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Global and Local Commodity Prices: A Further Look at the Indonesian Agricultural Commodities

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Abstract: Research Question: This paper examines whether global commodity futures prices can be used to enrich the prediction of local commodity spot prices in the absence of local commodity futures prices information. **Motivation:** Our objective is to investigate whether global prices can be used as a reference if commodity futures prices are unavailable or limited. Indonesia as a producer for several major commodities only has a small number of trades in the commodity futures exchanges which is not sufficient yet to create market liquidity in the local futures market or price reference for local spot trading. **Idea:** This research proposes the use of global commodity prices to improve the prediction of local commodity prices where the local futures prices are limited or not available. **Data:** This research employs daily spot prices for CPO (crude palm oil), TSR (technically specified rubber), and cacao, which are obtained from Indonesia Commodity Futures Trading Regulatory Agency (BAPPEBTI) from 2005 to 2017. Global commodity price will use daily commodity futures prices for the same commodity obtained from Thomson Reuters Eikon database. **Method/Tools:** We conduct the cointegration and non-linear causality tests between Indonesia local commodity spot prices and global commodity futures prices using bi-variate VAR/VECM methodology. **Findings:** The results show that using Indonesian commodity prices, local commodity spot prices and global commodity futures prices are cointegrated and have bi-directional causality, which contains important information about commodity pricing. Therefore, global commodity futures prices could be used as a reference when local commodity futures prices information is less reliable. Our results also imply that the relationship between local and global commodity markets is efficient, which can be beneficial for market participants to lower the cost for information search. **Contribution:** This paper expands existing finance literature mainly in emerging economies, particularly for commodity markets where the price information is unavailable or limited.

Keywords: Commodity price, cointegration, causality, Jakarta Future Exchange.
JEL classification: G15, G32, Q02

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1. Introduction

The abundance and variety of agricultural commodity produced in Indonesia are vital to the country's economy. Around 60% of Indonesia export is coming from commodity goods (Indonesia-Investments, 2018). This fact implies that Indonesia is more susceptible to the volatility of commodity prices in global markets. The statistics from Food and Agriculture Organization of the United Nations (2017) listed Indonesia as the world top producer for several agricultural commodities. Indonesia is the biggest producer for crude palm fruits in the world. For natural rubber, Indonesia is the second-biggest producer and the third for cocoa beans. The large volume of commodity production is supposed to be followed by a large number of commodity transactions. However, that is not the case for the commodity futures in Indonesia. The trading volume in Indonesia commodity exchange, especially futures trading, is still small compared to other countries. Jakarta Future Exchange (2018) released the statistics of global futures trading transaction volume in 2016 and 2017 detailed in Table 1. Total global futures contracts trading volume was 15.9 billion units in 2016 and 14.8 billion units in 2017. The trading volume of futures contracts decreased by around one billion contracts from 2016-2017. JFX trading volume in 2016 is 5.7 million units in 2016 and 5.5 million units in 2017. Compare to Asia future contracts trading volume, JFX futures volume trading is less than 0.1% of total Asia trading both in 2016 and 2017.

Table 1: Global futures trading in volume 2016-2017

Region	2016	2017
Global	15,892,093,636	14,842,763,368
Asia	6,702,591,250	5,574,573,537
JFX	5,713,970	5,497,892

Notes: All values are in units and sourced from http://jfx.co.id/home#home

Despite the high volume of commodity production, the low trading volume in Indonesia commodity future exchange means that the role of commodity exchange to collect and disseminate information about price is not yet sufficiently performed. When the price discovery mechanism is not yet developed, it will be harder for the market to grow since there is a lack of information about commodity pricing.

Capital market theories assume market efficiency where prices are complete. Lack of price references in Indonesia commodity future exchange shows that there is uncertainty on asset pricing, particularly for such commodities. Schwartz and Smith (2000) provide a theoretical framework of short-term prices and uncertainty in the equilibrium level, where mean-reversion prices exist in commodity markets. These two unobservable factors can be inferred using spot and futures prices. The spot and futures prices carry some critical information on commodity pricing. The differences between spot and futures prices generate short-term variations in prices, while price movements in future contracts contain information about equilibrium prices. Gorton *et al.* (2013) also show that price measures are important to provide information about commodity risk premiums. The notion of market efficiency is also important for investors who are looking for hedging using commodity derivatives (Chowdhury, 1991).

There are other commodity exchanges in other countries outside Indonesia, which trade the same commodities. Since there is less available information about Indonesia local commodity futures prices, this study explores some alternatives to use the data of commodity futures prices from other commodity exchanges as substitution of local commodity futures prices information. The purpose of this study is to find out whether price information from future global commodity can be used to help market participants ’discover’ the spot price when there are no local commodity futures prices available. To determine whether global commodity futures prices can be used to predict the local commodity prices better, we examine the cointegration and causality between global commodity futures prices and local commodity spot prices.

Cointegration represents the relationship between prices of local commodity spot prices and global commodity futures prices, which can not deviate too far from each other. Examining cointegration between these prices can help the market participants in commodity markets to better predict local commodity prices by benchmarking to future global commodity prices where the information is widely available and can be accessed almost real-time. Furthermore, this paper explores the Granger causality of global commodity futures prices and Indonesia local commodity spot prices. If there is Granger causality between local commodity spot prices and global commodity futures prices, there is a co-movement between current local commodity spot prices or current global commodity futures prices with past values of local commodity spot prices and past values of global commodity futures prices. The relationship between local spot markets and global futures markets is also critical to determine the price formation, particularly for emerging commodity markets. The rest of this paper is written as follows. Section 2 examined the literature on the spot and futures prices of agricultural commodities. Section 3 described the research methodology employed in this paper. Section 4 discusses the findings on the empirical relationship between Indonesia local spot prices of agriculture commodities and its counterparts in the global markets. The last section concludes.

2. Literature Review

Theoretically, futures prices and spot prices should “reflect” the same aggregated value of underlying assets. With the possibility of arbitrage, futures prices should not lead nor lag the spot price (Bekiros and Diks, 2008). An efficient market requires that the current futures price and the future spot price in commodity markets should “close together” (see Chowdhury, 1991; Crowder and Hamed,1993). If such markets exist, market participants can engage at lower transaction costs. Several factors determine the relationship between spot and futures markets. Schwartz and Smith (2000) examine the role of the mean-reversion process in estimating equilibrium prices in commodity markets, which are characterized by short-term changes in demand and market adjustments. Gorton *et al.* (2013) argue that commodity futures risk premiums or the difference between the expected future spot prices and the futures prices are influenced by price measures such as the futures basis, past futures returns, past spot returns, and spot price volatilities.

However, empirical evidence is mixed. The majority of studies indicate that futures prices influence spot prices but not the opposite. Due to lower transactions costs and flexibility of short selling, rationally, futures prices can respond more quickly to new information than spot prices. Spot purchases require more initial outlay and take longer to implement while future transactions can be implemented immediately by speculators with little up-front cash nor interest in the physical commodity. Hedgers with interest in physical commodity but have storage constraints will buy futures contracts. Both hedgers and speculators will react to new information by preferring futures transactions rather than spot transactions. This new information will cause a delay in the spot price formation. An early investigation of futures market efficiency using cointegration can be found in Chowdhury (1991) who studies four nonferrous metals in the London Metal Exchange. His results reject the efficient market hypothesis for these commodities, however the cointegration approach can be utilized further in any asset markets.

The price discovery function of futures markets hinges on whether changes in futures markets lead to price changes in cash markets more often than the reverse (Garbade and Silber, 1983). Their research findings on seven commodity markets are that in general, futures markets lead spot markets. Moosa (1996) proposed a model for futures price determination that supports the hypothesis that causality runs from futures to spot prices. In their model, the futures prices are determined by arbitrageurs and speculators. Arbitrageurs demand for futures depends on the difference between the arbitrage and actual futures prices, while speculators demand for futures contracts depends on the difference between the expected spot and actual futures prices. Futures prices are the reference for both arbitrageurs and speculators, not spot prices (Silvapulle and Moosa, 1999). Moosa (1996) finds that a spot price change triggers action from all kinds of market participants, including arbitrageurs and speculators, which will subsequently change futures prices. The change in spot price change will trigger a reaction from arbitrageurs caused by the cost-of-carry condition change. Then, speculators will revise their expectations due to the change in the disparity between current and expected futures prices.

Using S&P 500 futures and its underlying minute-to-minute data, Kawaller *et al.* (1987) find that the causality between futures prices and spot prices is bi-directional relationship. Their study introduced the principle that both futures prices and spot prices are affected by current market information and also their historical prices. They argue that the potential lead-lag patterns dynamically change as new information arrives. At any time of point, each market participants filter the new information relevant to their position, futures or spot, and each may lead the other depending on the market dynamics.

Brooks (2014) stated that changes in spot price and its corresponding futures prices are expected to be perfectly contemporaneously correlated and not cross-auto correlated if the markets are frictionless and functioning efficiently. However, many studies documented that futures market systematically “leads” the spot market since they are quickly reflecting the news. Several studies noted the relationship between global and local prices of commodities.

Mundlak and Larson (1992) studied the world prices of agricultural commodities and domestic prices showed that most of the world prices variations were transmitted into local prices and become a dominant component in domestic agricultural commodities prices variations. A study by Zhao (2017) finds that China soybean spot price is significantly guided by futures soybean prices. Using ECM methodology, Arnade *et al.* (2017) find a significant connection between international agricultural commodity prices to the Chinese market where Chinese soybeans, soymeal and chicken price are the most integrated. Trade policy and market bubbles can also affect the price discovery and transmission of commodity prices. Using Markov regime-switching model, Sun *et al.* (2018) show that China’s trade policies do not improve market integration. A recent study by Li and Xiong (2019) finds that the performance of price discovery in Chinese soybean futures markets are heavily affected by bubbles.

Similar observations can be found in other commodity markets. Using daily observation of spot and one-month futures prices of WTI crude oil, Moosa (2002) find that both spot and futures markets perform price discovery function, but the futures market contribution is higher than the spot market. Futures market contribute about 60% of price discovery function. Nicolau and Palomba (2015) examine crude oil and natural gas prices against gold using bivariate VAR models. They find that the interactions between spot and futures which depend on commodity type and the maturity of futures contracts. In terms of price discovery in agricultural commodity, Dimpfl *et al.* (2017) study the relationship between spot and futures prices of US commodities using VAR/VEC methodology to examine which markets lead the price discovery. For these agricultural commodities, they find that the futures market determines less than 10% of the price discovery process. Global commodity markets can also influence local commodity markets. Using stepwise estimation of error correction models, Dillon and Barrett (2016) find the relationship between global oil prices and local food prices in East Africa, mainly due to transportation costs.

To the best of our knowledge, the study of commodity spot and futures markets in Asian region particularly the relationship between local and global commodity exchanges is still limited although the underlying commodities are produced within the region. This paper contribution is to empirically examine the relationship between global futures prices and local spot prices in emerging economies where the underlying commodities are largely produced.

3. Research Design

3.1 The Models

Vector autoregressive models (VARs) is a systems regression model that can be considered a kind of hybrid between the univariate time series models and the simultaneous equations models (Brooks, 2014). VARs have often been advocated as an alternative to large-scale simultaneous equations structural models. An important feature of the VAR model is its flexibility and the ease of generalization. Another useful facet of the VAR model is the compactness with which the notation can be expressed. Brooks (2014) mentioned that financial theory suggests that spot and futures prices would be expected to hold some long-run relationship in the form of cointegration. A set of variables is defined as cointegrated if a linear combination of them is stationary. Many financial time series data are non-stationary but "move together" over time, which suggests the existence of some influences on the series. The implication is that these series are bound by some relationships in the long run. A cointegrating relationship can be seen as a long-term or equilibrium phenomenon since their association will return in the long run, but they can deviate in the short run.

Chowdhury (1991) argue that cointegration approach can be used as an alternative approach to examine the spot and futures markets since many of the price series are non-stationary and conventional statistical procedures may not be appropriate to account for stylised facts of time series. Spot and futures prices are expected to be integrated since both are actual prices for the same asset at a different time, so they are supposed to be affected in a similar way when given pieces of information. If there is no cointegration, the series could wander apart without bound since no long-run relationship binding the series together. However, market forces arising from no-arbitrage condition suggest that there should be an equilibrium relationship between spot and futures prices, hence cointegration. When two series are cointegrated, there would be a linear combination of them that is stationary. In this case, the error correction model will be more appropriate because this model will be able to capture the long-run relationship and short-run relationship between the series.

Brooks (2014) mentioned that when the non-stationarity concept was first considered in the 1970s, the response was to independently take the first difference of each $I(1)$ variables and use it for the next subsequent modelling process. This is the correct approach in the univariate modelling context. Nevertheless, this procedure is inadvisable when the relationship between variables is important due to the pure first difference model has no long-run solution. Error correction model or equilibrium correction model is more appropriate since the model use the combinations of first differenced and lagged levels of cointegrated variables. Hakkio and Rush (1989) show that if spot and futures markets are efficient, cointegration should exist since the spot and futures prices never drift far apart.

We employ Vector Autoregressive (VARs) approach to examine the relationship between local spot markets and global futures markets as follow:

$$y_{1t} = \beta_{10} + \beta_{11} y_{1t-1} + \cdots + \beta_{1k} y_{1t-k} + \alpha_{11} y_{2t-1} + \cdots + \alpha_{1k} y_{2t-k} + \varepsilon_{1t} \quad (1)$$
$$y_{2t} = \beta_{20} + \beta_{21} y_{2t-1} + \cdots + \beta_{2k} y_{2t-k} + \alpha_{21} y_{1t-1} + \cdots + \alpha_{2k} y_{1t-k} + \varepsilon_{2t} \quad (2)$$

where y_{1t} denotes the local commodity spot price at date *t*, y_{2t} denotes the global commodity spot price at date *t*, and ε_{it} denotes a white noise disturbance term for commodity *i* at date *t*.

We use the Johansen technique to test the equilibrium relationship between spot and futures market prices.

3.2 Variables and Data Sources

This research utilizes secondary data in the form of the daily spot nominal price of the Indonesia agricultural commodity: Crude Palm Oil (CPO), Technically Specified Rubber (TSR or block rubber), and cocoa. The data is collected from the Commodity Futures Trading Regulatory Agency (BAPPEPTI). For commodity global reference prices, this paper used daily nominal price data obtained from Thomson Reuters Eikon database. Each commodity is taken from different commodity exchange with detail as follows: CPO futures prices are taken from the Bursa Malaysia Crude Palm Oil Commodity Future Continuation 3, cocoa futures prices are taken from ICE Europe (ICE) Cocoa Commodity Future Continuation 2, and rubber futures prices are taken from TOCOM Rubber Full Session Commodity Future Continuation 6. We use the daily data between 2003 and 2017 for all commodities. The variables used in this research are provided in Table 2. Table 3 and 4 provides the descriptive statistics and correlation matrix of each variable, respectively. For each commodity pair, there is strong positive linear relationship between local spot market and global futures market. However, since financial time series tend to have a non-linear relationship, the conventional statistical approach may not be able to capture stylised facts in spot and futures prices and may generate spurious regressions (see Chowdhury, 1991; Brooks, 2014).

Table 2: Research variables

Variables	Definition	Unit	Location
LP-CPO	CPO local price	Indonesian rupiah per kilogram	Medan
LP-Rubber	Natural rubber local price	Indonesian rupiah per kilogram	Palembang
LP-Cacao	Cacao bean local price	Indonesian rupiah per kilogram	Makassar
GP-CPO	CPO global price	Malaysian ringgit per metric ton	Malaysia
GP-Rubber	Natural rubber global price	Japanese yen per kilogram	Tokyo
GP-Cacao	Cacao bean global price	British pound sterling per metric ton	London

Table 3: Descriptive statistics

Variables	Obs.	Mean	Max.	Min.	Std. dev.	Skewness	Kurtosis
LP-CPO	3383	7499.2	11969	3484	1846.9	-0.645	2.55
LP-Rubber	3383	22506	57161	8675	7850.9	1.246	5.11
LP-Cacao	3383	21923	38361	10912	6798.4	0.163	2.12
GP-CPO	3383	2442.8	4330	1258	597.15	-0.009	2.63
GP-Rubber	3383	244.8	528.4	105	69.1	0.722	3.88
GP-Cacao	3383	2444.7	3774	1318	588.9	-0.282	1.92

Notes: Above values are based on authors' calculations from BAPPEBTI and Thomson Reuters Eikon.

Table 4: Correlations

Variables	LP-CPO	LP-Rubber	LP-Cacao	GP-CPO	GP-Rubber	GP-Cacao
LP-CPO	1					
LP-Rubber	0.5123	1				
LP-Cacao	0.4836	-0.0465	1			
GP-CPO	0.8803	0.7088	0.2631	1		
GP-Rubber	0.3957	0.9122	-0.2165	0.6238	1	
GP-Cacao	0.579	0.3393	0.868	0.499	0.1693	1

Notes: Above values are based on authors' calculations from BAPPEBTI and Thomson Reuters Eikon.

3.3 Empirical Tests

We conduct several tests in examining our data which characterized by financial stylised facts. The first test is data testing for stationarity to check whether the price data can be used directly, or it should be differenced to be stationary. The tests at individual time series are important to detect unit roots and before the cointegration tests are conducted. Table 5 provides the unit root test results for each commodity at the price level and after differencing.

Table 5: Unit root test results for each commodity

	Price level	First difference
LP-CPO (local spot prices)	-3.144**	-73.03***
LP-Rubber (local spot prices)	-2.248	-59.24***
LP-Cacao (local spot prices)	-2.173	-61.23***
GP-CPO (global futures prices)	-2.338	-59.13***
GP-Rubber (global futures prices)	-2.377	-54.85***
GP-Cacao (global futures prices)	-2.482	-57.64***

Notes: We use Augmented Dickey-Fuller tests to examine the stationarity for each series. ** denote statistical significance at 5% level, *** denote statistical significance at 1% level. Model: $x_t = \alpha_0 + \theta_0 x_{t-1} + \sum \theta_i x_{t-i} + e_t$. H_0: x_t contains a unit root. Above values are based on authors' calculations from BAPPEBTI and Thomson Reuters Eikon.

After stationarity testing, we examine the lag length determination for each pair of commodities. Johansen test will be used to test the correlation between the local commodity spot price and global commodity futures price. The next step is using vector autoregressive model or vector error correction model for each pair of commodities, depend on the correlation result, to check the causality and long-term relationship between local commodity spot prices and global commodity futures prices.

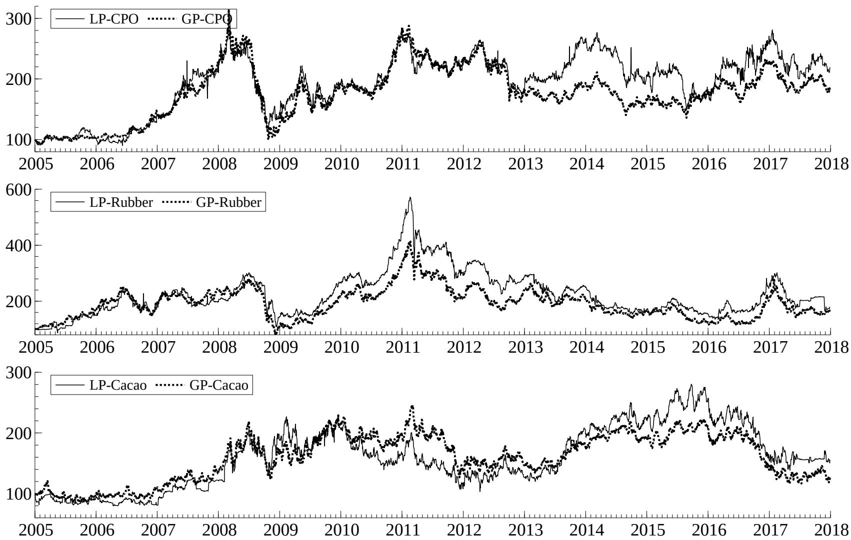
We use post-estimation analysis following Hjalmarsson and Österholm (2010) by applying the restrictions to the cointegrating vectors in the models to reduce the risk of spuriously concluding near-integrated variables as cointegrated variables. This additional test can be conducted by checking whether the cointegrating vectors satisfy $\boldsymbol{\beta}' = (0\ 1)$ and $\boldsymbol{\beta}' = (1\ 0)$. If both restriction conditions are satisfied, we can conclude that there is cointegration relationship between the variables.

4. Empirical Findings

Figure 1 shows the price movements for all commodity prices between 2005 and 2018. The local commodity spot prices tend to move together with its global counterpart prices. Both prices for each commodity pair tend to move together. As described in the previous section, the stationarity testing using Augmented Dickey-Fuller (ADF test) shows that nominal commodity prices are not stationary, and their first differences are stationary. Therefore, we use the first difference of nominal commodity prices for all the testing. For lag length determination, 10 lags are used for preliminary determination of optimal lag length for each pair.

Table 6 provides the lag significance test results with 10 lags. The results showed that optimal lag length for the pair of CPO commodity prices is 7, 9 for rubber commodity prices and 5 for the pair of cacao commodity prices. Since the lag length can affect the result of other tests, each pair of commodity lag length is re-tested using its own lag length from the preliminary test to see whether all lags are still significant. The pair of CPO and rubber showed that 7 and 9 lags are all significant respectively. However, using 5 lags for cacao, the fifth lag is no longer statistically significant. Therefore, we use 4 lags for cacao pair instead of 5 lags.

The Johansen test results in Table 7 showed that there is cointegration between all three commodity pairs of local commodity spot returns and global commodity futures returns for CPO, rubber, and cacao. Since the commodity returns are cointegrated, vector error correction model is more suitable than a vector autoregressive model to check the causality and long-term relationship between local commodity spot returns and global commodity futures returns.



*Source: A*uthors' calculations from BAPPEBTI and Thomson Reuters Eikon.

Figure 1: The movement of commodity prices, 2005-2017. LP denotes local prices for each commodity (left scale), and GP denotes global prices for each commodity (right scale).

Table 6: Optimal lag length - F test results

	CPO		Rubber		Cacao	
	Value	(Prob)	Value	(Prob)	Value	(Prob)
Lag 10- 10	15.137	(0.1952)	17.038	(0.1461)	16.394	(0.1613)
Lag 9 – 10	0.88969	(0.5241)	27.701	(0.0047)***	17.631	(0.0793)
Lag 8 – 10	0.78044	(0.6714)	21.604	(0.0111)**	13.205	(0.1987)
Lag 7 – 10	22.821	(0.0025)***	26.363	(0.0004)***	14.521	(0.1080)
Lag 6 – 10	24.758	(0.0003)***	23.111	(0.0008)***	15.441	(0.0572)
Lag 5 – 10	30.291	(0.0000)***	32.863	(0.0000)***	15.864	(0.0344)**
Lag 4 – 10	44.734	(0.0000)***	38.071	(0.0000)***	18.688	(0.0036)***
Lag 3 – 10	61.035	(0.0000)***	38.359	(0.0000)***	21.794	(0.0001)***
Lag 2 – 10	89.225	(0.0000)***	62.786	(0.0000)***	79.269	(0.0000)***
Lag 1 – 10	294.350	(0.0000)***	189.210	(0.0000)***	550.530	(0.0000)***

Notes: All series are *I*(1). p-value in parentheses. ** and *** denote statistical significance at the 5% and 1% level, respectively. Above values are based on authors' calculations from BAPPEBTI and Thomson Reuters Eikon.

Table 7: The Johansen test results

H_0: rank	DLP-CPO DGP-CPO	DLP-Rubber DGP-Rubber	DLP-Cacao DGP-Cacao
0	1,194.00 (0.000)***	785.38 (0.000) ***	1,802.20 (0.000) ***
1	397.69 (0.000)***	289.41 (0.000) ***	647.88 (0.000) ***

Notes: DLP denotes first-order difference of local spot price for respective commodity, DGP denotes diff(1) of global futures prices for respective commodity, CPO denotes Crude Palm Oil price index, Rubber denotes natural rubber price index, and Cacao denotes cacao bean price index. p-value in parentheses. ** and *** denote statistical significance at the 5% and 1% level, respectively. Above values are based on authors' calculations.

Table 8, 9, and 10 show the results of vector error correction model for each commodity pair. The cointegrating vector represents by β, show the long-term relationship (cointegration) between the two variables while α is the adjustment parameters. Table 8 showed the VECM results for DLP-CPO and DGP-CPO. Comparing the β value from both models in Table 8, it shows that DLP-CPO is more affected by DGP-CPO than the other way around since the β value in Model 1a is higher than Model 1b. α coefficient for DLP-CPO is higher than DGP-CPO in both models. We argue that when there is a deviation from its long-term equilibrium, DLP-CPO would adjust faster in the short run.

Table 8: Johansen cointegration analysis for crude palm oil

Model 1a (DLP-CPO)	ECM = (DLP-CPO) - 3.2819 (DGP-CPO)	
	DLP-CPO	DGP-CPO
Standardized β eigenvalues with standard errors	1	-3.2819
Standardized α coefficients with standard errors	-1.7407	0.15472
Model 1b (DGP-CPO)	ECM = (DGP-CPO) - 0.3047 (DLP-CPO)	
	DLP-CPO	DLP-CPO
Standardized β eigenvalues with standard errors	1	-0.30470
Standardized α coefficients with standard errors	-0.5078	5.71829

Notes: Number of lags used in the analysis: 7. DLP denotes the first difference of local spot price, DGP denotes the first difference of global futures prices, and CPO denotes Crude Palm Oil price index. p-value in parentheses. ** and *** denote statistical significance at the 5% and 1% level, respectively. Above values are based on authors' calculations.

Table 9 provides the VECM results for rubber commodity tests. In rubber commodity pair, β values showed that DLP-Rubber is highly affected by DGP-Rubber while DLP-Rubber only has a small effect on DGP-Rubber. The α coefficient showed that local rubber spot prices have a faster adjustment when there is a deviation from the long-term equilibrium compare to global rubber futures prices.

Table 9: Johansen cointegration analysis for rubber

Model 2a (DLP-Rubber)	ECM = (DLP-Rubber) - 95.595 (DGP-Rubber)	
	DLP- Rubber	DGP- Rubber
Standardized β eigenvalues with standard errors	1	-95.595
Standardized α coefficients with standard errors	-1.2349	0.0049
Model 2b (DGP-Rubber)	ECM = (DGP-Rubber) - 0.010461 (DLP-Rubber)	
	DGP- Rubber	DLP- Rubber
Standardized β eigenvalues with standard errors	1	-0.0105
Standardized α coefficients with standard errors	-0.4682	118.05

Notes: Number of lags used in the analysis: 9. DLP denotes the first difference of local spot price, DGP denotes the first difference of global futures prices, and Rubber denotes natural rubber price index. p-value in parentheses. ** and *** denote statistical significance at the 5% and 1% level, respectively. Above values are based on authors' calculations.

The VECM results for cacao pair are given in Table 10. The β values showed that global cacao futures prices have more effect on local spot cacao price than the other way around. The higher α coefficient for DLP-Cacao showed that local commodity prices would adjust faster to the long-term equilibrium with global cacao futures prices when there is short term deviation.

The VECM for all three pair of local commodity prices and global commodity prices differentiation are consistent. The coefficient values of α and β for local commodity show higher number compared to the respective global commodity. The values imply that Indonesia local commodity prices are more affected by global commodity prices than the other way around. Higher α coefficient showed that Indonesia local commodity prices would adjust faster to its long-run equilibrium with global commodity price when there is any deviation or shock in the local markets.

Table 10: Johansen cointegration analysis for cacao

Model 3a (DLP-Cacao)	ECM = (DLP-Cacao) - 9.8328 (DGP-Cacao)	
	DLP-Cacao	DGP-Cacao
Standardized β eigenvalues with standard errors	1	-9.8328
Standardized α coefficients with standard errors	-1.2228	0.0429
Model 3b (DGP-Rubber)	ECM = (DGP-Cacao) - 0.10170 (DLP-Cacao)	
	DGP-Cacao	DLP-Cacao
Standardized β eigenvalues with standard errors	1	-0.10170
Standardized α coefficients with standard errors	-0.4216	12.023

Notes: Number of lags used in the analysis: 4. DLP denotes the first difference of local spot price, DGP denotes the first difference of global futures prices, and Cacao denotes cacao bean price index. p-value in parentheses. ** and *** denote statistical significance at the 5% and 1% level, respectively. Above values are based on authors' calculations.

The results in Table 11 show that the restriction in the cointegrating vector significantly affects the model; thus, it can be concluded that the local price and the global price of commodity affecting each other. The results show that Indonesia commodity spot returns of CPO is affected by Bursa Malaysia CPO futures returns and vice versa. The same conclusion is also can be inferred for both the pair of Indonesia spot rubber returns - TOCOM rubber future returns and Indonesia spot cacao returns – ICE Europe cacao returns.

Table 11: Restriction test results using likelihood ratio

Restriction	DLP-CPO DGP-CPO	DLP-Rubber DGP-Rubber	DLP-cacao DGP-cacao
β = (0 1)	338.76 (0.0000)***	178.35 (0.0000)***	430.55 (0.0000)***
β = (1 0)	319.51 (0.0000)***	170.13 (0.0000)***	415.17 (0.0000)***

Notes: DLP denotes the first difference of local spot price for respective commodity, DGP denotes the first difference of global futures prices for respective commodity, CPO denotes Crude Palm Oil price index, Rubber denotes natural rubber price index, and Cacao denotes cacao bean price index. $\chi^2(1)$ probability values in parentheses. ** and *** denote statistical significance at the 5% and 1% level, respectively. Above values are based on authors' calculations.

The results also imply that the markets are efficient, which means that the Indonesian local spot markets and its global counterparts never drift apart and have a long-run relationship. However, we must carefully interpret this because the spot and futures markets are not in the same location. We argue that both markets contain similar information that makes the local spot and futures markets cointegrated. Such information would be beneficial for market participants to make investment and hedging decisions.

5. Conclusions

The study aims to investigate the use of prices information from global futures commodity exchanges when the information of local commodity futures prices is not available or limited. Using the samples of Indonesia agricultural commodity spot prices: CPO, rubber, and cacao paired with prices from global commodity futures exchange for the same agricultural commodity respectively, we show the necessary condition of cointegration and causality between Indonesia local commodity spot prices and global futures commodity prices.

Cointegration can be found between all three pairs of Indonesia local CPO spot prices – Bursa Malaysia CPO futures prices; Indonesia local rubber spot prices - TOCOM rubber futures prices; and Indonesia local cacao spot prices - ICE Europe cacao futures prices. This result showed that Indonesia local commodity spot prices have a long-term relationship with global commodity futures prices. The causality can be inferred between all three pairs of these commodities is bi-directional. This means that the current Indonesia local commodity spot returns can be explained by both its past values and the past values of global commodity futures returns and the other way around. The current global commodity futures returns can be explained by both its past values and the past values of Indonesia local commodity spot return. We also provide empirical evidence that the relationship between local and global commodity markets is efficient, which can be beneficial for market participants to lower the cost for information search.

In summary, we show that the information from global commodity futures exchanges could be used as an alternative when the local commodity futures prices information is not available. Since commodity mainly produced in the developing country while the futures exchange is mainly established in the developed country, the problem of price discovery in the commodity market can suggest an inefficient commodity market.

Many literature on market efficiency in commodity exchanges use spot and futures prices which are in the same market, while our study uses two different locations of spot and futures markets. Since our objective is not to examine market efficiency, we leave this issue for further research. Our study can also be expanded into the price discovery process within the markets and futures risk premium that emerges between different markets.

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