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Research article

Export Competitiveness of CPOPC Member Countries: Comparative Advantage, Market Dynamics, and RED II

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ABSTRACT

Crude palm oil (CPO) is a key global commodity. However, sustainability-related trade pressures, especially the European Union Renewable Energy Directive II (RED II), increasingly shape its export performance. This study examines CPO export competitiveness among CPOPC member countries—Indonesia, Malaysia, Papua New Guinea, and Honduras—over 2010–2024, and compares the pre-RED II (2011–2017) and post-RED II (2018–2024) periods. The analysis uses annual trade data, with 2024 as the latest full calendar year with complete annual observations available at the time of data extraction. Using a descriptive comparative quantitative approach and secondary trade data, the analysis evaluates comparative advantage through RCA and RSCA. It assesses competitive dynamics using Export Product Dynamics (EPD) and the Export Competitiveness Index (ECI). The analysis tests period differences with the Wilcoxon Signed-Rank test. The results confirm persistent comparative advantage across all members, but show heterogeneous competitive positioning: Indonesia is classified as a "lost opportunity," while Malaysia, Papua New Guinea, and Honduras are categorized as "rising stars." The RED II-period comparison shows no statistically significant median differences in RSCA or ECI. The available seven-year paired observations do not provide sufficient evidence of a discrete shift between the two periods. From a policy perspective, CPOPC members should focus not only on maintaining comparative advantage but also on strengthening market diversification, downstream processing, sustainability compliance, and export-market adaptability. These findings emphasize the importance of integrating comparative and competitive indicators to capture structural differences and dynamic market responses among palm oil exporting countries.

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1. INTRODUCTION

Crude palm oil (CPO) is a strategic global commodity used in the food, cosmetics, and renewable energy industries. Compared with other major vegetable oils, oil palm yields relatively high oil output per hectare, supporting its prominent position in international vegetable-oil trade (Murphy, 2025). However, export performance should not be interpreted solely through export magnitude or revealed comparative advantage. Comparative advantage reflects a country's relative specialization in a commodity. In contrast, export competitiveness also depends on a country's ability to maintain or expand market share amid changing demand, trade policies, and production structures. This distinction matters for palm oil because major producing countries increasingly differ not only in export scale but also in the composition of crude and processed palm-oil exports. Studies comparing Indonesia and Malaysia show that competitiveness differs across CPO and downstream palm-oil products (Arsyad et al., 2020; Tandra et al., 2023; Utsaha et al., 2022). It

suggests that commodity-level indicators may paint a different picture than the competitiveness of the broader palm-oil industry (Arsyad et al., 2020; Tandra et al., 2023).

International sustainability policies have added another layer to these trade dynamics. The European Union's Renewable Energy Directive II (RED II), adopted in 2018, tightened sustainability requirements for biofuels and was followed by Delegated Regulation (EU) 2019/807, which classified palm oil as a high indirect land-use change-risk feedstock (Antolis & Pandjaitan, 2022; Tyson & Meganingtyas, 2022). Nevertheless, this study uses RED II as a policy-period marker rather than a geographical boundary or causal treatment. A global trade perspective is necessary because CPO-producing countries can respond to tighter access or sustainability requirements in one destination by redirecting exports, strengthening national certification systems, or expanding trade with markets outside the European Union. Higgins & Richards (2019), for example, show that the development of ISPO and MSPO was also linked to South–South palm-oil trade requirements and major Asian markets, illustrating that sustainability governance extends beyond EU-bound trade alone. More recent evidence also suggests that responses to RED II involve interactions between external regulatory pressure and domestic policy conditions rather than a single direct trade effect (Wulandari et al., 2026). More broadly, international pressures and domestic institutions have shaped the evolution of Indonesian sustainable palm-oil governance (Astari et al., 2025). Related scenario-based research indicates that restrictions on EU imports of Indonesian palm oil may have limited aggregate economic effects while producing more concentrated regional impacts (Rum et al., 2022). Accordingly, examining global exports allows the analysis to capture changes in countries' overall competitive positions while treating RED II as an important shift in the international regulatory environment.

This distinction is particularly consequential for Indonesia, where palm-oil exports have shifted markedly from crude toward processed products. UN Comtrade data used in this study show that the share of CPO (HS 151110) in Indonesia's HS 1511 palm-oil exports declined from 56.80% in 2010 to 13.52% in 2024, while the share of other palm-oil products increased correspondingly. This shift changes how we interpret conventional competitiveness indicators. A declining share or weaker market-share growth for crude CPO does not necessarily imply that the palm-oil industry as a whole has become less competitive; it may instead reflect a deliberate reallocation toward downstream products and domestic uses. Arsyad et al. (2020) demonstrate that CPO and its processed derivatives can exhibit different competitiveness trajectories, while Tandra et al. (2023) find that downstream palm-oil competitiveness in Indonesia and Malaysia has evolved differently over time. Dermoredjo et al. (2025) likewise report a substantial long-term decline in Indonesia's CPO export share while emphasizing the importance of examining the broader structure of palm-oil trade. Domestic biodiesel policy further complicates the interpretation because greater domestic absorption of CPO can reduce exportable supply. Halimatussadiah et al. (2021) show that progressive biodiesel blending may involve a substantial opportunity cost in forgone CPO exports.

These structural changes also differ across CPOPC members. Indonesia and Malaysia are large producers with diversified export structures, whereas Papua New Guinea and Honduras have smaller export bases. As a result, the same competitiveness indicator may capture different economic mechanisms across countries: declining crude-CPO indicators in a large exporter may reflect product upgrading or domestic absorption, whereas high RCA or rapid market-share growth in a small exporter may partly reflect a narrow export base. This heterogeneity makes cross-country comparison informative only when comparative advantage and market dynamics are interpreted jointly rather than as interchangeable measures.

Existing studies have extensively assessed palm-oil competitiveness, particularly in Indonesia and Malaysia, and RCA-type indices and dynamic export measures are well established (Arsyad et al., 2020; Ramadhani & Santoso, 2019; Saban & Novianti, 2023; Tandra et al., 2023). The research gap therefore does not lie in combining these indicators, as previous studies have already applied multiple competitiveness indicators to palm-oil trade (Juhro et al., 2026; Tandra et al., 2023). Rather, it lies in explaining how differences in export structure alter the meaning of crude-CPO competitiveness across CPOPC members. In particular, relatively little attention has been given to whether weaker crude-CPO performance among major producers represents a loss of

competitiveness or a structural shift toward downstream products and domestic utilization. At the same time, smaller exporters may display strong indicators because of narrower export bases. This study addresses this gap by comparing four CPOPC members within a common framework and interpreting CPO-specific competitiveness in relation to these structural differences. The comparison of the pre- and post-RED II periods is descriptive, identifying whether competitiveness indicators changed across the two regulatory phases without attributing such changes causally to RED II. Therefore, this study's novelty lies in interpreting CPO competitiveness by linking conventional competitiveness indicators with structural differences across large and small exporters. This approach provides a more accurate comparison of CPO competitiveness among CPOPC member countries.

This study aims to (1) assess the revealed comparative advantage of CPO exports among Indonesia, Malaysia, Papua New Guinea, and Honduras using RCA and RSCA; (2) evaluate their competitive positioning and export-share dynamics using EPD and ECI; (3) compare patterns of comparative advantage and export competitiveness across CPOPC members while accounting for differences in export structure; and (4) examine whether RSCA and ECI indicators differ between the pre-RED II (2011–2017) and post-RED II (2018–2024) periods. By separating comparative advantage from market dynamics and interpreting crude-CPO performance within the broader transformation of the palm-oil export structure, the study provides a more precise assessment of competitiveness among CPOPC members.

2. RESEARCH METHODS

This study used a descriptive-comparative quantitative approach to assess CPO export competitiveness among four CPOPC member countries: Indonesia, Malaysia, Papua New Guinea, and Honduras. It addresses the limited comparative evidence on their CPO export performance. We obtained annual global trade data for 2010–2024 primarily from the UN Comtrade database. The dataset includes each country's CPO export value, total merchandise export value, world CPO export value, and total world merchandise export value. We used these variables to construct the RCA, RSCA, EPD, and ECI indicators. ITC Trade Map served as a supplementary source for checking trade patterns. We used BPS, USDA, and World Bank publications only for contextual information on production, domestic policy, and structural developments in the palm oil sector. Table 1 presents the data variables, analytical indicators, their definitions, corresponding HS codes, and data sources.

Table 1. Variables, Indicators, and Data Sources

Variable/ Indicator	Definition	HS code	Source
CPO export value of country *i*	Annual export value of crude palm oil from Indonesia, Malaysia, Papua New Guinea, or Honduras to the world	HS 151110	UN Comtrade
Total merchandise exports of country *i*	Annual value of all merchandise exports from country *i*	All products	UN Comtrade
World CPO export value	Annual global export value of crude palm oil	HS 151110	UN Comtrade
Total world merchandise exports	Annual global export value of all merchandise products	All products	UN Comtrade
Country CPO export market share	Country *i*'s CPO exports relative to global CPO exports	HS 151110	Calculated from UN Comtrade
RCA	Revealed comparative advantage of CPO in country *i* relative to world trade	HS 151110	Authors' calculation from UN Comtrade
RSCA	Symmetric transformation of RCA ranging from −1 to +1	HS 151110	Authors' calculation from UN Comtrade
EPD	Dynamic position of CPO exports based on changes in export market share and world demand	HS 151110	Authors' calculation from UN Comtrade

Variable/ Indicator	Definition	HS code	Source
ECI	Change in a country's CPO export share relative to the world market	HS 151110	Authors' calculation from UN Comtrade
Palm-oil export composition	Share of crude CPO within the broader palm-oil product group	HS 151110 within HS 1511	UN Comtrade; authors' calculation
Other palm-oil products	Palm oil and its fractions other than crude	HS 151190	UN Comtrade

CPO was defined at the six-digit Harmonized System (HS) level using HS 151110, which refers to crude palm oil. For supporting analysis of palm-oil export composition, HS 1511 was used for the broader palm-oil product group, while HS 151190 represents palm oil and its fractions other than crude. Because HS 151110 is maintained across HS 2007, HS 2012, and HS 2017 classifications, the same six-digit product definition could be applied consistently over the 2010–2024 observation period. The UN Statistics Division correspondence table confirms that HS 151110 in HS 2017 corresponds directly to the same code in HS 2012, while HS 2007 also identifies crude palm oil under 151110. To minimize classification inconsistency across years, the analysis harmonized all observations at the six-digit product level using HS 151110 rather than combining different product definitions across HS revisions, improving comparability across countries and over time.

All monetary trade values were expressed in current US dollars as reported by UN Comtrade. Because the analysis used reporter-country exports to the world rather than bilateral exports to a specific destination, it evaluates global export competitiveness. RED II is treated as a temporal policy marker for the pre- and post-2018 comparison, not as a destination-specific treatment variable.

We assessed comparative advantage using the Revealed Comparative Advantage (RCA) and Revealed Symmetric Comparative Advantage (RSCA) indices. RCA identifies whether a commodity has a revealed comparative advantage in international trade: RCA > 1 indicates comparative advantage, and RCA < 1 indicates the absence of comparative advantage (Krugman & Obstfeld, 2010). The RCA equation proposed by Balassa (1965), cited in Tandra et al. (2022), is specified as follows:

$$RCA_i = \frac{X_{it}/W_{it}}{X_t/W_t} \quad (1)$$

where X_{it} denotes the export value of CPO for country i in year t (US$), W_{it} is the total export value of all commodities for country i in year t (US$), X_t is the global export value of CPO in year t (US$), and W_t is the global total export value of all commodities in year t (US$), with i representing Indonesia, Malaysia, Papua New Guinea, and Honduras.

To address the asymmetry of RCA values and improve cross-country comparability, we applied RSCA by transforming RCA into a symmetric index ranging from -1 to +1. A commodity is considered to have revealed comparative advantage if RSCA > 0 (Tandra et al., 2022). The RSCA equation is specified as follows:

$$RSCA_i = \frac{RCA_i - 1}{RCA_i + 1} \quad (2)$$

We evaluated competitive advantage using Export Product Dynamics (EPD) and the Export Competitiveness Index (ECI). EPD classifies export performance into four quadrants: rising star, falling star, lost opportunity, and retreat (Sukmaya et al., 2022). The EPD indicators were calculated using export market share growth (X-axis) and world market growth (Y-axis), formulated as:

$$X = \frac{\sum_{t=1}^{n}\left(\frac{X_{it}}{X_t}\right)_t \times 100\% - \grave{}\sum_{t=1}^{n}\left(\frac{X_{it}}{X_t}\right)_{t-1} \times 100\%}{T} \quad (3)$$

$$Y = \frac{\sum_{t=1}^{n} \left(\frac{W_{it}}{W_t}\right)_t \times 100\% - \sum_{t=1}^{n} \left(\frac{W_{it}}{W_t}\right)_{t-1} \times 100\%}{T} \quad (4)$$

where T denotes the number of years in the analysis.

Furthermore, ECI measures export competitiveness trends based on changes in a country's export share relative to the world market. An ECI value greater than 1 indicates an increasing export trend, whereas an ECI value less than 1 indicates a declining export trend. The ECI equation is specified as follows:

$$ECI = \frac{\left(\frac{X_{it}}{X_t}\right)_t}{\left(\frac{X_{it}}{X_t}\right)_{t-1}} \quad (5)$$

To evaluate differences in export competitiveness across policy phases, we used the Wilcoxon Signed-Rank test on RSCA and ECI values. The test compared the pre-RED II period (2011–2017) with the post-RED II period (2018–2024) to keep the observation windows equal at 7 years. We selected this nonparametric test because index data tend to be non-normally distributed and the number of observations is limited (Rizki et al., 2023). Because the sample size for each country is limited, the test has reduced statistical power and limited ability to detect small or moderate differences between periods. Therefore, we interpret the Wilcoxon results as supplementary descriptive evidence of period differences rather than strong inferential evidence or a basis for causal claims regarding RED II.

The Wilcoxon Signed-Rank test statistics are specified as follows:

$$\mu W_R = \frac{n + (n+1)}{4} \quad (6)$$

$$\sigma W_R = \sqrt{\frac{n(n+1)(2n+1)}{24} - \frac{\sum t^3 - \sum t}{48}} \quad (7)$$

$$Z_w = \frac{W_R - \mu W_R}{\sigma W_R} \quad (8)$$

where μW_R is the expected value (mean) of the Wilcoxon Signed-Rank statistic, σW_R is the standard deviation, Z_W is the Z-statistic, W_R is the sum of positive ranks, n is the number of paired observations with non-zero differences, and t denotes tied ranks.

3. RESULTS AND DISCUSSION

3.1. Comparative Advantage of CPO Exports among CPOPC Member Countries

3.1.1. Revealed Comparative Advantage (RCA)

To assess the revealed comparative advantage of CPO exports across CPOPC member countries, Table 2 summarizes the RCA results for 2010–2024. RCA shows each country's relative specialization in CPO exports, but interpret RCA values alongside differences in export scale and national export structure. Therefore, Table 3 provides supporting information on CPO export scale and its share in total national exports. Use this information to explain why smaller exporters may record very high RCA values.

Table 2. RCA Values of CPO Exports in CPOPC Member Countries (2010–2024)

Year	Indonesia	Malaysia	PNG	Honduras
2010	66.28	15.90	104.63	42.43
2011	53.01	20.55	131.15	26.60
2012	49.10	27.45	141.90	59.34
2013	51.09	24.50	162.37	104.47
2014	46.62	28.57	101.01	73.03
2015	52.70	27.75	70.17	71.59
2016	49.18	26.51	103.45	117.58
2017	55.05	17.08	79.54	112.57
2018	49.64	19.49	86.85	113.91
2019	55.87	20.83	81.91	85.84
2020	50.97	21.94	69.50	105.94
2021	22.49	31.99	142.07	69.52
2022	21.77	23.83	144.92	104.70
2023	27.46	22.47	176.47	126.76
2024	25.48	24.88	125.00	103.99

Source: Authors' calculations

Table 3 shows a clear contrast in export structure across CPOPC members. Indonesia and Malaysia have much larger CPO export values, but CPO makes up a smaller share of their total exports. By contrast, Papua New Guinea and Honduras have smaller export values but greater dependence on CPO in their export structures. This difference helps explain the very high RCA values of Papua New Guinea and Honduras in Table 2, as RCA reflects relative export specialization rather than absolute market size.

Table 3. CPO Export Scale and Export Dependence of CPOPC Member Countries, 2010–2024

Country	CPO export value range (billion US$)	CPO share in total national exports	Main implication
Indonesia	2.69–8.78	1.02–4.85%	Large exporter with declining relative dependence on crude CPO
Malaysia	1.88–4.95	0.78–1.96%	Large exporter with a relatively diversified export structure
Papua New Guinea	0.32–0.85	3.18–10.67%	Small export base with relatively high dependence on CPO
Honduras	0.08–0.39	2.16–6.04%	Small export base with high sensitivity to changes in CPO exports

Source: Authors' compilation from official trade databases.

The results show that all CPOPC member countries consistently recorded RCA values above one throughout 2010–2024, confirming a revealed comparative advantage in CPO exports. However, RCA magnitude should not be interpreted as a direct measure of global market strength. Papua New Guinea and Honduras record much higher RCA values than Indonesia and Malaysia, but this mainly reflects CPO's greater importance within their relatively narrow export structures. Economies with smaller and less diversified export bases can record high specialization indices even when their absolute contribution to world exports remains limited (Lee & Zhang, 2022; UNCTAD, 2023). Thus, the very high RCA values of Papua New Guinea and Honduras indicate strong export specialization rather than dominance in the global CPO market.

Indonesia and Malaysia have lower RCA values but more diversified export structures. This matters because RCA differences across the four countries reflect not only CPO export performance

but also total export composition. Comparisons of RCA should therefore be read alongside export scale, diversification, and market-share dynamics, rather than as a simple competitiveness ranking. Earlier research on Indonesia's palm-oil exports also considered market penetration, export diversification, and comparative advantage in assessing international competitiveness (Nurkhoiry, 2017). Indonesia illustrates why CPO-specific indicators should be interpreted within a broader export structure. UN Comtrade data show that crude CPO (HS 151110) accounted for 56.80% of Indonesia's HS 1511 exports in 2010 but only 13.52% in 2024, while other palm-oil products rose to 86.48%. This suggests a shift from crude exports toward processed products. Similar studies show that competitiveness can differ between crude and downstream palm-oil products (Arsyad et al., 2020; Tandra et al., 2023). The Indonesian decomposition is therefore used as explanatory evidence for its EPD outcome, not as a comparable decomposition of all four countries.

3.1.2. Revealed Symmetric Comparative Advantage (RSCA)

To complement RCA and address its asymmetry limitation, Table 4 presents RSCA values for 2010–2024. RSCA transforms RCA into a symmetric scale ranging from –1 to 1. This transformation improves comparability across countries and over time. A positive RSCA value indicates revealed comparative advantage, while a negative value indicates comparative disadvantage. Values closer to 1 reflect stronger comparative advantage.

Table 4. RSCA Values of CPO Exports in CPOPC Member Countries (2010–2024)

Year	Indonesia	Malaysia	PNG	Honduras
2010	0.9703	0.8817	0.9811	0.9540
2011	0.9630	0.9072	0.9849	0.9275
2012	0.9601	0.9297	0.9860	0.9669
2013	0.9616	0.9216	0.9878	0.9810
2014	0.9580	0.9324	0.9804	0.9730
2015	0.9628	0.9304	0.9719	0.9724
2016	0.9601	0.9273	0.9809	0.9831
2017	0.9643	0.8894	0.9752	0.9824
2018	0.9605	0.9024	0.9772	0.9826
2019	0.9648	0.9084	0.9759	0.9770
2020	0.9615	0.9128	0.9716	0.9813
2021	0.9148	0.9394	0.9860	0.9716
2022	0.9122	0.9195	0.9863	0.9811
2023	0.9297	0.9148	0.9887	0.9843
2024	0.9245	0.9227	0.9841	0.9810

Source: Authors' calculations

RSCA values remain positive and near one across all observed countries, confirming persistent revealed comparative advantage in CPO exports. As Tandra et al. (2022) emphasize, RSCA > 0 indicates that a commodity retains revealed comparative advantage within a country's export structure. Papua New Guinea and Honduras record the highest and most stable RSCA values, aligning with the view that smaller exporters' high comparative advantage is closely linked to export structure concentration. UNCTAD (2023) notes that economies with limited diversification and heavy dependence on a few commodities tend to show high revealed comparative advantage indicators. Similarly, the World Bank (2025) describes Papua New Guinea as an economy dominated by resource-based sectors with limited export diversification, while the WTO (2023) reports that Honduras' export structure remains highly dependent on primary commodities and agricultural products.

A notable pattern is Indonesia's RSCA decline after 2020. This indicates that CPO remains a strong source of comparative advantage, although its relative importance in Indonesia's export structure has decreased. This pattern aligns with the broader shift from crude CPO toward downstream palm-oil products and greater domestic use, which reduces crude CPO's share of

exports (Arsyad et al., 2020; Tandra et al., 2023). Maulana et al. (2023) similarly suggest that a decline in RSCA does not necessarily reflect weaker competitiveness, but may instead indicate a more diversified export structure.

3.2. Competitive Advantage of CPO Exports among CPOPC Member Countries

3.2.1. Export Product Dynamics (EPD)

To assess competitive positioning, Table 5 and Figure 1 present EPD results. EPD examines changes in export market share and global demand. It classifies export performance into four quadrants. These include rising star, falling star, lost opportunity, and retreat. This classification helps identify differences in export dynamics across CPOPC members.

Table 5. EPD Classification of CPO Exports in CPOPC Member Countries

Values	Indonesia	Malaysia	PNG	Honduras
X	-0.027275	0.009019	0.002169	0.001981
Y	0.000045	0.000046	0.000013	0.000006

Source: Authors' calculation

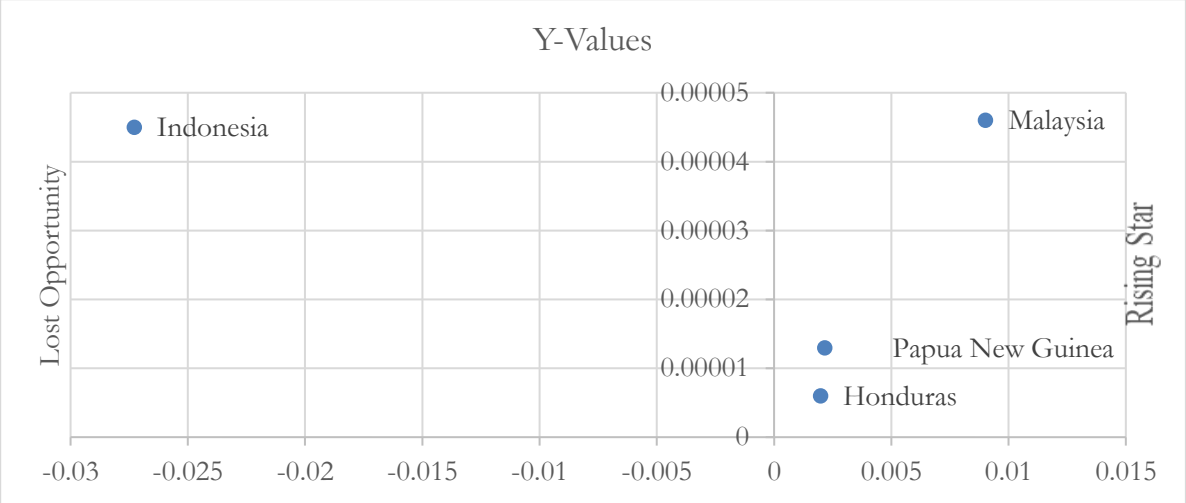


Figure 1. EPD Diagram of CPO Exports in Indonesia, Malaysia, Papua New Guinea, and Honduras
Source: Authors' calculation

The EPD results classify Indonesia as a "lost opportunity," whereas Malaysia, Papua New Guinea, and Honduras are classified as "rising stars." In EPD terms, Indonesia's position indicates that its share of global crude CPO exports declined while the world market continued to grow. However, this result should not be interpreted simply as a loss of competitiveness in Indonesia's palm-oil industry. It refers specifically to crude CPO and occurs alongside major changes in domestic palm oil use and processing.

Indonesia has steadily increased domestic CPO absorption through mandatory biodiesel programs, including B20, B30, and later B35, while also promoting downstream processing. Export levies have reinforced this policy direction, as have the temporary export ban in 2022 and the Domestic Market Obligation (DMO), which together redirected some crude CPO supply toward domestic consumption and processing. Halimatussadiah et al. (2021) show that higher biodiesel blending increases domestic CPO demand and can reduce the volume available for export. Papilo et al. (2022) also highlight the importance of national bioenergy policies in shaping the palm-oil sector. Together, these policies create a trade-off between crude CPO exports and domestic value-added uses. The sharp decline in the share of crude CPO within Indonesia's palm-oil exports therefore supports the interpretation that its "lost opportunity" position partly reflects structural transformation rather than a general weakening of the palm-oil industry. Dermoredjo et al. (2025) similarly show that changes in Indonesia's crude palm-oil export performance need to be interpreted within the broader evolution of its palm-oil trade structure.

Malaysia's rising-star position indicates positive growth in its share of the expanding global CPO market. The interpretation is different for Papua New Guinea and Honduras. Although both are classified as rising stars, their relatively small export bases mean that modest absolute increases can produce comparatively large percentage changes in export share. Lee & Zhang (2022) show that smaller economies tend to have narrower and more concentrated export structures, making relative trade indicators more sensitive to changes in a limited number of products. Their rising-star positions should therefore be viewed as evidence of positive CPO export dynamics, but not necessarily as equivalent to the market strength or scale of larger exporters such as Indonesia and Malaysia.

3.2.2. Export Competitiveness Index (ECI)

Figure 2 presents ECI patterns for each country to capture annual competitiveness trends. ECI measures changes in a country's export share over time. A value above 1 indicates an increasing export trend. A value below 1 indicates a declining export trend. These patterns help compare changes in CPO export competitiveness across CPOPC members. Indonesia's ECI fluctuates around the threshold value of one. This indicates unstable annual changes in its share of global CPO exports. As with the EPD result, interpret this pattern alongside rising domestic CPO use and the shift toward downstream products, rather than as direct evidence of declining industry-wide competitiveness. The growing use of CPO for domestic biodiesel and downstream processing can reduce the volume available for crude exports and, in turn, affect Indonesia's export-share dynamics. Therefore, Indonesia's ECI pattern is better understood as part of a broader structural change in the palm-oil sector rather than as a simple loss of export competitiveness.

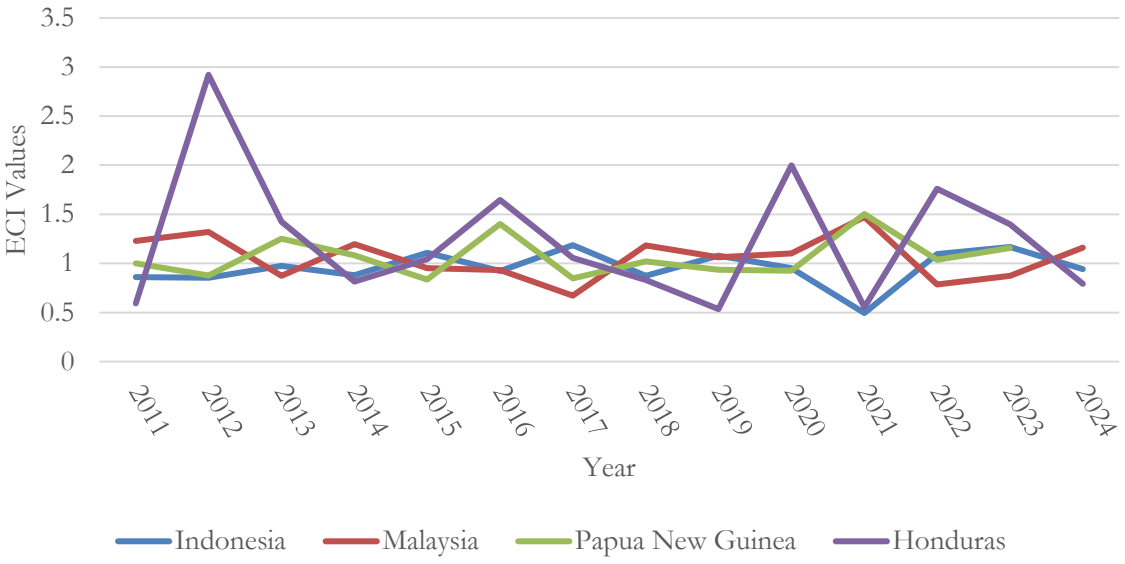


Figure 2. ECI Fluctuation of CPO Exports in CPOPC Member Countries (2010–2024)
Source: Authors' calculation

Malaysia shows a relatively more stable ECI pattern, indicating a smaller gap in crude CPO export competitiveness. Papua New Guinea and Honduras, in contrast, exhibit substantially larger year-to-year fluctuations, creating a wider gap in observed ECI values. These movements partly reflect a scale effect: when the initial export base is small, relatively modest changes in export value can generate large proportional changes in competitiveness indicators. Export size and diversification matter when comparing ECI values across countries (Cieslik & Parteka, 2021; Lee & Zhang, 2022). Consequently, high or volatile ECI values for smaller exporters should be interpreted as market-share dynamics rather than evidence that they are structurally more competitive than larger CPO exporters.

3.3. Pre–Post RED II Comparison

3.3.1. Wilcoxon Signed-Rank Test for RSCA

To assess differences in RSCA between the pre-RED II (2011–2017) and post-RED II (2018–2024) periods, Table 6 presents the Wilcoxon test results. The test compares the two seven-year periods using paired annual observations. It tests whether RSCA values differ significantly between the two periods. RED II is treated only as a policy-period marker in this comparison. Therefore, the results are not interpreted as evidence of a causal effect of RED II.

Table 6. Wilcoxon Signed-Rank Test Results for RSCA (Pre-RED II vs Post-RED II)

Country	Z	Asymp. Sig. (2-tailed)	Significance
Indonesia	1.859[b]	0.063	Not significant
Malaysia	-0.845[b]	0.398	Not significant
Papua New Guinea	0.000[b]	1.000	Not significant
Honduras	-1.185[b]	0.236	Not significant

Source: Authors calculation

The Wilcoxon test results show that the p-values for Indonesia, Malaysia, Papua New Guinea, and Honduras are all above the 5% significance level. Therefore, we cannot reject the null hypothesis, indicating that median RSCA differences between the two periods are not statistically significant. This suggests that changes in RSCA did not produce a consistent median shift within the limited observation window (N = 7). Sulaiman et al. (2024) similarly note that CPO competitiveness indicators may remain stagnant or volatile in the short run, making significant differences difficult to detect. Holzner et al. (2019) and Shepherd (2021) also show that trade standards and non-tariff policy pressures may operate gradually and differently across countries, while Curzi et al. (2020) suggest that adjustments related to sustainability standards may become statistically visible only over longer periods. Therefore, the Wilcoxon results should be interpreted as descriptive evidence of RSCA dynamics rather than as evidence of a causal policy effect.

3.3.2. Wilcoxon Signed-Rank Test for ECI

Table 7 presents the Wilcoxon test results for ECI, complementing the RSCA analysis. The results show that none of the four countries recorded a statistically significant median difference in ECI between the pre- and post-RED II periods. These findings suggest that export competitiveness changed gradually and did not shift clearly between the two periods. Sapto et al. (2024) similarly find that ECI values may change over time without generating statistically significant differences in the short run. Therefore, we interpret the Wilcoxon results as descriptive evidence of relative stability in competitiveness patterns rather than as evidence of a causal policy effect.

Table 7. Wilcoxon Signed-Rank Test Results for ECI (Pre-RED II vs Post-RED II)

Country	Z	Asymp. Sig. (2-tailed)	Significance
Indonesia	-0.338[b]	0.735	Not significant
Malaysia	-0.507[b]	0.612	Not significant
Papua New Guinea	-0.507[b]	0.612	Not significant
Honduras	-0.735[b]	0.735	Not significant

Source: Authors calculation

3.4. Discussion

This study shows that strong comparative advantage does not necessarily produce the same competitive position across CPOPC members. RCA and RSCA measure CPO's relative specialization within a country's export structure, whereas EPD and ECI capture changes in market share over time. This distinction explains why Papua New Guinea and Honduras can record very high comparative-advantage indicators and rising-star positions despite their much smaller export scale. Their narrow export bases raise the relative importance of CPO and make market-share indicators

more sensitive to small absolute changes. Thus, their high RCA and positive EPD results reflect strong specialization and positive export dynamics, but they should not be interpreted as market dominance. This scale effect is consistent with evidence that smaller economies generally have more concentrated export structures (Lee & Zhang, 2022).

Indonesia presents the opposite pattern. Its RCA and RSCA remain high, indicating continued specialization in CPO. Still, its EPD position is classified as a lost opportunity because its crude-CPO market share declined while the global market expanded. This divergence is better understood as a change in export structure than as a general loss of palm-oil competitiveness. Indonesia has increasingly directed CPO toward downstream processing and domestic biodiesel consumption. The expansion of mandatory biodiesel blending from B20 to B30 and B35 increased domestic demand for CPO, while down-streaming policies encouraged exports of processed palm-oil products rather than crude CPO. Halimatussadiah et al. (2021) and Fitrady et al. (2026) show that higher biodiesel blending can reduce exportable CPO through greater domestic absorption, while Arsyad et al. (2020) and Tandra et al. (2023) show that crude and downstream palm-oil products can follow different competitiveness paths. Dermoredjo et al. (2025) further support interpreting Indonesia's declining crude-CPO share within the broader transformation of its palm-oil exports. Indonesia's lost-opportunity classification should therefore be understood as a crude-product-specific outcome, not as evidence of declining competitiveness of the palm-oil sector as a whole.

The contrast among the four countries also shows why competitiveness indicators should not be interpreted separately. For large producers, changes in crude CPO indicators may reflect domestic demand, downstream processing, and portfolio restructuring. For smaller producers, the same indicators may be amplified by a narrow export base. Combining comparative advantage with market dynamics therefore provides a more meaningful cross-country interpretation than ranking countries solely by RCA, EPD, or ECI values.

The Wilcoxon Signed-Rank test results further show that median differences in RSCA and ECI between the pre-RED II and post-RED II periods are not statistically significant across all observed countries. This suggests that competitiveness indicators do not show clear shifts between the two periods and instead follow gradual, fluctuating dynamics. Importantly, this study treats RED II as a policy marker rather than a causal treatment. Therefore, interpret the results descriptively rather than as evidence of a direct policy effect. This interpretation is consistent with studies showing that trade adjustments under sustainability standards often occur gradually, vary across countries, and may become more visible over longer periods (Curzi et al., 2020; Holzner et al., 2019; Shepherd, 2021).

Overall, the findings show that both structural differences and market dynamics shape CPO export competitiveness among CPOPC members. In Malaysia, sustainability certification and the development of value-added biorefinery activities have also been identified as important components of palm-oil industry development (Hassan et al., 2024). For large exporters such as Indonesia and Malaysia, changes in competitiveness may reflect shifts in export structure, downstream processing, and domestic use. For smaller exporters such as Papua New Guinea and Honduras, competitiveness indicators can be more sensitive to changes in a narrow export base (Cieslik & Parteka, 2021; Lee & Zhang, 2022). These findings suggest that comparative advantage and export competitiveness are related but distinct concepts, especially when countries differ in export scale, product structure, and domestic absorption. Beyond these trade indicators, research on Guatemalan palm-oil supply chains highlights the importance of traceability and the limitations of certification in addressing deforestation risks (VanderWilde et al., 2023). Future studies should use longer time periods, compare EU and non-EU markets, include downstream palm-oil products, and apply panel or gravity-based models to identify the factors that shape CPO export competitiveness.

4. CONCLUSIONS

This study examined the export competitiveness of crude palm oil (CPO) among CPOPC member countries—Indonesia, Malaysia, Papua New Guinea, and Honduras—using comparative

advantage indicators (RCA and RSCA), competitive positioning measures (EPD and ECI), and a nonparametric comparison of the pre- and post-RED II phases with the Wilcoxon Signed-Rank test. The findings show that comparative advantage alone does not fully explain CPO export competitiveness among CPOPC members. Although these CPOPC countries have a strong comparative advantage, their competitive positions differ because of export scale, market-share changes, and export structure. Indonesia's weaker position in crude CPO should be viewed as part of its shift toward downstream palm-oil products and higher domestic use, rather than a decline in the overall competitiveness of its palm-oil industry. In contrast, the strong EPD positions of Papua New Guinea and Honduras should be interpreted carefully because their smaller export bases can make market-share changes appear larger.

The findings have several policy implications. For Indonesia, assess crude CPO performance alongside downstream processing and domestic biodiesel use, rather than treating it as a loss of competitiveness. For Malaysia, export-market diversification should continue alongside stronger sustainability certification. For Papua New Guinea and Honduras, value addition and export diversification should be prioritized because their competitiveness indicators can be sensitive to small changes in export volume. At the CPOPC level, cooperation should focus on market diversification, sustainability compliance, and downstream development.

This study has several limitations. First, the Wilcoxon Signed-Rank test is based on only seven paired annual observations for each country, which limits statistical power and reduces the ability to detect small or moderate differences between the pre- and post-RED II periods. Second, RCA, RSCA, EPD, and ECI capture observed competitiveness patterns but do not establish causal effects of RED II or other domestic and international policies. Future studies should therefore extend the observation period, apply panel or gravity-based econometric models with larger samples, distinguish EU and non-EU export destinations, and incorporate domestic policy variables such as biodiesel mandates, export restrictions, and down-streaming policies to identify the determinants of CPO export competitiveness better.

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AUTHORS CONTRIBUTION

DWP: Writing – original draft, Visualization, Validation, Methodology, Formal analysis, Conceptualization, Writing – review & editing. JS: Methodology, Funding acquisition, Supervision. PM: Writing – review & editing, Validation, Methodology, Conceptualization, Supervision.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this study.

USE OF AI TOOLS DECLARATION

Google Translate and Claude assisted with translation and language editing in parts of the manuscript. The authors wrote the remaining sections without AI assistance. The authors carefully reviewed the final manuscript and take full responsibility for its content and accuracy.

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