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Price Discovery of Crude Palm Oil in Indonesia Spot and Futures Market

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Abstract – Crude Palm Oil takes an essential role in the Indonesian economy. As the largest producer of Crude Palm Oil, it is necessary to analyze the process of price discovery in the market. The research investigates the price discovery of Crude Palm Oil Commodities of spot and futures market in Indonesia. Granger Causality is used to examine the price discovery of Indonesia's spot and futures market and the relationship with the Malaysia futures market and Rotterdam forward market as the International futures market. We used daily price data starting from January 2016 to December 2020. The findings depict a bidirectional causality relationship between spot and futures Crude Palm Oil markets in Indonesia. Futhermore, Jakarta futures market has an important role in the process of CPO price discovery in Indonesia. Bidirectional Causality also occurs in the Indonesian spot market with the international futures market and between the Jakarta futures market with the international futures market. The flow of information from the Malaysian futures market has the most significant impact on the Crude Palm Oil price discovery process. This research shows that the futures and spot markets play a vital role in the price discovery process for Crude Palm Oil commodities in Indonesia. Thus, market participants need to observe information related to the spot futures market and the spot market before making business decisions.

Keywords – Palm Oil, Futures Market, Price Discovery

I. INTRODUCTION

Palm oil is the most significant contributor to the supply of vegetable oil in the world. In 2019, the total world palm oil production was 73.5 million metric tons, followed by soybean oil with a total world production of 57 million metric tons. Rapeseed oil is in third place with 27.62 million metric tons and sunflower oil with a production volume of 19.33 million metric tons [1]. According to the data mentioned, palm oil has become the most consumed vegetable oil by consumers globally.

Palm oil also plays a vital role in the trade balance in Indonesia. In 2019, the total trade in Indonesia reached $338.95 billion. Moreover, total exports amounted to $167.68 Billion, and the import value was approximately $171.27 Billion. Thus Indonesia experienced a trade balance deficit of $3.59 billion. The deficit was due to fuel oil imports in the oil and gas sector of $ 10.09 billion. Meanwhile, in the non-oil and gas sector, Indonesia experienced a surplus of $6.5 billion [2]. Therefore, palm oil is one of the most significant contributors to Indonesia's trade surplus in the non-oil and gas sector.

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High price fluctuation is an issue that often occurs in the marketing process of agricultural products, including palm oil. Fluctuations in agricultural commodity prices are caused by an imbalance in the supply of goods from producers and the volume of consumer needs [3]. If consumer demand is greater than the goods supplied, the price of agricultural commodities will rise, and if the producer supply exceeds the volume demanded by consumers, the price will decline. In CPO commodities, the volume of production produced by farmers are highly dependent on climatic conditions, plant age, use of fertilizers, pesticides, and plant care processes [4]. In addition, the perishable nature of agricultural products causes prices to tend to fluctuate. As a result, price changes occur rapidly [5].

The effect of price fluctuations for producers is the fluctuating income received by producers. For consumers, price fluctuations can cause the budget allocation of planned expenditures to disrupt. Therefore, price fluctuations are conditions that producers and consumers do not expect. Due to high price fluctuations, the welfare obtained by consumers and producers is not optimal.

Price fluctuations and uncertainty of future CPO production make consumers and producers seek ways to overcome these difficulties. Making transactions on the futures exchange might be a solution to solve the issues. Transactions in the futures market will clarify how much volume producers must produce to provide an overview of the number of production factors needed to produce several products desired by the market. Producer comprehension about the certainty of the number of products produced is beneficial to minimize the risk of low prices due to excess supply.

Hedging is an activity carried out by CPO commodity market participants to reduce the risks due to price fluctuations. Buying and selling futures contracts on commodities on the futures exchange allow market participants to manage the risks faced by hedging activities. Moreover, hedging is a transfer of risk due to price volatility by making transactions in futures trading. Hedging activity is in the form of taking positions in the futures market instead of the physical market. The opposite position between the futures and physical markets aims to reduce the risk of losses arising from price fluctuations. The mechanism is that losses in the physical market will be decreased by the profits earned on the futures market and vice versa.

There are two types of the CPO futures market, namely the forward market and the futures market. The forward and futures markets are markets where the sale and purchase of CPO commodities are conducted at a specific price and volume in the future. The difference is where the trade takes place. Futures contracts are traded on the exchange floor, while forward contracts are traded on the over-the-counter market. Thus, a forward contract is a simple form of a futures contract traded outside the exchange. Transactions in the forward market and futures market are a form of hedging carried out by market participants.

The CPO Futures Market is also considered as a price discovery on CPO commodities; thus, the price developed in the futures market can be a reference for market participants in determining CPO prices [6]. Additionally, the futures market facilitates sellers and buyers of CPO contracts in the process of forming prices at the time of delivery of goods (future spot prices) by agreeing on futures contacts in advance, in which there is an agreement on the price and quantity of goods long before the goods are delivered. The certainty of prices received by market participants is beneficial for producers and consumers. For producers, the selling price agreed long in advance will increase the reliability of the income received.

Sellers and buyers are not associated with each other. However, they are facilitated by data on the number of bids and asks so that the amount of supply and demand at a specific price can be identified in the market. Otherwise, the futures market plays a role in a transparent and efficient price discovery process. The establishment of transparent CPO prices in the spot market is one solution to the issue of price formation in the spot market. However, the market structure of the spot market for CPO commodities in Indonesia leads to an oligopoly market. Four CPO producers control most of the CPO market in Indonesia, namely Astra Agro Lestari, Asian Agri, Sinar Mas, and Wilmar Nabati [7]. The market structure leading to oligopoly causes market players to have more influence than other market participants in the price formation process.

The futures market in Indonesia was established in 1999. Compared to the Malaysian futures market, the futures market in Indonesia for CPO commodities is still relatively new, which has conducted CPO commodity transactions since October 1980. As a relatively current market, evaluating the performance of the Indonesian futures market as a means of price discovery for CPO commodities is required. Thus, the price relationship between Indonesia's spot and futures markets and its relation to prices on the international futures market can be perceived. As the largest CPO producer globally, it is only natural that Indonesia has a high bargaining position and becomes a price reference for the international market.

Previous researchers who conducted studies about the price discovery process between the spot and futures markets have not produced a similar conclusion. Research conducted by [9] and [10] stated that the futures market had a vital role in influencing price discovery in the spot market. In comparison, the research [11] and [12] resulted in the opposite conclusion and stated that the spot market influenced the price formation on the futures market. Research [13] and [14] stated an unclear relationship and price discovery process between the spot and futures markets.

The difference in the results obtained by previous researchers regarding the price relationship between the spot market and futures market shows that there is no agreement yet. As a consequence, it is necessary to re-examine the relationship between spot and futures prices to add references to research results. Research on the relationship between the futures market and the spot market for CPO commodities in Indonesia is still relatively limited. Moreover, this research is essential to determine the influence of the Indonesian futures market on the function of the futures and spot markets in forming CPO commodity prices in Indonesia and the relationship occurring with the international futures market.

II. RESEARCH METHOD

2.1 Types and Data Sources

The data used in this research is secondary data. The secondary data used consists of the spot price of CPO in Medan, the price of CPO futures in Jakarta, the price of CPO futures in Malaysia, the forward price of CPO in Rotterdam, the Rupiah exchange rate against the US Dollar, and other data. 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.

Table 1. Types of Data, Amount, and Data Sources Used

No	Data	Unit	Data Period	Source
1	Medan CPO Spot Price	US $/Ton	2016-2020	BAPPEBTI
2	Indonesian CPO Futures Price	US $/Ton	2016-2020	ICDX
3	Malaysian CPO Futures Price	US $/Ton	2016-2020	MPOB
4	Rotterdam Forward Prices	US $/Ton	2016-2020	BAPPEBTI
5	Rupiah exchange rate	Rp	2016-2020	Bank Indonesia
6	Ringgit Exchange Rate	ringgit	2016-2020	Invest

2.2 Data Analysis Method

The stages passed to carry out the causality test begins with testing the stationarity of the data. The stationarity test (Unit Root Test) estimates the stationary of time series data. Engle and Granger popularized the Granger causality test in 1969. The Granger causality test is used to determine the relationship and effect of one-time series data set on another time series data set. (Granger, 1969). This study will examine the relationship between CPO commodity prices on the Indonesian spot market, Indonesian futures market, Malaysian futures market, and the Rotterdam forward market.

In this study, the unit root test used was the Augmented Dicky Fuller Test (ADF). The general equation model of the ADF test is as follows.:

$$\Delta P_t = \alpha_0 + \gamma P_{t-1} + \sum_{i=1}^{j} \beta_i \Delta P_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots(1)$$

Where:

Pt = Price in period t

Pt-1 = Price 1 month before

ΔPt = Pt – Pt-1

ε = Errors

$\alpha_0, \gamma, \beta_t$ = Parameter Coefficient

The statistical hypothesis tested is H0: = 0. It means that the time series data contains a unit root. As a result, the data is declared not stationary. If H1 : 0, it means that the data is stationary. Data that is not stationary at the level can be treated as stationary through the differentiation process (derivative). If the results of the first differentiation of the data are still not stationary, the data can be additionally differentiated so that the data are eventually stationary.

The following stage is to do a causality test. The causality test for inter-market CPO commodity prices is carried out using the Granger Causality test. The Granger Causality Test equation model is as follows:

$$S_t = \sum_{i=1}^{n} \alpha_i F_{t-i} + \sum_{j=1}^{n} \beta_j S_{t-j} + \varepsilon_{1t} \quad \text{.....(2)}$$

$$F_t = \sum_{i=1}^{n} \lambda_i F_{t-i} + \sum_{j=1}^{n} \mu_j S_{t-j} + \varepsilon_{2t} \quad \text{..... (3)}$$

Information:

St = Price of CPO Commodity in market S and time t

St-i = Price of CPO Commodity in market S and time t-i

Ft = Price of CPO Commodity in market F and time t

Ft-i = Price of CPO Commodity in market F and time t-i

ε_{1t} = Residual

The endogenous variable in equation 1 is St, while the exogenous variables in equation 1 are St-j and Ft-i. In equation 2, the endogenous variable is the variable F_t, and the exogenous variable is Ft-i and St-j. According to the theoretical framework, the price variable between the two markets will have a causal relationship based on the hypothetical relationship above.

The possible results obtained from the Granger Causality Test are as follows:

Unidirectional Causality from S to F occurs when the lag coefficient of the variable S in the first equation is statistically significant ($\sum_{j=1}^{n} \beta_j \neq 0$), while the lag variable F in the second equation is not statistically significant ($\sum_{i=1}^{n} \lambda_i = 0$). *Unidirectional Causality from F to S* occurs when the lag coefficient of the variable S in the first equation is not statistically significant ($\sum_{j=1}^{n} \beta_j - 0$), while the lag variable F in the second equation is not statistically significant ($\sum_{i=1}^{n} \lambda_i \neq 0$). *Bilateral Causality* occurs when the lag coefficient of the variable S and the lag coefficient of the variable F in both equations are statistically significant. Independent occurs when the lag coefficient of the variable S and the lag coefficient of the variable F in both equations are not statistically significant.

III. Result And Discussion

CPO commodity prices in each market in the period January 2016-December 2020 fluctuated. Consequently, data on the average price, standard deviation, minimum value, maximum value, and coefficient of variation for each market can be seen in the table.

Table 2 Average Value, Standard Deviation, Minimum, Maximum and Variation Coefficient of Each Market

Information	Average	Standard Deviation	Minimum	Maximum	Coefficient of Variation
Medan Spot Market	618.43	109.31	404.23	996.71	20.75%
Jakarta Futures Market	635.21	97.71	455.39	976.26	18.35%
Rotterdam Forward Market	672.90	99.47	480.00	1,035.00	17.19%
Malaysia Futures Market	619.23	90.01	451.30	961.09	18.33%

Referring to the information in table 2, the level of the coefficient of price variation existing in each market shows a varying value. Some markets have a coefficient of variation that has almost the same value, namely the Malaysian futures market and the Jakarta futures market, with the coefficients of variation of each market being 18.33% and 18.35%. The coefficient of variation in the Rotterdam forward market is 17.19%, and the highest coefficient of variation occurs in the Medan Spot market, which is 20.75%. Variations in the coefficient of variation between markets indicate differences in the level of fluctuations occurring between CPO markets. Variations in the coefficient of variation between markets indicate differences in the level of fluctuations between CPO markets.

The price stationarity test for each market in this study uses the Augmented Dickey-Fuller (ADF) test. In the use of time-series data, this test is required to determine whether there is a unit root in the variable. If there is a unit root, it can be determined that the data is non-stationary and vice versa. Acceptance of the hypothesis can be recognized based on the P-value of the ADF test. If the P-value is more significant than 0.05, the data are non-stationary and vice versa. If the P-value is less than 0.05, the data is stationary. The results of the price stationarity test for each market are presented in table 3.

According to the information in table 3, it shows that the p-value for each market is more significant than 0.05. These conditions indicate that price data in all markets are not stationary at the level. As a result, it is necessary to test stationarity at the first difference level.

Table 3. Unit Root Test Results

Information	Differenced	ADF value	P-Value	Conclusion
Medan Spot Market	Level	0.945975	0.8135	Not Stationary
	First Difference	-39.29946	0.0000	Stationary
Jakarta Futures Market	Level	0.978306	0.7539	Not Stationary
	First Difference	-29.65657	0.0000	Stationary
Rotterdam Forward Market	Level	1.168097	0.9193	Not Stationary
	First Difference	-38.11337	0.0000	Stationary
Malaysia Futures Market	Level	1.259691	0.9485	Not Stationary
	First Difference	-31.61682	0.0000	Stationary

The p-value obtained at the first difference level for prices in all markets is less than 0.05. Thus, it can be stated that the price data on the Medan Spot market, Jakarta Futures, Rotterdam Forward, and Malaysia Futures markets are stationary at the first difference level. If all the data has been declared stationary, the following step determines the optimal lag value.

Determination of the optimal lag in this study using Akaike Information Criteria (AIC). The optimal lag chosen is the lag with the smallest AIC value. Based on the data in table 4, the smallest AIC value is found in lag 4. Thus the lag used is lag 4.

Table 4. Optimal Lag Value

lag	LogL	LR	FPE	AIC	SC	HQ
0	-2014.28	NA	3.01e+11	37.78082	37.79949	37.78790
1	-15955.06	8279.39	1.26e+08	30.00012	30.09347	30.03549
2	-15805.40	296,786	97719591	29.74912	29.91714*	29.81278
3	-15757.46	94,705	92031272	29.68914	29.93184	29.78110*
4	-15735.90	42,430	91075953*	29.67870*	29.9608	29.79896
5	-15721.38	28,483*	91328925	29.68147	30.07352	29.83002

The following stage is to conduct a price causality test on the Medan spot market, Jakarta futures market, Malaysian futures market, and Rotterdam forward market. The results of the inter-market price causality test can be seen in table 5.

The data in table 5 show that the causal relationship between the Medan spot market and the Jakarta futures market is bidirectional (2 directions). This condition occurs because the spot price on the Medan spot market affects the price on the Jakarta futures market with a p-value lower than 0.01. Likewise, the hypothesis that the price on the Jakarta futures market affects the Medan spot market has a p-value lower than 1%. Consequently, the mutually influencing relationship between the two markets shows a bidirectional causality relationship between the Medan spot market and the Jakarta futures market.

Table 5. Granger Causality Test Results

Hypothesis	P-Value	Result	Direction
Spot Price Medan does not Granger Cause Futures Price Jakarta	4.E-27*	Rejected	Bidirectional
Futures Price Jakarta does not Granger Cause Spot Price Medan	0.0002*	Rejected	
Spot Price Medan does not Granger Cause Futures Price Malaysia	0.0723***	Rejected	Bidirectional
Futures Price Malaysia does not Granger Cause Spot Price Medan	8.E-65*	Rejected	
Spot Price Medan does not Granger Cause Forward Price Rotterdam	0.0104**	Rejected	Bidirectional
Forward Price Rotterdam does not Granger Cause Spot Price Medan	4.E-13*	Rejected	
Futures price Jakarta does not Granger Cause Futures Price Malaysia	0.0662***	Rejected	Bidirectional
Futures Price Malaysia does not Granger Cause Futures price Jakarta	6.E-46*	Rejected	
Futures price Jakarta does not Granger Cause Forward price Rotterdam	1.E-23*	Rejected	Bidirectional
Forward Price Rotterdam does not Granger Cause Futures price Jakarta	7.E-06*	Rejected	

The results show that prices on the Jakarta futures market affected prices on the Medan spot market. Thus, the role of the futures market as a means of establishing CPO commodity prices in Indonesia performs appropriately. This is because sellers and buyers in the futures market can access real-time information about the quantity and price. Besides, that market participants can also determine their bargaining position on futures according to the analysis implemented. Therefore the prices that occur in the futures market become more transparent.

The futures market is also considered efficient since market participants can swiftly change positions based on the information obtained. In addition, the low transaction costs and the speed of implementing portfolio changes in the futures market reflect that transactions on the futures market will be more accessible and more affordable than transactions on the cash market (spot).

The futures market for CPO commodities in Indonesia also plays a role in hedging activities for market players. Hedging is taking the opposite position in the futures market with a position in the spot market. Hedging activities are carried out to minimize risks that occur due to fluctuations in CPO prices.

The CPO futures market makes some contributions as a means of hedging market participants and as a place for price discovery for CPO commodities. The price discovery function will perform effectively if the futures market well facilitates the hedging function. The price discovery function will also drive well if numerous CPO market players perform hedging functions in the futures market [8]. The role of the futures market as a means of hedging and price discovery will race optimally if the price relationship between the spot and futures markets is integrated. Thus, it is necessary to study and innovate policies to play a better role in the future so that the futures market can play a better role.

Spot prices and futures prices have a mutually influencing relationship. Based on the information in Figure 5, prices in the spot market and futures market tend to move in the same direction with fluctuations that are not always identical. However, there are periods where each market has its movements that are opposed to other markets. The spot price is a reference for the formation of futures prices, but this condition does not always occur since different futures prices react differently to changes in spot prices.

In contrast, futures prices are price signals for the spot market. The effect of changes in futures prices for spot prices generally depends on the time of delivery occurring in futures trading. Accordingly, futures prices will be firmly affected by spot prices when delivery is due.

The relationship between prices on the spot market and the international futures market studied consists of the Malaysian futures market and the Rotterdam forward market. Prices on the Medan spot market affect prices on the Malaysian futures market with a significance level of 10%. Meanwhile, prices on the Malaysian futures market affect the Medan spot market price at a significance level of 1%. Hence the relationship between the Medan spot market and the Malaysian futures market is bidirectional.

Similar conditions occur in the relationship between prices on the Medan spot market and the Rotterdam forward market. As a result, the Medan spot market affects prices on the Rotterdam forward market with a significance level of 5%. Meanwhile, the Rotterdam forward market affects prices on the Medan spot market at a significant level of 1%. There is also a bidirectional relationship between the Medan spot market and the Rotterdam forward market.

The two-way relationship between the Medan spot market and the international futures market shows that the CPO market has a mutually influencing relationship in forming CPO prices. Consequently, CPO market participants are required to monitor the information that occurred in each market before executing transaction activities.

The Medan spot market can form international CPO prices as Indonesia is the largest producer of CPO. In 2018, the total CPO production of Indonesia was 43.57 million tons or 57% of world production. With such a massive production volume, CPO market players must consider CPO production in Indonesia. Moreover, factors that influence it, such as season, rainfall, and daily CPO production volume in Indonesia, must be perceived. Therefore, it is beneficial for them inasmuch as the information will affect the formation of CPO prices.

Prices on the international futures market that affect prices on the Medan spot market indicate that CPO market players in general and Indonesian CPO market players in particular need to observe information developments related to price formation in the international futures market. Thus the price formed on the international futures market influences the price formation process in the Indonesian spot market.

The data in table 5 also describe the relationship between CPO prices on the Indonesian futures market and the international futures market. Prices on the Indonesian futures market affect prices on the Malaysian futures market with a significance level of 10%. Meanwhile, the Malaysian futures market affects the Indonesian futures market significantly at the level of 1%. Thus, the Indonesian futures market and the Malaysian futures market have a two-way influence on each other. Likewise, the relationship between the Jakarta futures market and the Rotterdam forward market has a mutually influencing relationship at a significance level of 1%.

The interplay between the Indonesian futures market price and the world futures market shows that each market influences forming CPO prices. The difference in the significance level between the Malaysian futures market and the Jakarta futures market indicates a more substantial flow of information from the Malaysian futures market than the Jakarta futures market. One of the

factors causing this condition was that the Malaysian futures market stood earlier than the Jakarta futures market. CPO transactions in the Malaysian futures market began in October 1980, while the futures market in Indonesia was just established in 1999. As a consequence, the Malaysian futures market has a more considerable share than the Jakarta futures market in CPO contract transactions.

In 2017, the number of CPO contracts traded on the Jakarta Futures Exchange stood at 36,949 lots. This value is much more limited than the number of transactions on the Malaysian futures exchange, which transacted CPO contracts of 11.91 million lots in the same period of time. However, the difference in futures contract transactions between the Malaysian futures market and the Malaysian futures market is significant, indicating that market participants prefer the Malaysian futures market for CPO futures contract transactions. As a result, it is necessary to innovate so that the Indonesian futures market will advance. The steps selected are to increase local market participants in the Jakarta futures market. In addition, policymakers need to conduct more extensive socialization, especially to CPO commodity market players in Indonesia, so that new market players who conduct transactions on the Jakarta futures exchange will grow.

IV. Conclusion

There is a bidirectional relationship between the Indonesian spot market, the Indonesian futures market, and the international futures market. The result show that Jakarta futures market has an important role in the process of CPO price discovery in Indonesia

There is also a bidirectional relationship (2 directions) between the Indonesian futures market and the International Futures market. Therefore, information from the Malaysian futures market has a more significant influence than the Medan spot market, Jakarta futures market, and Rotterdam forward market.

The two-way relationship between the CPO markets shows that market players need to pay attention to developments in each market before making CPO transactions. In addition, the Indonesian futures market also plays a role in forming CPO prices in both the Medan spot market and the international futures market. Consequently, it is necessary to improve the performance of the Indonesian futures market to develop and have a more significant influence.

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