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THE EFFICIENCY OF THE SPOT MARKET AND CRUDE PALM OIL (CPO) COMMODITY FUTURES MARKET BEFORE AND DURING THE COVID-19 PANDEMIC IN INDONESIA

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Abstract: CPO prices fluctuation cause price uncertainty formed in the future. Hedging is an activity carried out by market participants to mitigate the risk of price fluctuations. The Covid-19 pandemic disrupts the supply and demand of CPO, affecting price alteration, especially in the spot and futures markets. This study determines market efficiency and the CPO price asymmetry relationship between the Medan spot market, the Jakarta futures market, the Malaysian futures market, and the Rotterdam forward market prior to and during the COVID-19 pandemic. The data used in this study are daily price data on each market from January 2016 to December 2020. They are analyzed using the NARDL model. There is a price asymmetry relationship between the spot and futures markets preceding and during the covid-19 pandemic. The increase in CPO prices causes a more significant impact than the decline in prices in the long term. In addition, there is also a long-term and short-term efficient relationship between the spot market and the futures market for CPO commodities. Thus, the hedging function performed by the CPO commodity market participants will run effectively.

Keywords: CPO price, NARDL model, market efficiency, cointegration, pandemic Covid-19

Abstrak: *Harga CPO yang berfluktuasi menyebabkan terjadinya ketidakpastian harga yang tercipta di masa depan. Hedging merupakan aktivitas yang dilakukan para pelaku pasar untuk alat memitigasi risiko fluktuasi harga. Pandemi covid-19 menyebabkan terjadinya guncangan pada sisi penawaran dan permintaan CPO sehingga berpengaruh terhadap fluktuasi harga, khususnya pada pasar spot dan berjangka. Tujuan penelitian ini adalah untuk mengetahui efisiensi pasar serta hubungan asimetri harga CPO antara pasar spot Medan, pasar futures Jakarta, pasar futures Malaysia dan pasar forward Rotterdam pada periode sebelum dan saat pandemi covid-19. Data yang digunakan adalah data harga harian pada masing-masing pasar periode Januari 2016 sampai Desember 2020. Teknik analisis data yang digunakan menggunakan model NARDL. Terjadi hubungan asimetri harga antara pasar spot dan pasar berjangka pada periode sebelum dan saat pandemi Covid-19. Peningkatan harga CPO menyebabkan pengaruh yang lebih besar dibandingkan penurunan harga dalam jangka panjang. Hasil penelitian juga menyatakan terdapat hubungan keseimbangan dalam jangka panjang dan jangka pendek antara pasar spot dan pasat berjangka untuk komoditas CPO pada periode sebelum dan saat pandemi covid-19.*

Kata kunci: *harga CPO, model NARDL, efisiensi pasar, kointegrasi, pandemi Covid-19*

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INTRODUCTION

Palm oil is an essential product for the Indonesian economy. Besides being used for domestic consumption, palm oil and its derivative products are exported abroad. Thus, palm oil has a role in generating foreign exchange. Indonesia and Malaysia are the most massive palm oil producers. In 2019, palm oil production in the two countries reached 88% of palm production for the global market. Therefore, they influence the production and trade of palm oil. The following largest palm oil producers are Thailand, Colombia, and Nigeria.

Fluctuating prices lead to price uncertainty created in the future. For CPO producers whose production process to harvest takes some time, the hesitancy of commodity prices when harvesting is one of the issues faced. For consumers, price inconstancy affects the production budget allocation issued by the company, involving the availability of raw materials. Hence, market participants are encouraged to hedge to mitigate the risks. Hedging is taking an opposite position in the futures market to its place in the spot market. If a loss arises from price fluctuations in the spot market, it can be reduced by the profits earned in the futures market.

The futures market for CPO commodities consists of 2 types: the forward market and the futures market. The forward market makes transactions on forwarding contracts. A forward contract is an agreement in selling or buying an asset at a particular time and amount in the future. Forward contracts are not standardized and are not traded on commodity exchanges. As a reference for market participants, the Rotterdam forward market is the largest forward market for CPO commodities (Buyung et al., 2017). The futures market is a financial market providing a place for buyers and sellers to transact futures contracts for certain things. Initially, the futures exchange was constructed to protect producers (farmers) and consumers from price fluctuations in the future. The Malaysian futures market is the reference for the CPO commodities market. It was founded in 1980 and was the pioneer of the futures market in Southeast Asia. On the contrary, the futures exchange in Indonesia was established in 1999 under the name of Bursa Berjangka Jakarta (Jakarta Futures Exchange). Futures contracts traded on the Jakarta Futures Exchange consist of gold, oil, cocoa, Robusta coffee, and Arabica coffee.

Globalization in the global economy causes markets between one country and another, increasing the affiliations and dependencies – likewise, the relationship between the spot market, forward market, and futures market for CPO commodities. Advances in information technology have also led to CPO market participants' ability to simultaneously conduct transactions in different markets. This situation can drive dependence and relationships between CPO markets. CPO price fluctuations in the Indonesian and international markets can be seen in Figure 1.

Variations in the coefficient of variation between markets indicate differences in the fluctuations occurring between CPO markets. Spot prices and futures prices have a mutually influencing relationship. Based on Figure 1, prices in the spot market and futures market tend to move in a similar direction with fluctuations that are not always the same. However, there are several periods when each market has its different movements from other markets. The spot price is a reference for forming futures prices, although this condition does not always appear since some futures prices react differently to changes in spot prices. In contrast, futures prices are price signals for the spot market. The adjustment in futures prices for spot prices generally depends on the time of delivery developed in futures trading. Therefore, futures prices will be firmly affected by spot prices when delivery is due.

In March 2020, Indonesia was affected by the spread of the Covid-19 virus; the virus outbreak firstly appeared in Wuhan at the end of 2019. Additionally, the spread of the virus spread rapidly to other countries. To overcome the advancement of the coronavirus, the government of Indonesia issued several policies to minimize the dissemination of the virus. The policies implemented to prevent the spread of Covid-19 impact the decline in the supply of food consumed. The actions taken by the government include Work from Home, School from Home, and Large-Scale Social Restrictions. Enforcement of Large-Scale Social Restrictions policies disturbs many sectors, exclusively the agricultural sector. Therefore, the direct impact of the policy alters the distribution of agricultural products. In addition, the existence of the policy has also hampered the distribution of agricultural products.

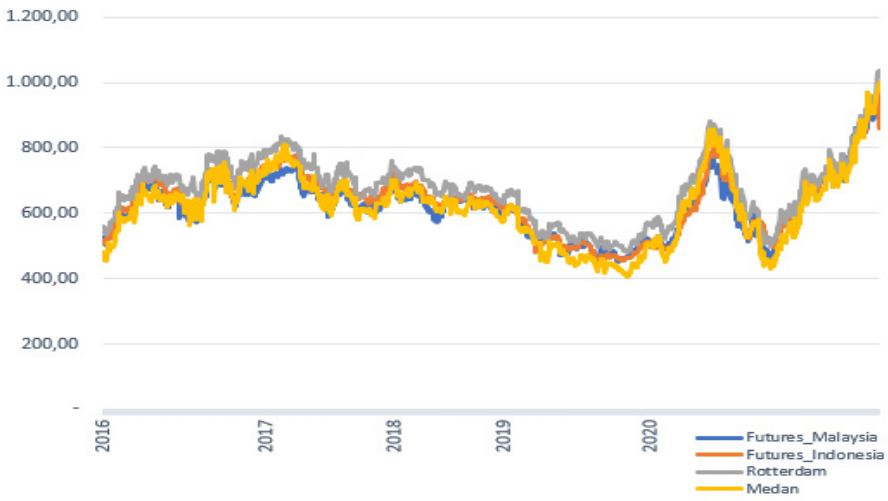

Figure 1. CPO price movements in the spot, forward and futures markets

The impact of the policy to prevent the spread of COVID-19 harms the Indonesian economy. In the second quarter of 2020, Indonesia's economic growth contracted by 5.32% (BPS, 2020). In fact, by the first quarter of 2020, the Indonesian economy had grown by 2.97%. However, the whole country also experienced negative economic growth. In the second quarter, few countries experienced more than 10% contractions, including the European Union, the Philippines, Singapore, and Mexico (OECD, 2020). Therefore, the Covid-19 pandemic has caused a considerable impact on the fall in economic growth.

The COVID-19 pandemic may also affect CPO commodity prices. This condition ensues since the government policies related to the COVID-19 pandemic caused shocks in the supply and demand for CPO commodities. The shocks can also influence the relationship between the spot and the futures markets for CPO commodities. Several previous researchers have investigated the effect of the economic crisis on the efficiency of the spot and futures markets. Talbi et al. (2020) conducted a study on the effect of the global financial crisis in 2007 on the relationship between spot and futures markets for metal commodities at the London Bullion Market Association (LBMA), Commodity Exchange, Inc. (COMEX), and the New York Mercantile Exchange (NYMEX). Avinash & Mallikarjunappa (2017) analyze the effect of the economic crisis on the efficiency of the relationship between the spot and futures markets in India for the nifty50 index. Chen et al. (2017) researched the effect of the economic crisis on the relationship between the spot market and the United States futures market for energy commodities. However, few studies examine the impact of the crisis in the COVID-19 pandemic period, especially for CPO commodities.

Previous research also discusses the asymmetric effects between the futures and spot markets. The asymmetrical effect shows differences in market response to price fluctuation. Research examining the effects of price asymmetry includes (Kocaarslan & Soytas, 2019), (Kocaarslan & Soytas, 2019), (Kocaarslan & Soytas, 2019), (Kocaarslan & Soytas, 2019), (Kocaarslan & Soytas, 2019), (Kocaarslan & Soytas, 2019), (Kocaarslan & Soytas, 2019), (Bhat & Sharma, 2020), and (Jiang et al., 2021). The analysis provides more comprehensive results since it discusses positive and negative changes in the variables studied. However, despite the research mentioned previously, studies examining the effect of price asymmetry during the COVID-19 pandemic are still limited, especially for CPO commodities. To analyze the asymmetry relationship between markets, the non-linear autoregressive model is used. Thus, price increases and decreases in the futures market on the spot market for CPO commodities can be known.

The level of efficiency between the spot market and futures market for CPO commodities is important to analyze so that hedging activities carried out by market participants can run effectively. The cointegration test is used to determine the efficiency relationship between markets. Therefore, this study examines the efficiency analysis and price asymmetry condition between the spot and futures markets preceding and during the COVID-19 pandemic for CPO commodities in Indonesia.

METHODS

This study discusses the relationship between CPO price efficiency between the Medan spot market and the futures market, consisting of the Jakarta futures market, Malaysia futures market, and the Rotterdam forward market in the period prior to and during the COVID-19 pandemic. The data used in this research were CPO daily data one each market from January 2016 to December 2020. The price of each market is converted into US dollars. In addition, data were obtained from the Commodity Futures Trading Regulatory Agency (BAPPEBTI), Malaysian Palm Oil Board (MPOB), Center for Agricultural Data and Information Systems, Ministry of Agriculture, World Bank, Bank Indonesia. The type of data used, the amount, and the source can be seen in Table 1.

Analysis of the short-term and long-term market efficiency of CPO commodities in Indonesia in this study was performed using the NARDL (Nonlinear Auto Regressive Distributed Lag) model. The NARDL model can also detect price asymmetry relationships appearing between markets. Thus, it can be seen that there is a price asymmetry relationship that occurs when the price of CPO in one market increases and decreases against prices in other markets.

A long-term relationship between futures and spot prices indicates that the market is efficient (Wulandari et al., 2019). Otherwise, the absence of a long-term relationship indicates that future prices provide inadequate information. Thus, the futures market cannot respond to changes developing in spot prices (Ali & Gupta, 2011). Therefore, a market in equilibrium in the long term has the possibility of an imbalance in the short term.

The stages of the efficiency testing of the spot and futures market for CPO commodities in this study started with the stationarity test. The stationarity test used in this study is the Augmented Dickey-Fuller (ADF) test. The research hypothesis used in the ADF test consists of the null hypothesis (Ho), stating that there is a unit root in the data used and Hypothesis one (H1) states that there is no unit root in the data used. The data is stationary if H0 is rejected when the t-statistic value is less than the critical value at the 5% significance level, or 10%, or the resulting p-value is less than 0.05.

A stationary test was first performed at the data level. If the results obtained state rejecting Ho, the data are stationary at the level. However, if the data are not stationary, the stationary data test is carried out repeatedly at the first derivative level (first difference). Finally, if the results are obtained to state that Ho rejected at the level of the first derivative, the data are stationary at the first difference and can be carried out in the following test stage.

After the stationarity test, the next test is the Bound test. The Bound test is a cointegration test used to determine whether there is a cointegration relationship between variables that are not stationary at the data level. Pesaran et al. (2001) popularized Bound Test, which stated that there were two critical values, namely the lower critical value (lower bound) and the upper critical value (upper bound). The presence of cointegration is indicated by the F-Statistic value, which is above the critical value. Meanwhile, if the result of the F-statistic value is less than the lower bound, it can be concluded that there is no cointegration. If the F-Statistic value lies between the two critical values, the condition shows that it cannot be concluded.

Table 1. Types of data, amount, and data sources used

Data	Unit	Data Period	Source
Medan CPO Spot Prices	US $/Ton	2016-2020	BAPPEBTI
Indonesian CPO Futures Price	US $/Ton	2016-2020	ICDX
Malaysian CPO Futures Price	US $/Ton	2016-2020	Investing
Rotterdam Forward Prices	US $/Ton	2016-2020	BAPPEBTI
Rupiah exchange rate	Rp	2016-2020	Bank Indonesia
Ringgit Exchange Rate	Ringgit	2016-2020	Investing

NARDL Model

The variables used in this study consisted of CPO prices on the Medan Spot Market, CPO prices on the Jakarta Futures market, CPO prices on the Malaysian Futures market, and CPO prices on the Rotterdam Forward market. The NARDL model used in this study consists of two periods: the period prior to and during the covid 19 pandemic. Therefore, the price relationship between the Medan Spot market and the Jakarta futures market will be attached to the NARDL model in equation 1 and 2 as follows:

$$LN\_SM\_SAAT_t = \alpha_0 + \theta_1 LN\_SM\_SAAT_{t-1} + y^{+} LN\_FJ\_SAAT\_POS_{t-1} + y^{-} LN\_FJ\_SAAT\_NEG_{t-1} + \Sigma^{q}_{i=1} (\beta^{+}_{i} \Delta LN\_FJ\_SAAT\_POS_{t-1} + \beta^{-}_{i} \Delta LN\_FJ\_SAAT\_NEG_{t-1}) + \varepsilon_t \ldots(1)$$

$$LN\_SM\_SEB_t = \alpha_0 + \theta_1 LN\_SM\_SEB_{t-1} + y^{+} LN\_FJ\_SEB\_POS_{t-1} + y^{-} LN\_FJ\_SEB\_NEG_{t-1} + \Sigma^{q}_{i=1} (\beta^{+}_{i} \Delta LN\_FJ\_SEB\_POS_{t-1} + \beta^{-}_{i} \Delta LN\_FJ\_SEB\_NEG_{t-1}) + \varepsilon_t \ldots(2)$$

The price relationship between the Medan Spot market and the Malaysian futures market in the period during and before the covid-19 pandemic will be connected to the NARDL model in equations 3 and 4 as follows:

$$LN\_SM\_SAAT_t = \alpha_0 + \theta_1 LN\_SM\_SAAT_{t-1} + y^{+} LN\_FJ\_SAAT\_POS_{t-1} + y^{-} LN\_FM\_SAAT\_NEG_{t-1} + \Sigma^{q}_{i=1} (\beta^{+}_{i} \Delta LN\_FM\_SAAT\_POS_{t-1} + \beta^{-}_{i} \Delta LN\_FM\_SAAT\_NEG_{t-1}) + \varepsilon_t \ldots(3)$$

$$LN\_SM\_SEB_t = \alpha_0 + \theta_1 LN\_SM\_SEB_{t-1} + y^{+} LN\_FM\_SEB\_POS_{t-1} + y^{-} LN\_FM\_SEB\_NEG_{t-1} + \Sigma^{q}_{i=1} (\beta^{+}_{i} \Delta LN\_FM\_SEB\_POS_{t-1} + \beta^{-}_{i} \Delta LN\_FM\_SEB\_NEG_{t-1}) + \varepsilon_t \ldots(4)$$

The price relationship model between the Medan Spot market and the Rotterdam forward market in the period during and before the covid-19 pandemic will be connected to the NARDL model in equations 5 and 6 as follows:

$$LN\_SM\_SAAT_t = \alpha_0 + \theta_1 LN\_SM\_SAAT_{t-1} + y^{+} LN\_FR\_SAAT\_POS_{t-1} + y^{-} LN\_FR\_SAAT\_NEG_{t-1} + \Sigma^{q}_{i=1} (\beta^{+}_{i} \Delta LN\_FR\_SAAT\_POS_{t-1} + \beta^{-}_{i} \Delta LN\_FR\_SAAT\_NEG_{t-1}) + \varepsilon_t \ldots(5)$$

$$LN\_SM\_SEB_t = \alpha_0 + \theta_1 LN\_SM\_SEB_{t-1} + y^{+} LN\_FM\_SEB\_POS_{t-1} + y^{-} LN\_FM\_SEB\_NEG_{t-1} + \Sigma^{q}_{i=1} (\beta^{+}_{i} \Delta LN\_FR\_SEB\_POS_{t-1} + \beta^{-}_{i} \Delta LN\_FR\_SEB\_NEG_{t-1}) + \varepsilon_t \ldots(6)$$

Description: LN_SM_TIME (CPO prices on the Medan Spot market during the pandemic period); LN_SM_SEB (CPO prices on the Medan Spot market in the preceding the pandemic period); LN_FM_TIME_POS (Positive CPO prices on the Malaysian futures market during the pandemic period); LN_FM_TIME_NEG (Negative CPO price on Malaysian futures market during pandemic period); LN_FM_SEB_POS (Positive CPO prices on the Malaysian futures market in the preceding pandemic period); LN_FM_SEB_NEG (Negative CPO prices on the Malaysian futures market in the preceding pandemic period); LN_FJ_TIME_POS (Positive CPO prices on the Jakarta futures market during the pandemic period); LN_FJ_TIME_NEG (Negative CPO prices on the Jakarta futures market during the pandemic period); LN_FJ_SEB_POS (Positive CPO prices on the Jakarta futures market in the preceding pandemic period); LN_FJ_SEB_NEG (Negative CPO prices on the Jakarta futures market in the preceding pandemic period); LN_FR_TIME_POS (Positive CPO prices on the Rotterdam forward market during the pandemic period); LN_FR_TIME_NEG (Negative CPO prices in the Rotterdam forward market during the pandemic period); LN_FR_SEB_POS (Positive CPO prices on the Rotterdam forward market in the preceding pandemic period); LN_FR_SEB_NEG (Negative CPO prices in the Rotterdam forward market in the preceding pandemic period); α (Constant); θ, Y^{+}, Y^{-} , β^{-}_{i} , β^{+}_{i} (Coefficient); ε (Residual).

The hypothesis used in this study consists of:

H1: there is an asymmetric relationship between the Medan spot market and the Jakarta futures market in the period before the covid-19 pandemic

H2: there is an asymmetric relationship between the Medan spot market and the Jakarta futures market in the period during the covid-19 pandemic

H3: there is an asymmetric relationship between the Medan spot market and the Malaysia futures market in the period before the covid-19 pandemic

H4: there is an asymmetric relationship between the Medan spot market and the Malaysia futures market in the period during the covid-19 pandemic

H5: there is an asymmetric relationship between the Medan spot market and the Rotterdam forward market in the period before the covid-19 pandemic

H6: there is an asymmetric relationship between the Medan spot market and Rotterdam forward market in the period during the covid-19 pandemic

Efficient market relations is a condition the market can react quickly to reach a new equilibrium based on available information. Thus, a new balance will occur quickly if market participants make decisions adjustments based on the new information. The shock from the supply and demand sides due to the pandemic caused a shock to the price equilibrium of agricultural products, especially CPO commodities. Therefore, this study will analyze the effect of the Covid-19 pandemic on the efficiency of the CPO commodity market in Indonesia. The researcher will also discuss the market efficiency that occurred in the period before and during the pandemic so that the influence caused by the Covid 19 pandemic can be seen on the efficiency of the CPO commodity futures market in Indonesia.

RESULT

According to the information in Table 2, it can be seen that the lowest average CPO price in the preceding period of the pandemic occurred in the Malaysian futures market, which stood at $609.22. In the post-pandemic period, the least average price was also found in the Malaysian futures market at $664.94. The average price on the Malaysian futures market was the flattest. Overall, the average CPO price in all markets was more significant during the Covid-19 period than in the preceding period of the covid-19 pandemic. Thus, the pandemic has increased the average price of CPO received by market participants. Research conducted by (Zmami & Ben-Salha, 2019) shows the same condition, where there was an increase in agricultural commodities and crude oil prices during the financial crisis in 2008.

The standard deviation value reflects the lowest level of CPO price fluctuation in the preceding period of the COVID-19 pandemic in the Malaysian futures market, which was 74.3. The lowest standard deviation value occurred during the pandemic in the Jakarta futures market. The results obtained indicate that the risk of price fluctuations faced by market participants in the Malaysian futures market increased higher than the risk experienced by market participants in the Jakarta futures market during the pandemic. The identical pattern also occurred in the coefficient of variation, when the smallest coefficient of variation arose in the Malaysian futures market preceding the covid-19 pandemic. In contrast, the low coefficient of variation during the covid-19 pandemic existed in the Rotterdam forward market. As a result, each market's standard deviation and coefficient of variation increased. Thus, the COVID-19 pandemic has caused an increase in the level of risk of price uncertainty experienced by CPO market participants. These results follow the study results (Tadesse et al., 2014), which stated that the crisis period caused an increase in price volatility and the risk of price fluctuations experienced by market participants. The test carried out at the initial stage is the data stationarity test. The test was conducted using the Augmented Dicky Fuller (ADF) test. The variable is declared stationary if the p-value is less than 0.05. Based on the information in Table 3, the p-value of the Medan spot market, Jakarta

Futures market, Malaysian futures market, and Rotterdam forward market prior to and during the pandemic level is more significant than 0.05. Thus, all variable price data at the level are not stationary. Therefore, it is necessary to gauge stationarity at the first difference level (first derivative).

Table 4 shows the stationarity test results for all CPO price variables at the first difference level. The p-value of the price variable in all markets at the first difference level is less than 0.05. Thus, the price variable in all markets is stationary at the first difference level. Static data have a constant average value and variance so that the time series data used are complimentary from trend elements. If all price data are stationary at the first difference level, the further step is to perform a cointegration test.

Table 2. Descriptive Statistics of CPO Prices in the Period Before and During the Covid-19 Pandemi

Information	Period	Average	Standard Deviation	Minimum	Maximum	Coefficient of Variation
Malaysia Futures	Before the Pandemic	609.22	74.30	451.30	768.06	12.20%
	During the Pandemic	664.94	131.76	462.48	961.09	19.82%
Futures Jakarta	Before the Pandemic	626.98	88.26	455.39	801.39	14.08%
	During the Pandemic	673.03	126.02	495.29	976.26	18.72%
Forward Rotterdam	Before the Pandemic	667.27	91.53	480.00	880.00	13.72%
	During the Pandemic	697.99	126.98	500.00	1,035.00	18.19%
Medan Spot	Before the Pandemic	610.64	99.16	404.23	857,72	16.24%
	During the Pandemic	653.80	142.25	430.39	996.71	21.76%

Table 3. Stationarity Test Results at Level

Description	Level	Before the Pandemic	Conclusion	During the Pandemic	Conclusion
		P-Value		P-Value	
Medan Spot Market	Level	0.2740	Not Stationary	0.9685	Not Stationary
Jakarta Futures Market Positive	Level	0.0341	Not Stationary	0.9865	Not Stationary
Jakarta Futures Market Negative	Level	0.7275	Not Stationary	0.5572	Not Stationary
Malaysia Futures Market Positive	Level	0.9320	Not Stationary	0.8752	Not Stationary
Malaysian Futures Market Negative	Level	0.9982	Not Stationary	0.1130	Not Stationary
Rotterdam Forward Market Positive	Level	0.9224	Not Stationary	0.9837	Not Stationary
Rotterdam Forward Market Negative	Level	0.9917	Not Stationary	0.3356	Not Stationary

Table 4. Stationarity Test Results at the First Difference

Description	Before the Pandemic	Conclusion	During the Pandemic	Conclusion
	P-Value		P-Value	
Medan Spot Market	0.0000	Stationary	0.0000	Stationary
Jakarta Futures Market Positive	0.0000	Stationary	0.0000	Stationary
Jakarta Futures Market Negative	0.0000	Stationary	0.0000	Stationary
Malaysia Futures Market Positive	0.0000	Stationary	0.0000	Stationary
Malaysian Futures Market Negative	0.0000	Stationary	0.0000	Stationary
Rotterdam Forward Market Positive	0.0000	Stationary	0.0000	Stationary
Rotterdam Forward Market Negative	0.0000	Stationary	0.0000	Stationary

Cointegration Test Analysis

A cointegration test was conducted to determine the long-term relationship between CPO prices in the Medan spot market, Jakarta futures market, Malaysian futures market, and Rotterdam forward market. The cointegration test was used to analyze the relationship between price variables that are not stationary. In addition, a cointegration test was carried out using Bound Testing Cointegration. The F statistic value generated from the cointegration test was compared with I(0) and I(1) in the Bound Testing table. If the F-statistic value obtained is less than I(0), it can be concluded that there is no cointegration relationship between variables. However, if the F statistic obtained is higher than I(1), it can be concluded that there is a cointegration relationship between variables.

The relationship between the price variables analyzed in this study consisted of the price relationship between the Medan spot market and the Jakarta futures market, the price relationship between the Medan spot market and the Malaysian futures market, and the price relationship between the Medan spot market and the Rotterdam Forward market. Table 5 shows the cointegration relationship between the markets formed.

Table 5. Cointegration test results

Description		F Statistics	Prob	99% Bound Table		Results
				I(0)	I(1)	
The Relationship between the Medan Spot Market and the Jakarta Futures Market	Before the Pandemic	10.90	0.0000	4.13	5	There is Cointegration
	During the Pandemic	5.9	0.0000	4.13	5	There is Cointegration
The Relationship between the Medan Spot Market and the Malaysian Futures Market	Before the Pandemic	15.4	0.0000	5.15	6.36	There is Cointegration
	During the Pandemic	13.89	0.0000	4.13	5	There is Cointegration
The Relationship between the Medan Spot Market and the Rotterdam Forward Market	Before the Pandemic	63.35	0.0000	3.55	4.38	There is Cointegration
	During the Pandemic	82.33	0.0000	4.13	5	There is Cointegration

Based on the data in Table 5, the cointegration test results of the price relationship between the Medan spot market and the Jakarta futures market stand at 10.9 in the preceding pandemic and 5.9 during the pandemic. Therefore, the F statistic value before and during the pandemic is more than I(1) in the Bound Test table. Thus, it can be stated that there is cointegration between the CPO price on the Medan spot market and the Jakarta futures market.

F value test statistic cointegration of the CPO price variable between the Medan spot market and the Malaysian futures market in the pre-pandemic period was 15.4. However, it reached 13.89 during the pandemic period. Therefore, the F value in both periods is greater than the value of I(1) Bound Test table. Therefore, it can be concluded that there is a cointegration relationship between the Medan spot market and the Malaysian futures market preceding and during the pandemic. The cointegration relationship between the Medan spot market and the Rotterdam forward market shows a statistical F value of 63.55 in the pre-pandemic period and 82.33 during the pandemic. The value of the F statistic formed in both periods is greater than the value of table I(1). Hence, it can be stated that there is a long-term relationship (cointegration) between CPO prices on the Medan spot market and the Rotterdam forward market in both periods.

The results obtained from the cointegration relationship between markets in the three models above show a long-term relationship between markets previous to and during the COVID-19 pandemic. The cointegration between variables indicates an error correction mechanism in the model where the long-term relationship between variables is an adjustment of the short-term relationship between variables in the model.

NARDL Model Result

This study discusses the price relationship between the spot market in Indonesia and the CPO commodity futures market, which consists of the Jakarta futures market, the Malaysian futures market, and the Rotterdam forward market. Table 6 presents the most acceptable non-linear ARDL model for the relationship between the Medan spot market and the Jakarta futures market before and during the Covid-19 pandemic.

The advantage of using the NARDL model is the capacity model to analyze the asymmetric relationship occurring between the dependent and independent variables. Thus, the asymmetric relationship exists due to price rises and declines that develop from one market to another (Kamaruddin et al., 2021). From Table 6, the long-term asymmetric value is less than 1%, which is approximately 0.0003 prior to the Covid-19 pandemic. Moreover, it slightly drops to 0.0023 during the covid 19 pandemic. Consequently, the effect of price movement has a remarkable impact in both periods. The increase in CPO prices has a more considerable impact than the decline in the prices.

Table 6. Results of the NARDL model price relationship between the medan spot market and the jakarta futures market

Period During Pandemic			Period Before the Pandemic		
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
C	1.154453	0.0001	C	0.938383	0.0000
LN_SM_TIME(-1)	-0.182798	0.0000	LN_SM_SEB(-1)	-0.153431	0.0000
LN_FJ_TIME_POS(-1)	0.213618	0.0004	LN_FJ_SEB_POS(-1)	0.177032	0.0000
LN_FJ_TIME_NEG	0.210345	0.0022	LN_FJ_SEB_NEG(-1)	0.173913	0.0000
D(LN_FJ_TIME_POS)	0.99562	0.0000	D(LN_SM_SEB(-1))	-0.234509	0.0000
			D(LN_SM_SEB(-2))	-0.110562	0.0012
			D(LN_SM_SEB(-3))	-0.047	0.1391
			D(LN_FJ_SEB_POS)	0.363189	0.0004
			D(LN_FJ_SEB_POS(-1))	0.752711	0.0000
			D(LN_FJ_SEB_POS(-2))	0.320709	0.0017
			D(LN_FJ_SEB_POS(-3))	0.176166	0.0840
			D(LN_FJ_SEB_NEG)	0.570397	0.0000
			D(LN_FJ_SEB_NEG(-1))	0.390574	0.0001
Error Correction Term					
CointEq(-1)*	-0.182798	0.0000	CointEq(-1)*	-0.153431	0.0000
Asymmetric Effect					
Long-term	12.97162	0.0003	Long-term	9.330255	0.0023
Short-term	26,27816	0.0000	Short-term	6.073139	0.0137
Coefficient Of Determination					
R-squared		0.185722	R-squared		0.254424

The CPO price relationship between the Medan spot market and the Malaysian futures market has a long-term asymmetric effect before and during the COVID-19 pandemic. This is indicated by a significant value of less than 0.05 in each period. In the preceding covid-19 pandemic, the probability value of the long-term asymmetric effect was 0.0060, while it soared to 0.0375 during the Covid-19 pandemic (Table 7). Thus, there is a difference in the effect of CPO price movements on the Malaysian futures market on CPO prices on the Medan spot market. The short-term asymmetric effect only appeared during the covid pandemic with a probability value of 0.0066. Prior to the COVID-19 pandemic, the short-term asymmetric effect was not identified since the probability value was 0.6986.

The error correction term value illustrates the speed of balance adjustment in the long term as a response to the balance shocks in the short term. The Error Correction Term (ECT) variable was significant preceding and during the Covid-19 pandemic. This condition implies that the

CPO price relationship between the Medan spot market and the Malaysian futures market is efficient in the short and long term. The ECT model lag coefficient value prior to the Covid-19 pandemic was 0.2969; it dropped to 0.1515 during the Covid-19 pandemic. Therefore, the ECT value indicates that the level of price adjustment in the long term between the Medan spot market and the Malaysian futures market is 29.69% in the pre-pandemic period and 15.15% during the pandemic period.

Table 7. Results of the NARDL Model Price Relationship between the Medan Spot Market and the Malaysian Futures Market

Period During Pandemic			Period Before the Pandemic		
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
C	1.880275	0.0000	C	0.937060	0.0000
LN_SM_TIME(-1)*	-0.29694	0.0000	LN_SM_SEB(-1)*	-0.151590	0.0000
LN_FM_TIME_POS(-1)	0.37133	0.0000	LN_FM_SEB_POS(-1)	0.209577	0.0000
LN_FM_TIME_NEG	0.394222	0.0000	LN_FM_SEB_NEG(-1)	0.207709	0.0000
D(LN_FM_TIME_POS)	0.195125	0.1960	D(LN_SM_SEB(-1))	-0.244613	0.0000
D(LN_FM_TIME_POS(-1))	0.476265	0.0034	D(LN_SM_SEB(-2))	-0.102293	0.0009
			D(LN_SM_SEB(-3))	-0.049071	0.0966
			D(LN_FM_SEB_POS)	0.215267	0.0121
			D(LN_FM_SEB_POS(-1))	0.667939	0.0000
			D(LN_FM_SEB_NEG)	0.206319	0.0136
			D(LN_FM_SEB_NEG(-1))	0.424749	0.0000
			D(LN_FM_SEB_NEG(-2))	0.171467	0.0542
Error Correction Term					
CointEq(-1)*	-0.29694	0.0000	CointEq(-1)*	-0.151590	0.0000
Asymmetric Effect					
Long-term	4.328356	0.0375	Long-term	7.556490	0.0060
Short-term	10.04491	0.0066	Short-term	0.149938	0.6986
Coefficient Of Determination					
R-squared		0.3135	R-squared		0.3017

Table 8. Results of the NARDL Model Price Relationship between the Medan Spot Market and the Forward Rotterdam market

Period During Pandemic			Period Before the Pandemic		
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
C	3.878763	0.0000	C	2.865618	0.0000
LN_SM_TIME(-1)	-0.60826	0.0000	LN_SM_SEB(-1)	-0.463555	0.0000
LN_FR_TIME_POS	0.752546	0.0000	LN_FR_SEB_POS(-1)	0.558335	0.0000
LN_FR_TIME_NEG(-1)	0.756201	0.0000	LN_FR_SEB_NEG(-1)	0.555831	0.0000
D(LN_FR_TIME_NEG)	1.15104	0.0000	D(LN_SM_SEB(-1))	-0.08958	0.0001
			D(LN_FR_SEB_POS)	1.194841	0.0000
			D(LN_FR_SEB_NEG)	0.754454	0.0000
Error Correction Term					
CointEq(-1)*	-0.60826	0.0000	CointEq(-1)*	-0.463555	0.0000
Asymmetric Effect					
Long-term	32.4154	0.0000	Long-term	30.39099	0.0000
Short-term	171.5227	0.0000	Short-term	26.09989	0.0000
Coefficient Of Determination					
R-squared		0.7229	R-squared		0.579079

Regarding the data in Table 8, the long-term asymmetric effect arose between the Medan spot market and the Rotterdam forward market preceding and during the Covid-19 pandemic.

Short-term asymmetry effects also occurred in the prior period of the Covid-19 pandemic. The short-term asymmetric probability value in the preceding period and during the covid-19 pandemic was 0.000. A probability value of less than 5% indicates an asymmetric effect in the short term. Accordingly, it can be stated that there is an asymmetric effect of price fluctuations in the Rotterdam forward market on the Medan spot market in the short term.

In the pre-pandemic period, the ECT coefficient of the relationship model between the Rotterdam forward market and the Medan spot market was 0.6082. Meanwhile, in the post-pandemic period, the ECT coefficient value was corrected to 0.4035. The long-term price adjustment rate between the Medan spot and the Rotterdam forward markets was 60.82% in the pre-pandemic period and 40.35% during the pandemic. Therefore, the value of the adjustments occurring between markets is lesser during the pandemic.

Based on the results of the NARDL model of the price relationship between the Medan spot market with the Jakarta futures market, the Medan spot market with the Malaysian futures market, and the Medan spot market with the Rotterdam forward market, it can be implied that there is a short-term and long-term asymmetry relationship between markets. Thus, increases and decreases in CPO prices on the futures market have disparate effects on the Medan spot market prices. The consequence of price increases on the futures market has a more significant impact than price declines in the long term.

The price asymmetry relationship between the spot and futures markets also occurred before and during the COVID-19 pandemic. Consequently, CPO market players must be alert to price fluctuations occurring in the futures market since they will affect prices that exist in the spot market. The results of this study are consistent with the results of the study conducted by (Peri et al., 2013), which stated that the futures market affects the spot market in periods of crisis. (Baur & Dimpfl, 2018) also stated an asymmetry relationship between the price of iron (metal) commodities and agricultural commodities consisting of meat, milk, and cereals during the global financial crisis in 2007.

The ECT value in all models is significant and efficient. The efficient relationship between the spot market and futures market signals the effectiveness of hedging carried out by market participants for CPO commodities (Gandhy et al., 2021). The results of this study are also parallel with the research conducted by (Mckenzie & Holt, 2002), which analyzed the efficiency of futures markets for catfish, pork, corn, and soybeans on the Chicago Board of Trade Chicago Mercantile Exchange futures. The results showed that the futures market is efficient in the long run. A study on the integration of spot and futures markets for agricultural commodities in Turkey was also conducted (Ozturk, 2020). The commodities studied consisted of wheat, corn, soybeans, rice, and barley. The results presented that the spot prices of wheat, corn, soybeans, and barley correlated with prices on the futures market.

Managerial Implication

The Covid-19 pandemic has induced the average price of CPO to be more considerable than the period prior to the Covid-19 pandemic on the spot market and futures market. It reflects the level of risk faced by CPO commodity market participants, which also grew during the Covid-19 pandemic. Increased uncertainty and risk faced by market participants have led to the demand for hedging. The purpose of hedging activity is to minimalize risks caused by the increased price fluctuations during the Covid-19 pandemic. Hedging is an activity taking the opposite position in the futures market from the spot market. With the opposite position between the spot and futures markets, the risks faced by market participants can be diminished, especially during the Covid-19 pandemic.

The relationship between the spot and futures markets examined is efficient in the short and long terms. An efficient relationship between the spot market and the futures market for CPO commodities occurred before and during the Covid-19 pandemic. An efficient market is a market whose price construction reflects the complete information that market participants can access instantly. Thus, the hedging function performed by the CPO commodity market participants will run effectively.

CONSLUSIONS

The Covid-19 pandemic generates the average CPO price to increase in spot and futures markets. Moreover, the risk of price uncertainty experienced by CPO commodity market participants was also enhanced during the Covid-19 pandemic. There is a price asymmetry relationship between the spot and futures markets before and during the covid-19 pandemic—an increase in price causes a more significant impact than a decline in price in the long run. In addition, there is a balanced relationship in the long term and short term between the spot market and the futures market for CPO commodities preceding and during the Covid-19 pandemic. Thus, the hedging function performed by the CPO commodity market participants will run effectively. The research results indicate that CPO market players, especially oil palm farmers in Indonesia, can use the futures market to carry out hedging activities. Thus, the risk of price fluctuations faced in the future can be minimized. The results of this study are in line with the findings of (Govindan Nair, 2018), (Salerno, 2017) and (Umar et al., 2021), which state that hedging activities have a positive effect during a crisis period.

REFERENCES

Avinash, Mallikarjunappa T. 2017. Impact of economic crises on the price discovery dynamics of spot & index futures market. *Asian Journal of Research in Banking and Finance* 7(7):78. https://doi.org/10.5958/2249-7323.2017.00070.0

Baur DG, Dimpfl T. 2018. The asymmetric return-volatility relationship of commodity prices. *Energy Economic*s 76:378–387. https:// doi.org/10.1016/j.eneco.2018.10.022

Bhat JA, Sharma NK. 2020. Identifying fiscal inflation in India: Some recent evidence from an asymmetric approach. *Journal of Economics, Finance and Administrative Science* 25(50):363–393. https://doi.org/10.1108/JEFAS-03-2019-0032

[BPS] Badan Pusat Statistik. 2020. *Berita Resmi Statistik No 64/08/Th.XXII, 5 Agustus 2020.* Jakarta: Badan Pusat Statistik.

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

Chen JV, Prince YG, Ha QA. 2017. The lead lag relationship between spot and futures markets in the energy sector. *International Journal of Energy Economics and Policy* 7(4):23–30.

Gandhy A, Harianto, Nurmalina R, Suharno. 2021. Price discovery of crude palm oil in indonesia spot and futures market. *International Journals of Sciences and High Technologies* 29(2):430–438. https://doi.org/10.4135/9781412952613.n203

Govindan Nair ST. 2018. The effects of financial crisis on hedging efficiency of Indian rubber future markets. *Financial Statistical Journal* 1(2):1–7. https://doi.org/10.24294/fsj.v1i3.608

Jiang C, Zhang Y, Razi U, Kamran HW. 2021. The asymmetric effect of COVID-19 outbreak, commodities prices and policy uncertainty on financial development in China: evidence from QARDL approach. *Economic Research-Ekonomska Istrazivanja* 10(0):1–36. https:// doi.org/10.1080/1331677X.2021.1930092

Kamaruddin K, HazmY , Masbar R, Syahnur S, Majid MSA. 2021. Asymmetric impact of world oil prices on marketing margins: Application of nardl model for the indonesian coffee. *International Journal of Energy Economics and Policy* 11(6):212–220. https:// doi.org/10.32479/ijeep.11857

Kocaarslan B, Soytas U. 2019. Asymmetric pass-through between oil prices and the stock prices of clean energy firms: New evidence from a nonlinear analysis. *Energy Reports* 5:117–125. https://doi.org/10.1016/j.egyr.2019.01.002

Mckenzie A, Holt M. 2002. Market efficiency in agricultural futures markets. *Applied Economics* 34(12):1519–1532.

OECD. 2020. *Covid-19 and The Food and The Agriculture Sector: Issues and Policy Responses.* Rome: OECD.

Ozturk O. 2020. Market integration and spatial price transmission in grain markets of Turkey. *Applied Economics* 52(18): 1–13.

Peri M, Baldi L, Vandone D. 2013. Price discovery in commodity markets. *Applied Economics Letters* 20(4):397–403.

Pesaran H, Shin H, Smith R. 2001. Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics* 16(3):289–326.

Salerno T. 2017. Cargill's corporate growth in times of crises: How agro-commodity traders are increasing profits in the midst of volatility. Agriculture and Human Values 34(1):211–222.

https://doi.org/10.1007/s10460-016-9681-8

Tadesse G, Algieri B, Kalkuhl M, von Braun J. 2014. Drivers and triggers of international food price spikes and volatility. *Food Policy* 47:117–128. https://doi.org/10.1016/j. foodpol.2013.08.014

Talbi M, de Peretti C, Belkacem L. 2020. Dynamics and causality in distribution between spot and future precious metals: A copula approach. *Resources Policy* 66(18):0–30. https://doi.org/10.1016/j. resourpol.2020.101645

Umar Z, Gubareva M, Naeem M, Akhter A. 2021. Return and volatility transmission between oil price shocks and agricultural commodities. *PLoS ONE* 16(2 February 2021):1–18. https:// doi.org/10.1371/journal. pone.0246886

Wulandari AE, Harianto H, Arifin B. 2019. The interdependence of Indonesia coffee futures and spot market and its relationship with offshore futures market. *Jurnal Manajemen dan Agribisnis* 16(1):30–43. https://doi. org/10.17358/ jma.16.1.30

Zmami M, Ben-Salha O. 2019. Does oil price drive world food prices? Evidence from linear and nonlinear ARDL modeling. *Economies* 7(1):1–18. https://doi.org/10.3390/ economies7010012