

## A Crude Palm Oil Industry Concentration and Influencing Factors: A Case Study of Indonesia as the World's Largest Producer

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### Abstract

The Crude Palm Oil (CPO) industry is one of the plantation commodities that has a strategic role in Indonesia's economic development. The number of companies and CPO production is always increasing, but the concentration of the industry that always decreases every year makes it important to analyze the factors that affect the concentration of the CPO industry in Indonesia. The data period used in this study was from 2001 to 2020. In this study, data sources were obtained from the Central Bureau of Statistics (BPS) Indonesia, World Bank, and UN Comtrade. The data analysis method used is regression analysis of the Error Correction Model (ECM). The results showed that technical efficiency has a negative and significant relationship both in the long and short term to the concentration of the CPO industry. Competitiveness in the long term has a positive and significant relationship, while in the short term it is negative but not significant to the concentration of the Indonesian CPO industry. In the long run, the relationship between RSPO and Indonesia's CPO industry concentration tends to be negative but not significant, while in the short term it shows a significant influence. World CPO prices, both long-term and short-term, provide a positive and significant correlation to the concentration of the Indonesian CPO Industry. Indonesia's CPO exports in the long and short term have a negative and significant effect on the concentration of the Indonesian CPO industry.

### Keywords

Error Correction Model (ECM), Crude Palm Oil (CPO), Industrial concentration, competitiveness, technical efficiency, policy.

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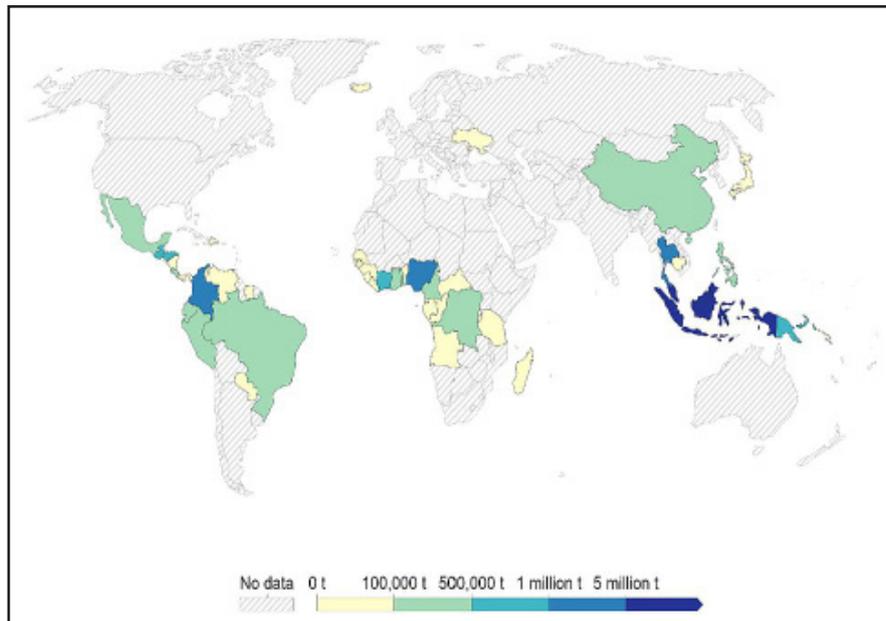
### Introduction

Crude Palm Oil (CPO) is an important vegetable oil in the global fats and oils market and its industry is also one of the leading global agricultural industries (Ahmed et al., 2015). World CPO production has grown steadily and relatively faster than oil-producing crops Vegetable Other. Industry Crude Palm Oil (CPO) is one of the plantation commodities that has a strategic role in Indonesia's economic development. Based on Figure 1, Indonesia as the world's largest CPO producer controls 56 percent of total global exports, export capacity is 72 percent of total production in 2020. This industry is able to absorb the production of smallholders, improve the welfare of independent oil palm farmers, and increase foreign exchange earnings for the country (Tiku and Bullem, 2015). Palm oil products and derivatives have been

utilized by various industrial sectors, ranging from the food, beauty, pharmaceutical, to energy industries (Ministry of Industry, 2022). Indonesia's CPO export destination countries such as India, China, Pakistan and Bangladesh are very dependent on CPO which is the region where most of the world's population is located (Ali, 2019).

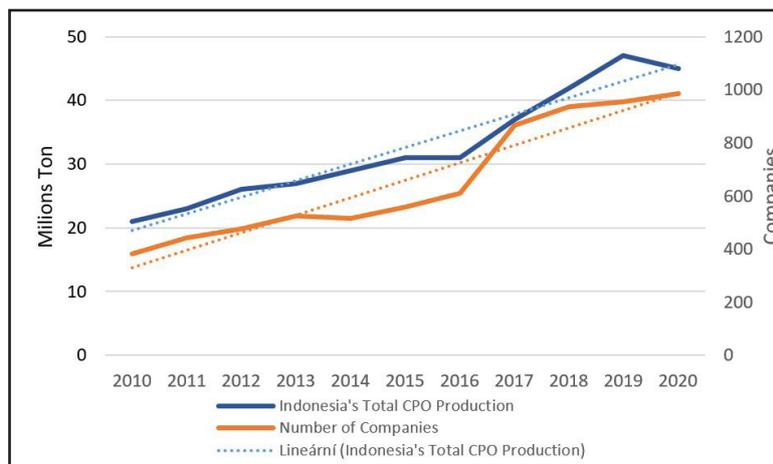
According to Carlton and Perloff (2005) and Scherer (1980), one of the determining factors of industry concentration is the number of sellers. Based on Figure 2, the number of companies and Indonesia's CPO production always increases. The more sellers there are in the CPO Industry the lower the concentration of the industry and the more balanced the market forces.

Industry concentration is also closely related to international competition. Industry concentration is important in international competition for several



Source: Food and Agriculture Organization of the United Nations

Figure 1: World CPO producer.



Source: Central Bureau of Statistics (2022)

Figure 2: Number of companies and total production of Indonesian CPO.

reasons (Porter, 1990). First, it creates different requirements for success in different industries. Industries of concentration interest create ongoing barriers to entry in areas such as technology, specific skills, access, and reputation. Changes in concentration, can create genuine opportunities for competitors from a country to penetrate new industries (Surugiu, 2015). The effect of competitiveness on industrial concentration has been studied previously by Ergashodjaeva et al., (2018) and Pomarici et al. (2021) which results in competitiveness affecting concentration.

The improvements in technical efficiency and economies of scale that occur in the CPO industry can impact on industrial concentrations. When CPO companies are more efficient and have economies of scale, they can produce more products at lower production costs. This can help lower CPO prices globally and make it difficult for small, less efficient competitors to compete. As a result, large companies with high technical efficiency and economies of scale will become major players in the CPO industry, and industry concentration may be lower as small competitors find it difficult

to survive. The influence between technical efficiency and industrial concentration has been studied by Setiawan et al. (2012).

The concentration and performance of the CPO Industry has always been an interesting study in empirical analysis, especially in terms of supporting sustainability through policy implementation. Porter (1990), and Carlton and Perloff (2005) suggests that policies can affect the concentration of an industry. In addition, the findings were also revealed in the study Dechezlepr (2017) and Lu et al. (2015). The CPO industry is faced with various challenges, including negative impacts on the environment and human rights violations. Therefore, efforts are needed to overcome this problem and promote sustainable and environmentally friendly CPO production. One of them is the development of sustainable certification policies through the Roundtable on Sustainable Palm Oil (RSPO) as a form of implementation of global standards for sustainable palm oil since 2008. The high cost of implementing RSPO can negatively impact the concentration of the CPO industry.

Some research results mention that product prices greatly affect industry concentration, this finding by Bonny (2017) and Clapp (2021). The CPO industry is a very competitive market and CPO prices are one of the main factors in determining a company's profits and market share. Companies that can offer lower CPO prices can have a competitive advantage and tend to have a larger market share, while companies with higher CPO prices may struggle to compete and tend to have a smaller market share. Therefore, fluctuations in CPO prices can affect the concentration of the CPO industry and determine the survival of companies in the CPO industry.

The concentration of the industry is strongly influenced by the export capacity of the product. High export capacity enables the company to export products to international markets and expand market share. Thus, the domestic market will not be the only market that companies in the CPO industry can tap into. In the long run, high export capacity can encourage the entry of new players into the CPO industry, which can reduce industry concentration. This has been researched by Awalludin et al. (2015) and Tanner et al., (2017). Therefore, we answer the following questions:

What is the concentration of Indonesia's CPO industry?

How does the effect of technical efficiency,

competitiveness, RSPO policy, CPO price, and CPO Export affect the concentration of Indonesia's CPO industry?

### **Literature review**

According to Bain (1956), concentration ratios are an important element in studying market structure. It signifies the extent to which companies in the industry hold market power. Companies with a high level of market power have the ability to raise prices and earn high profits in the process. Market share is often used to illustrate the level of market power a company has in an industry (Loecker et al., 2020). In analyzing the behavior of firms in the market, particularly as seen in oligopoly industries, firms compete with each other in building market power by gaining more market share. By increasing their market share, established companies prevent the entry of potential entrants following the studies contributed by Geras'kin and Chkhartishvili (2017), Tandra et al. (2022) and Hu et al. (2014).

According to Carlton and Perloff (2005), there are two models of approach in market research; the first is the Structure, Conduct and Performance (SCP) approach, which is generally used to describe market models. In the approach of the traditional New-Harvard SCP model, each component interacts with each other, as, market performance depends on market behavior. Furthermore, the market structure depends on fundamental factors, namely demand and production, including demand, substitution, seasonality, economic growth rate, location, number of orders, development methods and technologies, raw materials, product consistency, product elasticity, location, economies of scale and economic reach. The basic conditions of structure, conduct, performance affect government policy.

Economists have used a number of alternative centers in measuring industrial levels. To assist users in making informed choices among available alternatives in Lipczynski et al. (2017) suggests a number of general criteria that a particular concentration measure must meet if it is to adequately reflect the most important characteristics of the company's size distribution.

The issue of measuring market concentration has always attracted the attention of the scientific and professional community. According to Pavic et al. (2016), in a market economy, some firms do not have the ability to influence the price of their products, while other firms have the ability to influence the prices of their products.

In theory and practice, different measures of market concentration are known. Some of the steps are very simple and easy to understand, and therefore used very widely using the concentration ratio (CR). Concentration ratio provides a useful and practical indicator of market strength (Wang and Shailer, 2015). Since these indices are market-based values, they are much more useful when a company's strength in the market is determined along with other data (Ukav, 2017).

By Bikker and Haaf (2002), if the value of CR = 0 percent, the market is in a state of perfect competition, if it is between 0-50 percent, the market is perfectly competitive towards oligopoly, if CR is 50-80 percent, the market is identical to oligopoly, if CR 80-100 percent belongs to oligopoly towards monopoly, and if CR is equal to 100 percent-monopoly market. Furthermore, according to Tremblay (2012) if the CR value is between 0-40 then it is classified as a perfectly competitive market.

Naldi and Flamini (2014) it uses concentration ratio to measure how a quantity is distributed among a number of subjects (individuals or aggregates, such as households or firms). Market concentration is an important indicator to see market structure and level of competition, one of which is research Nendissa et al., (2019) analyze the CR4 of beef cattle farming industry. Research Napasintuwong (2017) analyzed the concentration of the corn seed industry and found that the market share of corn seeds in Thailand is quite concentrated with a tendency towards oligopolistic competition. Deconinck (2020) analyze the market concentration in China's seed and agricultural biotech market. Baker and Friel (2016) researched the concentration of the ultraprocessed food market in Asia. Research Outreville (2015) examine the relationship between market structure and performance in the wine sector using data from two Canadian provinces.

## Materials and methods

The scope of this research is the Crude Palm Oil (CPO) industry. The industry category in this study is from the 2020 Indonesian Business Field Standard Classification (KBLI) with code 10432. The data period used in this study was from 2001 to 2020. The data used in this study are secondary data, including Indonesian CPO industry data,

such as Indonesian CPO export data, the number of Indonesian exports, Indonesian cooking oil prices, while the international data used include world CPO exports, world exports, international CPO prices, and the Roundtable on Sustainable Palm Oil (RSPO) policy. In this study, data sources were obtained from the Central Bureau of Statistics (BPS) Indonesia, the Commodity Futures Trading Supervisory Agency (BAPPEPTI), Wordbank, UN Comtrade, the Ministry of Industry of the Republic of Indonesia, as well as factual supporting data from books and journals.

The data analysis method used is regression analysis of the error correction model (ECM). The use of this technique aims to explain whether or not there is an influence of the independent variable on the dependent variable in the short and long term (Banerjee et al., 2016). The ECM model is a model used to find long-term and short-term equilibrium regression equations and whether or not a model is consistent. The regression model used is as follows:

Long-term equation model:

$$CR4_t = \beta_0 + \beta_1 E_t + \beta_2 RCA_t + \beta_3 RSPO_t + \beta_4 PCPO_t + \beta_5 PCO_t + \beta_6 XCPO_t + e_t \quad (1)$$

Short-term equation model:

$$\Delta CR4_t = \beta_0 + \beta_1 \Delta E_t + \beta_2 \Delta RCA_t + \beta_3 \Delta RSPO_t + \beta_4 \Delta PCPO_t + \beta_5 \Delta PCO_t + \beta_6 \Delta XCPO_t + \beta_7 ECT_t + e_t \quad (2)$$

where:

- $e$  = technical efficiency,
- $RCA$  = competitiveness,
- $RSPO$  = Roundtable on Sustainable Palm Oil Policy,
- $PCPO$  = CPO Price,
- $PCO$  = Cooking Oil Price,
- $XCPO$  = Indonesian CPO Exports, Constant,
- Regression direction coefficient,
- and  $ECT$  = Error Correction Term,
- $e$  = error term.
- $\beta_0$  = intercept;  $\beta_{1,2,3,4,5,6,7}$  = Coefficient of regression direction; and  $ECT$  = Error Correction Term

Variable	Definition	Formula	Source
Concentration Ratio Four Biggest Firm (CR4)	A measure of market concentration that calculates the combined market share of the four largest companies in a given industry.	$CR_n = \sum_{i=1}^n \frac{X_i}{T_j}$	Central Bureau of Statistics Indonesia
Technical Efficiency is measured using the Stochastic Frontier Analysis method	Econometric methods are used to measure the technical efficiency of an organization or company by considering uncontrollable factors such as environmental factors, government policies, and luck factors. In stochastic frontier analysis, technical efficiency is measured by comparing the actual output produced with the expected or optimal output.	$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + (Vi - Ui)$ Information: $\ln Y_i$ = Total amount of production; $\beta_0$ = Constant; $\beta_i$ = Elasticity of production of the $i^{\text{th}}$ CPO manufacturing factor of production; $\ln X_1$ = Labor; $\ln X_2$ = raw material; $\ln X_3$ = Capital; $\ln X_4$ = fuel oil; $\ln X_5$ = Electricity; $Vi - Ui$ = error term ( $Vi$ is the noise effect, $Ui$ is the effect of technical inefficiencies in the model).	Central Bureau of Statistics Indonesia
Competitiveness (RCA)	Competitiveness is the ability of companies, regions, countries, or between regions to increase income by utilizing productive and sustainable labor and other resources to face competition by maximizing the potential of their superior products (Porter, 1990: 6).	$RCA = \frac{\left(\frac{X_{IK}}{X_{IM}}\right)}{\left(\frac{X_{WK}}{X_{WM}}\right)}$	UN Comtrade
Roundtable on Sustainable Palm Oil (RSPO)	RSPO is certified to promote sustainable palm oil production by developing and promoting environmentally friendly, social, and economic practices.		
International CPO Price	International CPO price refers to the price of crude palm oil traded on the international market		World Bank
Packaged Cooking Oil Price	The price of Indonesian packaged cooking oil refers to the price of cooking oil packaged in ready-to-use packaging and produced in Indonesia.		Central Bureau of Statistics Indonesia
Indonesia's CPO Export Value	Indonesia's CPO export value is the total value of all palm oil (CPO) exports made by Indonesia in a certain period of time. This value includes the selling price of CPO and its derivative products, minus export costs such as shipping costs, insurance, and export duties.	$\text{CPO Export Value} = \text{CPO export volume} \times \text{CPO Export Price} - \text{Export Cost}$	UN Comtrade

Source: Indonesian Central Bureau of Statistics, Worldbank, UN Comtrade, 2023

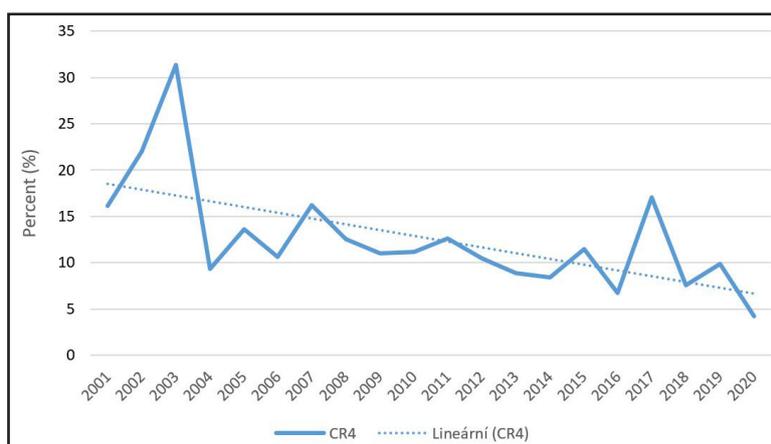
Table 1: Variable operational definition.

## Results and discussion

### Industrial concentration (CR4)

Based on Figure 3, industrial concentration (CR4) always decreases every year. The increasing number of companies entering the CPO industry and the tighter competition can cause a decrease in industry concentration (Frenken et al., 2014). This happens because the existence of new competitors can reduce the market share of existing companies and encourage healthier competition

among CPO companies (Hidayat et al., 2023). The Indonesian government has issued several regulations and policies aimed at encouraging the existence of smaller and more sustainable CPO companies (Singh and Setiawan, 2013). One example is the smallholder oil palm policy which provides opportunities for oil palm farmers to manage their own oil palm plantations. This can reduce the dominance of large companies and increase the number of smaller CPO companies.



Source: Data Processed, Central Bureau of Statistics Indonesia, 2001-2020

Figure 3: CR4 Movement of Indonesian CPO industry in 2001-2020.

The increasingly unconcentrated CPO industry can have a negative impact on production efficiency, land and environmental exploitation, and labor welfare (Otieno et al., 2016; Abdul-hamid et al., 2021). One of the impacts of the increasingly unconcentrated CPO industry is the lack of efficiency in production (Avdelas et al., 2021). When the concentration of the CPO industry is getting lower, it means that more producers are competing in the market (Gosens and Lu, 2014). This causes producers to tend not to have strong control over the selling price of their products, making it difficult for them to set higher prices. This condition makes producers try to reduce production costs in order to remain competitive in the market.

The CPO industry is also known for its overexploitation of land. The CPO industry is often associated with overexploitation of land, especially in terms of deforestation and forest degradation (Kyere-Boateng and Marek, 2021). In general, the land used for oil palm plantations is natural forest that is logged and converted to plantation land (Khatun et al., 2020). This practice can cause damage to ecosystems and loss of natural habitats for flora and fauna, including endangered species such as Sumatran tigers and orangutans. Deforestation and forest degradation can also have a negative impact on the global climate, as tropical forests store large amounts of carbon in biomass and soil (Bustamante et al., 2016). When forests are cut down, carbon stored in soil and biomass can be released into the atmosphere, causing greenhouse gas emissions that contribute to climate change. In addition, the CPO industry is also often criticized for excessive use of pesticides and herbicides, which can pollute soil and water and negatively impact human health and the environment (Pretty

and Bharucha, 2014). Therefore, efforts need to be made to reduce the use of harmful chemicals in CPO production, including by promoting environmentally friendly and sustainable agricultural practices.

The labor problem is also a result of the increasingly unconcentrated CPO industry. In the increasingly unconcentrated CPO industry, there are usually many small companies or individuals involved in the production process. However, due to the large amount of production and the need for a considerable amount of labor, often the workers involved in the CPO industry are employed illegally and do not have adequate legal protection (Azhar et al., 2017). The impact of the lack of legal protection and labor rights includes frequent cases of labor exploitation, low wages, and working in unsafe and unhealthy conditions (Min et al., 2019). In addition, there are also problems such as forced labor and child labor that are the result of the lack of supervision and regulation of the increasingly unconcentrated CPO industry (Abrams and Selfa, 2022). Labor issues related to the CPO industry can also have an impact on the sustainability of the industry. If these problems are not immediately addressed, there will be a decrease in productivity and quality of production, which in turn can affect the competitiveness of the CPO industry in the global market. Therefore, appropriate measures are needed to address labor issues in the CPO industry, such as adequate legal protection for workers and stricter regulations to prevent illegal practices and labor exploitation.

### Movement of variables independent of industry concentration

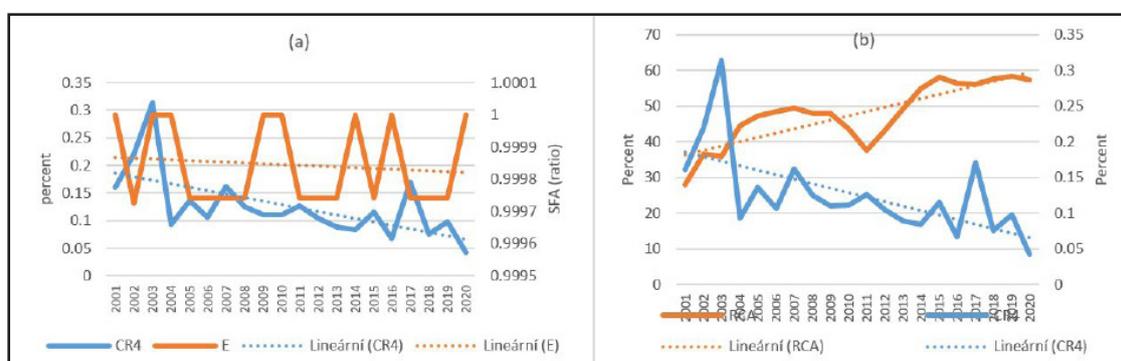
Based on Figure 4a, the technical efficiency of the Indonesian CPO industry has a downward trend every year or is getting farther away from value 1 which means that the industry is increasingly inefficient. Although Indonesia is the largest CPO producer in the world, the technology used in CPO production in Indonesia is still relatively lagging when compared to other countries (Iskandar et al., 2018). This may affect the technical efficiency of the CPO industry and reduce the concentration of the CPO industry. Changing government policies, such as tax or regulatory changes, can affect the technical efficiency of the CPO industry and the concentration of the CPO industry (Papilo et al., 2022). This condition supports and is in line with the analysis in the previous section.

The movement of the competitiveness variable (RCA) of the CPO industry in Indonesia tends to fluctuate in the period 2001-2020 (Figure 4b), although there is an increasing trend over the study period. It can be seen that the highest increase in the competitiveness of the CPO industry in Indonesia occurred in 2014 with a percentage increase of 10.31 percent. While the highest decline occurred in 2011 with a percentage decrease of 15.7%. This happened because the price of CPO in the international market decreased in 2011 (Gan and Li, 2014). This can have a negative impact on the competitiveness of the CPO industry in Indonesia, and reduce the concentration of CPO.

Several policies in overcoming environmental issues caused by palm oil production include the development of sustainable certification through the Roundtable on Sustainable Palm Oil (RSPO) as a form of implementation of global standards

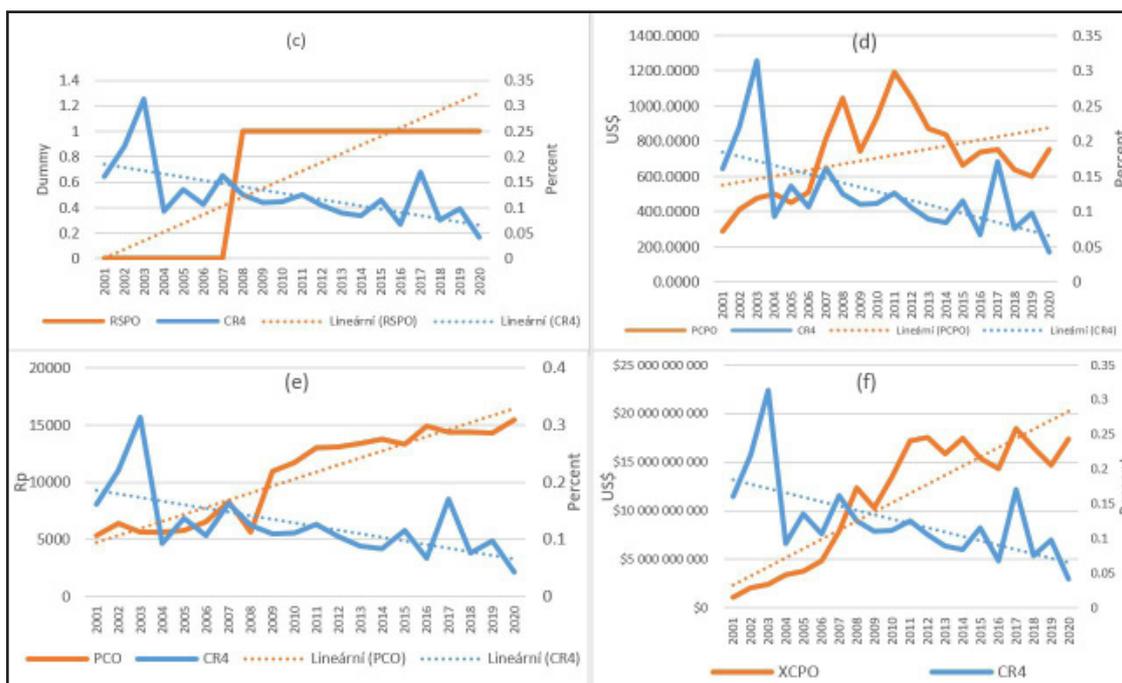
for sustainable palm oil since 2008 (Schouten and Glasbergen, 2011). Based on Figure 4c in 2008, when RSPO was introduced into the CPO industry, the concentration of the CPO industry decreased slightly. The RSPO requires that palm oil producers must meet certain sustainability standards in their production, such as not damaging the environment and complying with human rights. Implementation of these requirements entails additional time and costs for producers, and leads to temporary production reductions or production cuts in some companies that are unable to meet sustainability standards (Angulo-Mosquera et al., 2021).

Based on Figure 4d, in years where the concentration of the CPO industry rises, CPO prices tend to rise. This is due to the increase in demand for CPO when the CPO industry is growing and increasing production. The highest increase in CPO prices in 2011, this happened because increased demand from countries such as India and China became the main factor in the increase in CPO prices (Zulqarnain et al., 2020). Both countries are the largest consumers of crude palm oil in the world. World crude oil prices also increased in 2011, which affected the increase in CPO prices. World CPO prices can fluctuate because they are influenced by several factors such as global demand, production, currency exchange rates, and competition with other vegetable oils. High or low demand and production can affect the availability of CPO supply and ultimately affect prices. In addition, currency exchange rates can also affect CPO prices because world CPO trading is carried out in US dollars (Halimatussadiyah et al., 2021). Competition between CPO and other vegetable oils can also affect CPO prices (Johari et al., 2015). If the price of other vegetable oils is cheaper, then consumers tend to switch



Source: Indonesian Central Bureau of Statistics and World Bank, data processed (2001-2020)

Figure 4: movement of variables independent of industry concentration. (To be continued).



Source: Indonesian Central Bureau of Statistics and World Bank, data processed (2001-2020)

Figure 4: movement of variables independent of industry concentration. (Continuation).

to these vegetable oils and influence the price of CPO. Therefore, changes in these factors can affect fluctuations in world CPO prices.

The highest increase in cooking oil prices in 2016 occurred because the increase in world crude oil prices in early 2016 affected the increase in packaged cooking oil prices in Indonesia. World crude oil is the main raw material for making packaged cooking oil. The increase in fuel oil prices in 2016 also affected the increase in the price of packaged cooking oil. The increase in fuel prices causes an increase in transportation and distribution costs, thus affecting the increase in the price of final products. Fluctuations in the rupiah exchange rate against the US dollar also affect the increase in the price of packaged cooking oil. If the rupiah exchange rate weakens against the US dollar, then the price of imported packaged cooking oil will rise because import costs to be paid in dollars become more expensive. In addition, it can be seen that the concentration of the CPO industry has an opposite trend to the price of cooking oil (Figure 4e). This can be explained by the fact that cooking oil is a derivative product of CPO. The higher the concentration of the CPO industry, the more CPO produced, so the supply of cooking oil also increases (Mosarof et al., 2015). The increase in supply can cause cooking oil prices to fall if demand does

not increase along with the increase in supply, but if demand remains high, then cooking oil prices can rise along with the increase in CPO industry concentration.

Indonesia's CPO exports show an increasing upward trend from year to year as seen from Figure 4f, although there are fluctuations in certain years. In 2020, Indonesia's CPO export value reached \$17.36 billion, a significant increase from 2019 which reached \$14.72 billion. The highest increase in CPO exports occurred in 2017. 2017 was a year where international market demand for CPO was quite high, especially from countries such as India, China, and the European Union (Naylor and Higgins, 2017). This causes CPO producers in Indonesia to increase their production and increase CPO exports. The Indonesian government provides policies to encourage CPO exports, such as reducing CPO export taxes and providing incentives for CPO producers (Naylor and Higgins, 2018). This policy increases CPO exports and encourages the growth of the CPO industry in Indonesia. This positive trend shows that Indonesian CPO is still an important export commodity and has the potential to continue to grow in the future. However, as exports increase, concentrations tend to decrease. Indonesia's increasing CPO exports can be caused by several factors such as increasing international market

demand, increasing CPO production in Indonesia, and government policies in supporting exports. Meanwhile, the decline in the concentration of the Indonesian CPO industry can be caused by factors such as policy changes in CPO industry regulations, the entry of new competitors in the CPO market, and changes in global market conditions that affect CPO prices.

**Econometric analysis**

**- Descriptive statistics**

Table 2 is the result of analysis for 6 variables, namely CR4, RCA, RSPO, PCPO, PCO, and XCPO, each of which has 20 observations. Statistical values such as mean, median, maximum, minimum, and standard deviation are also presented.

Based on Table 2, it can be seen that the mean and median values in each variable are not always the same, thus indicating that there is an unsymmetrical distribution of data (skewness) on some variables. In addition, the standard

deviation value that varies in each variable also shows different variations or distribution of data. RSPO variables have a minimum value of 0 and a maximum of 1, indicating a large variation in the data. While the RCA variable has a narrower range of values compared to other variables, with a minimum value of 27.98183 and a maximum of 58.23941.

**- Unit root test**

From Table 3, it can be seen that all variables have been stationer at first different, because all variables have a probability of less than alpha  $\alpha = 5$  percent (significant).

**- Cointegration test**

This cointegration test (Table 4) is performed to find out if there is a long-term relationship between the dependent variable and the independent variable and is intended to test whether the resulting regression residual is stationary or not.

	CR4	RCA	RSPO	PCPO	PCO	XCPO
Mean	0.125723	47.88960	0.650000	6.622167	9.192500	22.89165
Median	0.110826	48.14995	1.000000	6.621791	9.425000	23.35587
Maximum	0.313670	58.23941	1.000000	7.084537	9.650000	23.64176
Minimum	0.042256	27.98183	0.000000	6.110501	8.590000	20.80107
Std. dev.	0.059899	8.613335	0.489360	0.272098	0.415868	0.869800
Observations	20	20	20	20	20	20

Source: Eviews (2022)

Table 2: Descriptive statistics.

Variable	Level 1		Level 1		Level 2	
	T-Statistic	Probability	T-Statistic	Probability	T-Statistic	Probability
CR4	-1.962114	0.2985	-9.030148	0.0000	-5.984888	0.0004
E	-5.065054	0.0013	-4.759076	0.0027	-4.084762	0.0096
RCA	-1.474396	0.5231	-3.610380	0.0165	-6.263977	0.0001
RSPO	-1.337712	0.5897	-4.242641	0.0046	-6.708204	0.0000
PCPO	-2.741903	0.0856	-4.776703	0.0017	-3.954856	0.0109
PCO	-0.795949	0.7960	-6.899735	0.0000	-3.954856	0.0109
XCPO	-3.863403	0.0094	-4.172907	0.0053	-3.344359	0.0342

Source: Eviews (2022)

Table 3: Unit root test.

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistics		-3.771598	0.0142
Test critical values:	1% level	-3.659148	
	5% level	-3.081002	
	10% level	-2.68133	

Source: Eviews (2022)

Table 4: Cointegration test.

From the Augmented Dickey-Fuller test statistic produces t-statistics  $-3.771598 >$  from test critical values and probability  $0.0142 < 0.05$ . The Error Correction Term (ECT) value is stationary at the level level, the data has been cointegrated. That is, the data has a relationship both short and long term.

**- Long-term and short-term estimation results**

Model estimation results: (Table 5)

$$CR4 = 129.1103 - 128.4751E_t + 0.004622 \beta_2 RCA_t - 0.015654 \beta_3 RSPO_t + 0.218569 \beta_4 PCPO_t + 0.029569 PCO_t - 0.107458 XCPO_t + e_t$$

Model estimation results: (Table 6)

$$\Delta CR4 = 0.015782 - 154.7064 \Delta E_t - 0.002083 \Delta RCA_t - 0.099217 \Delta RSPO_t + 0.140016 \Delta PCPO_t - 0.025026 \Delta PCO_t - 0.068964 \Delta XCPO_t - 0.015782 ECT + e_t$$

**Discussion**

The declining technical efficiency in the Indonesian CPO industry both in the short and long term has led to an increase in industry concentration. Lower technical efficiency can weaken the dominance of large companies in the industry because they have a competitive advantage in producing CPO at a lower cost (Foxon, 2013). When the technical efficiency of the CPO industry declines, inefficient companies have difficulty in competing in a competitive market (Kumbhakar et al., 2014). As a result, they go out of business or are acquired by more efficient companies. In the process, efficient companies become more dominant and gain a larger market share (Autor et al., 2017). Decreased technical efficiency can create higher barriers to entry for start-ups looking to break into the CPO industry. Established and efficient companies have a competitive advantage in terms of price, quality,

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	129.1103	66.41519	1.943988	0.0739
E	-128.4751	66.23107	-1.939800	0.0744*
RCA	0.004622	0.002099	2.202289	0.0463**
RSPO	-0.015654	0.041571	-0.376557	0.7126
PCPO	0.218569	0.048158	4.538564	0.0006***
PCO	0.029569	0.039909	0.740914	0.4719
XCPO	-0.107458	0.035124	-3.059376	0.0091***
R-squared	0.788757			
Adjusted R-squared	0.691260			
F-statistic	8.090084			
Prob(F-statistic)	0.000870			

Note: Description: \* = significant at 10 percent; \*\* = significant at 5 percent; \*\*\* = significant at 1 percent  
Source: Data processed, Output Eviews (2023)

Table 5: Long-term model estimation results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(E)	-154.7064	30.80550	-5.022037	0.0004***
D(RCA)	-0.002083	0.002121	-0.982331	0.3470
D(RSPO)	-0.099217	0.033889	-2.927694	0.0137**
D(PCPO)	0.140016	0.031289	4.474845	0.0009***
D(PCO)	-0.025026	0.036586	-0.684041	0.5081
D(XCPO)	-0.068964	0.033121	-2.082185	0.0615*
ECT (-1)	-1.742474	0.248655	-7.007591	0.0000***
C	0.015782	0.007473	2.111918	0.0584*
R-squared	0.940944			
Adjusted R-squared	0.903363			
F-statistic	25.03767			
Prob(F-statistic)	0.000006			

Note: Description: \* = significant at 10 percent; \*\* = significant at 5 percent; \*\*\* = significant at 1 percent  
Source: Data processed, Output Eviews (2023)

Table 6. Short-term model estimation results.

and distribution. This can make it difficult for new competitors to compete effectively. Thus, existing companies can maintain their dominant position and increase CR4 concentrations. In addition, industries with low efficiency, those companies that remain viable and efficient can have a greater influence in determining market dynamics (Tortorella and Fettermann, 2018). They have the power to set prices, set industry standards, or influence sector policy. In the process, they can strengthen their dominant position and increase CR4 concentrations.

Competitiveness (RCA) in the long term has a positive and significant relationship, while in the short term it is negative but not significant to the Indonesian CPO industry. Competitiveness (RCA) measures how much the export value of a product is compared to the global market share of that product (Mizik, 2021). A high RCA indicates that the country has a comparative advantage in producing such products and can compete in the global market (Rossato et al., 2018). In the long run, competitiveness (RCA) has a positive and significant relationship with the Indonesian CPO industry because increasing competitiveness can strengthen the market position of Indonesian CPO products in the global market and increase export demand (Pacheco et al., 2020). This can boost industry growth and help reduce the concentration of Indonesia's CPO industry by introducing more competitors in the global market. However, in the short term, the relationship between competitiveness (RCA) and the concentration of Indonesia's CPO industry is insignificant or may even be negative. In the short term, other factors such as market price fluctuations, global demand, and government policies can affect industry concentration (Dechezleprêtre and Sato, 2017). Moreover, in the short term, large companies that are dominant in the industry can still maintain their market share, even if the competitiveness of Indonesian products increases.

In the long run, the relationship between RSPO and Indonesia's CPO industry concentration tends to be negative but not significant. This is due to the fact that efforts to encourage sustainable palm oil production can increase production costs, which in turn can reduce corporate profits and reduce the tendency of new companies to enter the market (Tey et al., 2021). However, RSPO's efforts can also improve the image of Indonesia's CPO industry and open access to a wider global market, which in turn can help reduce the concentration of Indonesia's CPO industry by introducing more

competitors in the global market (Lim et al., 2021; Sakai et al., 2022; Nagiah and Azmi, 2012). Meanwhile, in the short term, the relationship between RSPO and Indonesia's CPO industry concentration tends to be negative and significant. This is due to the fact that RSPO requirements for sustainable palm oil production could cause such large unqualified companies to lose their market share, and in turn could introduce more competitors into the industry. In addition, RSPO's efforts can also improve the image of Indonesia's CPO industry in the short term, which can open access to a wider global market in a faster time than in the long term.

World CPO Price (PCPO) both long and short term provides a positive and significant correlation to the concentration of the Indonesian CPO Industry. High world CPO prices (PCPO) can provide huge profits for CPO producers in Indonesia, because Indonesia is one of the largest CPO producers in the world. In the short term, the positive and significant correlation between PCPO and the concentration of Indonesia's CPO industry is due to the fact that companies that produce CPO will generate greater profits when CPO prices are high, and thus they will command a larger market share (Tey et al., 2020). In the long run, a positive and significant correlation between CPO prices (PCPO) and the concentration of the Indonesian CPO industry occurs because companies that produce CPO can gain substantial economic benefits when CPO prices are stable and high for a long period of time (Friedman, 2014). This can increase the company's profits, strengthen their position in the market, and reduce the likelihood of new companies entering the market. Thus, Indonesian CPO producers with low production costs and good technical efficiency can obtain large profits and control a larger market share.

The price of cooking oil (PCO) in the long run has a positive and insignificant effect, while in the short term it has a negative and insignificant effect. The price of cooking oil (PCO) is a factor that affects production costs for CPO producers in Indonesia (Nurcahyani et al., 2018). In the long run, high cooking oil prices can increase production costs, and thus can reduce the profits of CPO producers in Indonesia (Johari et al., 2015). Therefore, the positive correlation between PCO and the concentration of Indonesia's CPO industry is less significant in the long run. However, in the short term, the negative correlation between PCO and the concentration of Indonesia's CPO industry occurs because falling cooking oil prices

can trigger an increase in demand for cooking oil products, thereby increasing demand for CPO as a raw material (Kaltschmitt and Neuling, 2017). In this situation, CPO companies may be able to increase their production and sales, and thus expand their market share. However, this correlation may not be significant because the decline in cooking oil prices may only be temporary and does not have a significant impact on CPO companies' long-term profits and production.

Indonesia's CPO exports in the long and short term have a negative and significant effect on the concentration of the Indonesian CPO industry. This is because the increase in demand from abroad for Indonesian CPO can make Indonesian CPO producers focus more on exports and less focus on strengthening the domestic industry. In the long run, if Indonesia continues to rely on CPO exports, there will be dependence on foreign markets (Nambiappan et al., 2018). If there is a fluctuation in global CPO prices, it will have a direct impact on the Indonesian economy. In addition, if the domestic industry is not strengthened, then Indonesia will not be able to compete with other countries that produce CPO. In the short term, an increase in Indonesia's CPO exports can make domestic CPO prices increase (Yanita et al., 2020). This can make domestic CPO producers prefer to export CPO rather than sell it domestically. As a result, the concentration of Indonesia's CPO industry may decrease due to declining domestic demand.

## **Conclusion**

From the results of the research conducted, it was found that the concentration of the Indonesian CPO industry has a decreasing concentration value, which means that competition conditions increasingly lead to perfect competition criteria towards weak oligopolies with an average market share value of four companies of 12.9 percent. A decrease in technical efficiency in the CPO industry can also have negative economic consequences, such as decreased productivity, increased production costs, and decreased industrial competitiveness. In addition, negative impacts on the environment can also affect the image of the industry and have an impact on global market demand that increasingly demands sustainability and responsible production practices. To overcome these negative impacts, it is important to drive improved technical efficiency in the CPO industry through the adoption of modern technology, sustainable agricultural practices, and adequate

workforce training. In addition, strong regulations and policies, both from governments and industrial organizations, can promote efficient, sustainable production-practices that take into account human rights and labor welfare.

Based on the results of econometric analysis, it was found that technical efficiency has a significant negative relationship with the concentration of the CPO industry, both in the short and long term. The competitiveness of Indonesia's CPO industry, in the long run, has a positive significant relationship, but in the short term it has a negative significant relationship. In the long run, the relationship between RSPO and Indonesia's CPO industry concentration tends to be negative, but not proven significant, while in the short term, the relationship shows a significant influence. In addition, world CPO prices in the long and short term have a significant positive correlation with the concentration of the Indonesian CPO industry. Meanwhile, Indonesia's CPO exports in the long and short term have proven to have a significant and negative effect on the concentration of the Indonesian CPO industry.

To mitigate the negative impact of the increasingly deconcentrated CPO industry, Indonesia has implemented policies and standards to promote sustainability and responsible practices in the CPO industry. Two important policies are the Indonesia Sustainable Palm Oil (ISPO) policy and the Roundtable on Sustainable Palm Oil (RSPO). CPO industry players need to ensure that they understand and implement ISPO and RSPO policies comprehensively. It involves a good understanding of the requirements, audit procedures, and standards to be met. Companies must conduct a thorough evaluation of their operations to ensure compliance with the policy. In addition to policy implementation, it is also important to ensure effective monitoring and enforcement of compliance with established sustainability standards. Collaboration between governments, producers, civil society, and international institutions is also an important factor in achieving the success of such policies and certifications. The implementation of ISPO and RSPO requires changes in technology and production-practices. Industry players need to allocate resources to investments in employee training, more efficient equipment procurement, and technologies that support sustainable production-practices. This helps improve the company's ability to meet sustainability standards.

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