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Analysis of Factors Influencing the Export Competitiveness of the Largest CPO Exporters to the European Union's Main Markets

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ABSTRACT
Crude palm oil (CPO) is one of the most heavily traded vegetable oils in the world, with Indonesia and Malaysia jointly supplying more than 80% of global production. Although both countries maintain a Revealed Comparative Advantage (RCA) above one in the European Union (EU) market, their competitiveness trends have diverged sharply across destination countries between 2010 and 2024. This study examines the influence of economic distance, real effective exchange rate (REER), rule of law, and the Renewable Energy Directive II (RED II) policy on the export competitiveness of the largest CPO exporters, Indonesia and Malaysia, in the four main EU import markets (Germany, the Netherlands, Italy, and Spain) during 2011-2024. Using panel data of 112 observations from eight exporter-importer country pairs, the study applies a Fixed Effect Model (FEM) with White cross-section robust standard errors, selected through Chow and Hausman tests. The results show that economic distance has a significant non-linear, inverted U-shaped effect on RCA, while RED II has a significant negative effect, reflecting its function as a sustainability-based non-tariff barrier. REER and rule of law show no significant effect, suggesting that CPO trade, as a homogeneous primary commodity, is less sensitive to short-term exchange rate movements and domestic institutional quality than to external trade-cost and regulatory factors. These findings imply that EU sustainability regulation, rather than macroeconomic or institutional conditions, is the dominant force shaping CPO export competitiveness, offering practical direction for trade diplomacy and sustainability certification strategies for Indonesia and Malaysia.

Keywords: *Economic distance; Export competitiveness; Palm oil; RED II; Rule of law*

INTRODUCTION

Crude palm oil (CPO) is the world's most widely traded vegetable oil, and Indonesia and Malaysia together supply more than 80% of global production, making it a strategic source of foreign exchange for both countries (Tandra et al., 2022; Dermoredjo et al., 2025). The European Union (EU) is one of their most important yet most demanding destinations, combining substantial import capacity with the world's strictest sustainability-based trade regulation, most notably the Renewable Energy Directive II (RED II), which classified palm oil as a high Indirect Land Use Change (ILUC)-risk biofuel feedstock in 2019.

Export competitiveness data for 2010-2024, measured through the Revealed Comparative Advantage (RCA) index (Balassa, 1965), show that this position is far from stable. RCA for Indonesia-Netherlands fell by roughly 90%, while Malaysia-Germany rose by nearly 495% over the same period (Figure 1), indicating that competitiveness moves inconsistently across exporter-importer pairs rather than following a single shared trend.

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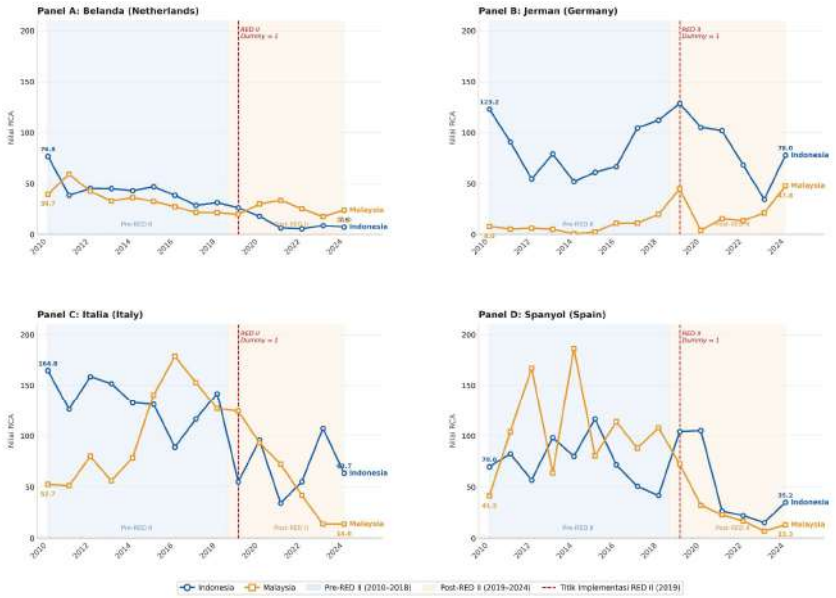

Figure 1. Trend of CPO Revealed Comparative Advantage (RCA) for Indonesia and Malaysia in the EU's Main Importing Countries, 2010-2024

Source: UN Comtrade Database, processed by the authors, 2026.

Existing studies confirm this instability from different angles. Hidayat et al. (2023) and Arsyad et al. (2020) find that Indonesia's and Malaysia's comparative advantage diverges by product stage; Jamilah et al. (2022) show that Indonesia's competitive position varies substantially by EU destination country; Meliany et al. (2025) document a shift from a “falling star” to a “lost opportunity” position as EU regulation tightened; and Firdaus et al. (2022) similarly find diverging Indonesia-Malaysia competitiveness patterns in the Pakistani and surrounding regional markets.

This literature, however, leaves three gaps unaddressed. First, most studies isolate either macroeconomic determinants (trade value, GDP, exchange rate) or policy shocks (RED II), rather than testing trade-cost, macroeconomic, institutional, and regulatory factors jointly within a single empirical framework. Second, the trade-cost effect of economic distance is conventionally assumed to be linear, even though recent gravity-model theory suggests that trade-cost elasticity can vary non-linearly with distance (Carrère et al., 2020; Chen & Novy, 2022). Third, institutional variables such as rule of law remain rarely tested in CPO trade research, despite New Institutional Economics suggesting that institutional quality can shape export performance.

This study addresses these gaps and offers three points of novelty: it is among the first to jointly estimate trade-cost, macroeconomic, institutional, and international-policy determinants of CPO export competitiveness within a single panel model; it explicitly tests for a non-linear (inverted U-shaped) effect of economic distance rather than assuming linearity; and it incorporates rule of law as an institutional determinant alongside RED II as a regulatory determinant. Specifically, this study examines the influence of economic distance, real effective exchange rate (REER), rule of law, and RED II on the export competitiveness of the largest CPO exporters, Indonesia and Malaysia, in the EU's four main import markets, Germany, the Netherlands, Italy, and Spain, over 2011-2024.

LITERATURE REVIEW

Export Competitiveness and Revealed Comparative Advantage

Revealed Comparative Advantage (RCA), introduced by Balassa (1965), measures a country's comparative advantage in a given commodity based on its actual trade pattern rather than its

production potential. Unlike absolute export volume, RCA corrects for market size and domestic trade intensity, making it a more reliable indicator for comparing competitive positions across countries and, in this study, across exporter-importer country pairs (Ramadhani & Santoso, 2019).

Economic Distance and the Gravity Model of Trade

The Gravity Model of Trade posits that bilateral trade flows are positively related to the economic size of trading partners and negatively related to the distance between them. Head and Mayer (2014) extend this framework by combining geographical distance with relative economic size to form a composite economic distance measure. Recent developments in gravity theory, however, suggest that the elasticity of trade with respect to distance is not necessarily constant across the full range of trade costs; Carrère et al. (2020) and Chen and Novy (2022) show that trade-cost elasticities can vary non-linearly, which provides theoretical grounds for testing a non-linear, inverted U-shaped relationship between economic distance and export competitiveness.

Real Effective Exchange Rate and Purchasing Power Parity

The Purchasing Power Parity (PPP) framework predicts that real currency depreciation improves export competitiveness by lowering the relative price of domestic goods abroad. Empirically, however, this relationship is not always confirmed for homogeneous primary commodities. Rasbin et al. (2021) and Salvacesa and Ervani (2025) find that REER has a limited or statistically insignificant effect on Indonesia's export performance, arguing that internationally referenced commodity prices and long-term trade contracts reduce short-term exchange-rate sensitivity.

Rule of Law and New Institutional Economics

New Institutional Economics (NIE) argues that institutional quality, including rule of law, lowers transaction costs and contract-enforcement risk, thereby facilitating trade. Lukman et al. (2023) find supportive evidence for this mechanism in ASEAN countries, although the effect tends to be weaker for resource-based, low contract-intensity commodities such as CPO, where trade relies less on complex domestic legal enforcement.

The Renewable Energy Directive II and Non-Tariff Measures

The EU's Renewable Energy Directive II (RED II) classified palm oil as a high ILUC-risk feedstock, functioning as a sustainability-based Non-Tariff Measure (NTM) that restricts market access. Pratama and Widodo (2020), Ramadhani et al. (2022), and Tyson and Meganingtyas (2022) identify RED II as a discriminatory, protection-oriented barrier that has measurably reduced CPO export performance from Southeast Asia to the EU.

Building on this theoretical and empirical foundation, the following hypotheses are proposed:
H1: Economic distance has a non-linear (inverted U-shaped) effect on the export competitiveness of the largest CPO exporters in the EU market.
H2: Real effective exchange rate has a negative effect on the export competitiveness of the largest CPO exporters in the EU market.
H3: Rule of law has a positive effect on the export competitiveness of the largest CPO exporters in the EU market.
H4: The Renewable Energy Directive II policy has a negative effect on the export competitiveness of the largest CPO exporters in the EU market.

METHODS

This study uses a quantitative panel-data approach. The unit of analysis is the exporter-importer country pair engaged in bilateral CPO trade, representing the trade relationship between the two largest exporters, Indonesia and Malaysia, and four main EU importing countries: Germany, the

Netherlands, Italy, and Spain, selected because they account for approximately 92% of total EU CPO imports from Indonesia and Malaysia during 2010-2024. Applying purposive sampling, the study yields eight exporter-importer country pairs observed annually. Although the underlying data span 2010-2024, the estimation sample covers 2011-2024 because the RED II variable is entered as a one-year lag, D_REDII(-1); the 2010 observation is thereby consumed as the base year for constructing this lagged term rather than used directly in the regression, yielding 112 panel observations.

The dependent variable, export competitiveness, is proxied by the Revealed Comparative Advantage (RCA) index (Balassa, 1965), calculated as:

$$RCA = (Xij / Xi) / (Xwj / Xw) \quad (1)$$

where Xij is the export value of CPO from exporter country i to importer country j, Xi is total export value of country i across all commodities, Xwj is the world's total CPO exports, and Xw is total world exports across all commodities. An RCA value above one indicates comparative advantage.

Economic distance, following Head and Mayer (2014), combines weighted geographical distance with relative economic size between trading partners:

$$ECDIST = distwij \times (GDPjt / GDPit) \quad (2)$$

where distwij is the weighted geographical distance between exporter i and importer j, and GDPit and GDPjt are the gross domestic products of the exporter and importer at time t. A quadratic term of economic distance is added to test for a potential non-linear relationship with export competitiveness. Real effective exchange rate (REER) data are obtained from IMF statistics, rule of law is measured using the World Governance Indicators (WGI) Rule of Law Estimate from the World Bank, and RED II is entered as a one-year lagged policy dummy variable (0 before, 1 after the regulation took effect), following the Policy Transmission Lag Theory.

The panel regression model is specified as:

$$LOG(RCA)it = a + b1\ LOG(ECDIST)it + b2\ [LOG(ECDIST)it]^2 + b3\ LOG(REER)it + b4\ ROLit + b5\ D\_REDII(-1)it + eit \quad (3)$$

The most appropriate estimation model, Common Effect Model (CEM), Fixed Effect Model (FEM), or Random Effect Model (REM), is determined through the Chow test and the Hausman test (Wooldridge, 2010). The selected model is then evaluated against the classical assumption tests relevant to panel-data estimation, namely normality (Jarque-Bera test), multicollinearity (pairwise correlation matrix), and heteroskedasticity (Glejser test) (Gujarati & Porter, 2009). Where heteroskedasticity is detected, the final model is re-estimated using White cross-section robust standard errors, which correct standard errors without altering the estimated coefficients (White, 1980). Hypothesis testing is conducted through the t-test for partial effects, the F-test for simultaneous effects, and the adjusted coefficient of determination (Adjusted R2) to assess the model's explanatory power.

RESULTS

Model selection was carried out through the Chow test and the Hausman test. The Chow test yielded a Cross-section F probability of 0.0003 and a Cross-section Chi-square probability of 0.0001, both below the 5% significance level, indicating that the Fixed Effect Model (FEM) is preferred over the Common Effect Model. The Hausman test produced a Chi-square statistic of 16.5427 with a probability of 0.0054, confirming that FEM is also preferred over the Random Effect Model. The Glejser test on the initial FEM estimation indicated heteroskedasticity in the economic distance variables ($p = 0.0224$ and $p = 0.0162$ respectively), while the Jarque-Bera normality test (probability

= 0.0523) and the pairwise correlation matrix showed no serious violation of the normality or multicollinearity assumptions, aside from the expected high correlation between the linear and quadratic economic distance terms. The final model was therefore re-estimated using White cross-section robust standard errors. Table 1 presents the final FEM estimation results with White cross-section robust standard errors.

Table 1. Fixed Effect Model Estimation Results with White Cross-Section Robust Standard Errors

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-168.9771	32.8990	-5.1362	0.0002
LOG(ECDIST)	33.7250	6.5513	5.1478	0.0002
(LOG(ECDIST))²	-1.6240	0.3243	-5.0084	0.0002
LOG(REER)	-0.2771	0.6976	-0.3972	0.6976
ROL	0.1457	0.5798	0.2513	0.8055
D_REDII(-1)	-0.6567	0.1445	-4.5432	0.0006

Source: EViews 14 output, processed by the authors, 2026. Adjusted R-squared = 0.5983; F-statistic = 14.7750; Prob(F-statistic) = 0.0000.

The estimated regression equation is:

LOG(RCA)it = -168.9771 + 33.7250 LOG(ECDIST)it - 1.6240 [LOG(ECDIST)it]^2 - 0.2771 LOG(REER)it + 0.1457 ROLit - 0.6567 D_REDII(-1)it (4)

The Adjusted R-squared of 0.5983 indicates that the model explains approximately 59.8% of the variation in CPO export competitiveness, while the Prob(F-statistic) of 0.0000 confirms that the independent variables jointly and significantly affect export competitiveness at the 5% significance level.

The positive coefficient on the linear economic distance term together with the negative coefficient on its quadratic term indicates a non-linear, inverted U-shaped relationship between economic distance and export competitiveness, illustrated in Figure 2. The turning point is identified by setting the first derivative of the regression equation with respect to LOG(ECDIST) to zero, which yields LOG(ECDIST) = 10.38, or an actual economic distance value of approximately 32,314.56.

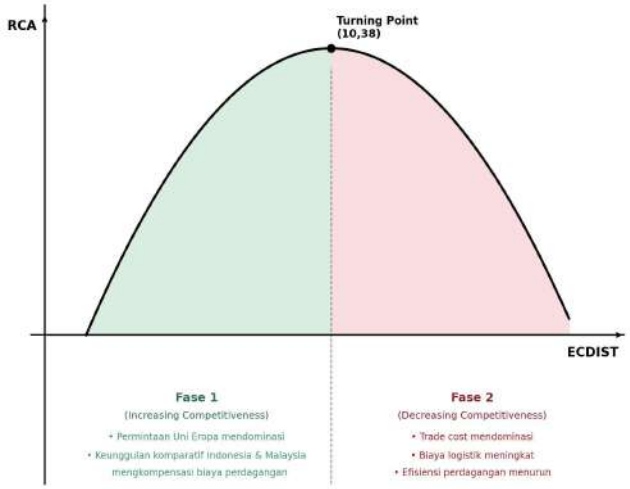

Figure 2. Inverted U-Shaped Curve of Economic Distance and CPO Export Competitiveness
Source: processed by the authors, 2026.

DISCUSSION

Economic distance shows a statistically significant non-linear relationship with export competitiveness, confirming H1. The positive linear coefficient combined with a negative quadratic coefficient produces an inverted U-shaped curve with a turning point at approximately LOG(ECDIST) = 10.38. Below this threshold, the size of EU demand and CPO's comparative advantage are able to offset the trade costs generated by distance; beyond the turning point, trade costs increasingly dominate and begin to erode export competitiveness. This finding extends, rather than simply confirms, the Gravity Model: while the conventional model assumes a uniformly negative distance effect, the result here supports the more recent theoretical development of Carrère et al. (2020) and Chen and Novy (2022), who show that trade-cost elasticity with respect to distance is not constant across the full range of observed distances. Practically, this implies that Indonesia and Malaysia should treat distance not as a fixed constraint but as a cost that can still be actively managed, for instance through logistics efficiency and shipping-route optimization, for destinations approaching or beyond the turning point.

Real effective exchange rate shows no statistically significant effect on export competitiveness ($p = 0.6976$), leading to the rejection of H2. This result does not support the Purchasing Power Parity framework, which predicts that real currency depreciation should improve export competitiveness by lowering relative prices abroad. The discrepancy is best explained by CPO's status as a homogeneous, price-taking commodity: because CPO prices are set in an integrated world market and traded under long-term contracts, competitiveness responds more to trade-cost and regulatory conditions than to short-term currency movements, an interpretation consistent with Rasbin et al. (2021) and Salvacesa and Ervani (2025), who likewise find limited exchange-rate sensitivity for Indonesian primary commodity exports. This implies that exchange-rate management is unlikely to be an effective policy lever for improving CPO's position in the EU market.

Rule of law also shows no statistically significant effect ($p = 0.8055$), leading to the rejection of H3. This finding runs counter to New Institutional Economics, which predicts that stronger institutions lower transaction costs and facilitate trade, and it parallels the weaker institutional effect reported by Lukman et al. (2023) for resource-based ASEAN commodities. Two mechanisms plausibly explain this divergence from theory. First, Indonesia's and Malaysia's WGI rule-of-law scores are relatively stagnant over the observation period, leaving limited time-series variation to explain changes in RCA. Second, CPO is a low contract-intensity primary commodity: unlike manufactured or differentiated goods, its trade relies less on complex domestic legal enforcement, so the institutional-quality channel that NIE emphasizes may simply carry less weight for this commodity type. The policy implication is that domestic governance reform, while valuable for other trade sectors, is unlikely by itself to meaningfully improve CPO's competitive position in the EU.

The Renewable Energy Directive II policy has a statistically significant negative effect on export competitiveness ($p = 0.0006$), supporting H4 and representing the study's most policy-relevant finding. This result substantiates the Non-Tariff Measures framework and the broader green protectionism critique: by classifying CPO as a high ILUC-risk biofuel feedstock, RED II has effectively restricted EU biofuel market access for Indonesian and Malaysian CPO, consistent with Pratama and Widodo (2020), Ramadhani et al. (2022), and Tyson and Meganingtyas (2022), who identify RED II as a discriminatory, sustainability-based barrier to Southeast Asian palm oil exports. Because this effect is both the largest in magnitude among the significant variables and the one most directly under policy influence, it points to a concrete implication: strengthening and pursuing mutual recognition of national certification schemes, such as ISPO and MSPO, alongside sustained trade diplomacy through the WTO, is likely to be a more effective response than domestic macroeconomic or institutional reform.

Taken together, these results indicate that CPO export competitiveness in the EU market is shaped more strongly by external trade-cost structures and sustainability-based regulatory barriers than by macroeconomic conditions or domestic institutional quality. This pattern suggests that the evolving international trade regulatory landscape, rather than exchange-rate or governance reform, is the primary challenge to the sustainability of CPO exports to the EU, and that policy attention is best directed toward trade diplomacy, certification, and logistics rather than macroeconomic or institutional levers.

CONCLUSIONS

This study examined the factors influencing the export competitiveness of the largest CPO exporters, Indonesia and Malaysia, in the European Union's main import markets. Economic distance is found to affect export competitiveness in a non-linear, inverted U-shaped pattern, while the Renewable Energy Directive II policy exerts a significant negative effect, confirming its function as a sustainability-based non-tariff barrier. Real effective exchange rate and rule of law, in contrast, show no significant influence, indicating that, for a homogeneous, price-taking commodity such as CPO, external trade-cost and regulatory factors outweigh short-term macroeconomic movements or domestic institutional quality.

Theoretically, these findings contribute to the gravity-model and export-competitiveness literature by providing empirical evidence that the distance-trade relationship for CPO is non-linear rather than uniformly negative, and by demonstrating that institutional and international-policy dimensions carry unequal weight in shaping commodity export performance, an integration still rarely attempted within a single empirical framework in CPO trade research.

Practically, the dominance of the RED II effect suggests that trade diplomacy and sustainability certification, including efforts toward mutual recognition of Indonesia's and Malaysia's national palm oil certification schemes with EU sustainability criteria, deserve greater policy priority than exchange-rate management or domestic governance reform in preserving competitiveness in the EU market. The non-linear distance effect further suggests that trade-facilitation measures, such as improved logistics efficiency toward more distant EU destinations, may help extend the range over which increasing distance still supports rather than erodes competitiveness.

This study is nonetheless limited to four EU importing countries and two exporting countries, so the findings may not generalize to the full EU market or to other vegetable-oil exporters, and its institutional dimension is represented solely through the rule-of-law indicator, which may not capture other aspects of governance quality relevant to trade. Future research may extend this framework to the full set of EU member states, incorporate additional institutional or sustainability-compliance indicators, or apply a similar non-linear specification to other primary commodities facing comparable regulatory pressure in export markets.

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USE OF ARTIFICIAL INTELLIGENCE (AI)

The authors declare that the generative artificial intelligence (AI) tool Claude AI was used exclusively for language editing and/or grammatical improvement. The use of AI did not influence the scientific

content, study design, data analysis, data interpretation, results, or conclusions of the manuscript. Full responsibility for the content remains with the authors.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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