oleofood and biodiesel to stabilize vegetable oil prices. It is also recommended to consider macroeconomic variables such as the exchange rate, GDP growth, CPI, interest rates and the volatility of world crude oil prices in designing and formulating price stabilization policies for vegetable oil.

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REFERENCES

Alom, F., Ward, D., Hu, B. (2010), Cross country mean and colatility spillover effects of food prices: Evidence for Asia and Pacific. International Review of Business Research Papers, 6(5), 334-355.

Apergis, N., Rezitis, A. (2003), Food price volatility and macroeconomic factor volatility: Heat waves or meteor showers? Applied Economics Letters, 10, 55-160.

Balcombe, K. (2011), The nature and determinants of volatility in agricultural prices: An empirical study. In: Prakash, A., editor. Safeguarding Food Security in Volatile Global Markets. Rome: FAO. p85-106.

Bernhardt, M. (2017), Dynamic Volatility Behaviour in Agricultural Commodity Markets: Evidence From VIRF Analysis And Spillover Index Calculations, Working Papers in Economics, No. 2017-02. University of Salzburg, Department of Social Sciences and Economics, Salzburg.

Black, F. (1976), Studies in stock price volatility changes of the nominal excess return on stocks. Proceedings of the 1976 Business Meeting of the Business and Economics Statistics Section. American Statistical Association. p177-181.

Bohl, M.T., Stephan, P.M., (2013), Does futures speculation destabilize spot prices? New evidence for commodity markets. Journal of Agricultural and Applied Economics, 45(4), 595-616.

Bollerslev, T. (1986), Generalized autoregressive conditional heteroskedasticity. Journal of Econometrics, 31(3), 307-327.

Boonyanuphong, P., Sriboonchitta, S. (2014), The Impact of trading activity on volatility transmission and interpendence among agricultural commodity markets. Thai Journal of Mathemathics, 2014, 211-227.

Brummer, B., Donmez, A., Jaghdani, T., Korn, O., Magrini, E., Schlubler, K. (2016), Has agricultural price volatility increased since 2007. Agricultural Markets Instability: Revisiting the Recent Food Crises. London and New York: Routledge.

Brummer, B., Korn, O., Schlubler, K., Jaghdani, T.J. (2015), Volatility in oilseeds and vegetable oil markets: Drivers and spillovers. Journal of Agricultural Economics, 67(3), 1-21.

Brunetti, C., Buyuksahin, B., Harris, J.H. (2016), Speculators, prices, and market volatility. Journal of Financial and Quantitative Analysis, 51(5), 1545-1574.

Busse, S., Brummer, B., Ihle, R. (2010), Investigating rapeseed price volatilities in the course of the food crisis. 50th Annual Conference, Braunschweig. Germany: German Association of Agricultural Economists (GEWISOLA).

Busse, S., Brummer, B., Ihle, R. (2012), Price formation in the German biodiesel supply chain: A markov switching VEC modelling approach. Agricultural Economics, 43, 545-560.

Buyung., Syechalad, N., Masbar, R., Nasir, M. (2017),The analysis of factors affecting cpo export price of Indonesia. European Journal of Accounting and Finance Research, 5(7), 17-29.

Čermák, M., Malec, K., Maitah, M. (2017), Price volatility modelling wheat: garch model application. Agris On-Line Papers in Economics and Informatics, 9(4), 15-24.

Chang, T.H., Su, H.M., (2010), The substitutive effect of biofuels on fossil fuels in lower and higher crude oil price periods. Energy, 35, 2807-2813.

De Schutter, O. (2010), Food commodities speculation and food price crises: Regulation to reduce the risks of price volatility. United Nations special rapporteur on the right to food. Briefing Note, 2, 1-14.

Enciso, S.R.A., Blanco, M., Artavia, M., Ramos, F., M'Barek, R., Van Doorslaer, B., Stanca, L., Donmez, A. (2016), Medium-term drivers of food market' variability and uncertainty. In: Garrido, A., Brümmer, B., M'Barek, R., Meuwissen, P.M., Morales-Opazo, C., editors. Agricultural Markets Instability: Revisiting the Recent Food Crises. London and New York: Routledge. p59-73.

Gilbert, C.L. (2010), How to understand high food prices? Journal of Agricultural Economics, 61(2), 398-425.

Gilbert, C.L., Morgan, C.W. (2010), Food price volatility. Philosophical Transactions of the Royal Society of London Series B, Biological Sciences, 365(1554), 3023-3034.

Hassanov, A., Shitan, M. (2014), Volatility model estimation of palm oil price return via long memory, asymmetric and heavy tailed GARCH parameterization. Malaysian Journal of Mathematical Sciences, 8(1), 15-34.

Hayo, B., Kutan, A.M., Neuenkirch, M. (2011), Communication Matters: U.S. Monetary Policy and Commodity Price Volatility. MAGKS Joint Discussion Paper Series in Economics No. 05-2011. On 4 March, 2011.

Headey, D. (2011), Rethinking the global food crisis: The role of trade shocks. Food Policy, 36(2), 136-146.

Huchet-Bourdon, M. (2011), Agricultural Commodity Price Volatility: An Overview, OECD Food, Agriculture And Fisheries Working Papers, No. 52. OECD.

Irwin, S.H., Sanders, D.R. (2012), Testing the masters hypothesis in commodity futures markets. Energy Economics, 34(1), 256-269.

Irwin, S.H., Sanders, D.R., Merrin, R.P. (2009), Devil or angel? The role of speculation in the recent commodity price boom (and bust). Journal of Agricultural and Applied Economics, 41(02), 377-391.

Karali, B., Power, G.J. (2013), Short-and long-run determinants of commodity price volatility. American Journal of Agricultural Economics, 95(3), 724-738.

Khin, A.A., Mohammed, Z., Malarvizhi, C.A., Thambiah, S., (2013), Price forecasting methodology of the Malaysian palm oil market. The International Journal of Applied Economics & Finance, 7(1), 23-36.

Kim, A., (2015), Does futures speculation destabilize commodity markets? Journal of Futures Markets, 35(8), 696-714.

Klotz, P., Lin, T.C., Hsu, S.H., (2014), Global commodity prices, economic activity and monetary policy: The relevance of China. Resources Policy, 42, 1-9.

Kristoufek, L., Janda, K., Zilberman, D. (2012), Correlations between biofuels and related commodities before and during the food crisis: A taxonomy perspective. Energy Economics, 34(5), 1380-1391.

Lahiani, A., Nguyen, D.K., Vo, T. (2013), Understanding return and volatility spillovers among major agriculture commodities. Journal of Applied Business Research, 29(6), 1781-1790.

Manera, M., Nicolini, M., Vignati, I. (2013), Futures Price Volatility in Commodities Markets: The Role of Short Term vs. Long Term Speculation. Working Papers 243, University of Milano-Bicocca, Department of Economics.

Martin, T.B., Pierre, L.S., Claudia, W. (2017), Speculative Activity and returns volatility of chinese agricultural commodity futures. Journal of Asian Economics, 54, 69-91.

Masters, M.W., White, A.K. (2008), The Accidental Hunt Brothers: How Institutional Investors are Driving up Food and Energy Prices. Available from: https://www.loe.org/images/content/080919/Act1.pdf. [Last accessed on 2018 Jul 10].

Mcphail, L., Du, X., Muhammad, A. (2012), Disentangling corn price volatility: The role of global demand, speculation, and energy. Journal of Agricultural and Applied Economics, 44, 401-410.

Mielke, T. (2015), Global Supply, Demand and Price Outlook of Oils and Fats. Presentation at 18 Annual Convention of NIOP.

Miffre, J., Brooks, C. (2013), Do long-short speculators destabilize commodity futures markets? International Review of Financial Analysis, 30, 1-31.

Mitchell, D., (2008), A Note on Rising Food Prices. The World Bank, Policy Research Working Paper Series: 4682.

Musunuru, N. (2014), Modeling price volatility linkages between corn and wheat: A multivariate GARCH estimation. International Atlantic Economic Society, 2014, 1-12.

Namini, S.S., Hudson, D. (2017), Volatility Spillover between Oil Prices, US Dollar Exchange Rate and International Agricultural Commodities Prices. Annual Meeting, Southern Agricultural Economics Association. 4-7 February, 2017.

Nazlioglu, S., Erdem, C., Soytas, U. (2013), Volatility spillover between oil and agricultural commodity markets. Energy Economics, 36, 658-665.

Peri, M., Baldi, L. (2010), Vegetable oil market and biofuel policy: An asymmetric cointegration approach. Energy Economics, 32(3), 687-693.

Pietola, K., Liu, X., Robies, M. (2010), Price, Inventories and Volatility in the Global Wheat Market. International Food Policy Research Institute. Discussion Paper 00996.

Prakash, A., editor. (2011), Why volatility matters. In: Safeguarding Food Security in Volatile Global Markets. Rome: Food and Agriculture Organization of The United Nations. p3-26.

Priyati, R.Y., Tyers, R. (2016), Price Relationship in Vegetable Oil and Energy Markets. Australian Development Economics Workshop Deakin University. 9-10 June, 2016.

Purba, H.J., Sinaga, B.M., Novianti, T., Kustiari, R. (2018), The impact of changes in external factors on the world vegetable oil market. International Journal of Economics and Financial Issues, 8(6), 176-186.

Rahman, A.K., Shariff, F.M., Abdullah, R., Sharif, N.H. (2007), Price volatility spillover in the Malaysian palm oil industry. Oil Palm Industry Economic Journal, 7(1), 24.

Roache, S.K. (2010), What explains the rise in food price volatility? International Monetary Fund (IMF) Working Papers 10/129. Washington, DC: International Monetary Fund.

Robles, M., Torero, M., Braun, J.V. (2009), When Speculation Matters, IFPRI Issue Brief 57. Washington, DC: International Food Policy Research Institute.

Rude, J., Henry, A. (2015), Explaining grain and oilseed price volatility: The role of export restrictions. Food Policy, 57, 83-92.

Sanders, D.J., Balagtas, J.V., Gruere, G. (2014), Revisiting the palm oil boom in South East Asia fuel vs. food demand driver. Applied Economics, 46(2), 127-138.

Serra, T., Zilberman, D., Gil, J.M. (2011), Price volatility in ethanol markets. European Review of Agricultural Economics, 38, 259-280.

Songsiengchai, P., Sidiqui, S.F., Djama, M., Hook, L.S. (2018), Volatility spillovers in the Thai palm oil market. Advance Science Letter, 24(1), 543-546.

Stigler, M., Prakash, A. (2011), The role of low stocks in generating volatility and panic. In: Prakash, A., editor. Safeguarding Food Security in Volatile Global Markets. Rome: FAO. p314-328.

Sy, M., Li, L., Nguyen, L. (2015), Volatility spillover from soybean oil futures to crude palm oil spot and future: An empirical evidence. Proceedings of The 5th Conference on Derivative Market 13-14 August 2015. Auckland, New Zealand.

Tadesse, G., Algieri, B., Kalkuhl, M., Braun, J.V. (2014), Drivers and triggers of international food price spike and volatility. Food Policy, 47, 117-128.

Timmer, C.P. (2010), Reflections on food crises past. Food Policy, 35, 1-11.

Trujillo-Barrera, A., Mallory, M., Garcia, P. (2012), Volatility spillovers in U.S. crude oil, ethanol, and corn futures markets. Journal of Agricultural and Resource Economics, 37(2), 247-262.

Ubilava, D., Holt, M. (2013), El Nino Southern Oscillation and its effects on world vegetable oil prices: Assessing asymmetries using smooth transition models. Australian Journal of Agricultural & Resource Economics, 57, 273-297.

Wright, B.D. (2011), The economics of grain price volatility. Applied Economic Perspectives Policy, 33(1), 32-58.

Zhang, Z., Lohr, L., Escalante, C., Wetzstein, M. (2009), Ethanol, corn, and soybean price relations in a volatile vehicle-fuels market. Energies, 2, 230-339.