THE CHANGING ROLE AND ITS DETERMINANTS OF THE LEADING VEGETABLE OIL EXPORTING COUNTRIES

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ABSTRACT

The expansion of biofuel use is driving the demand for vegetable oils and changing the role of leading exporting countries. At the same time, the world is paying great attention on how international trade is based on ways that consider environmental sustainability. This research compared the competitiveness of the leading countries exporting palm oil, soybean oil, and sunflower oil. The study sought to analyze factors determining the competitiveness of the leading vegetable oil exporting countries. The study was conducted from 2023 to 2024. Specifically, this research analyzed how changes in the competitiveness of a leading vegetable oil exporting country affected the competitiveness of other leading vegetable oil exporting countries. The research used secondary data from 1997 to 2022 with seemingly unrelated regression estimations of equations. The key factors influencing the competitiveness of the leading vegetable oil exporting countries are land, productivity, exchange rate, GDP per capita, and trade freedom. Ukraine, Argentina and Indonesia are market leaders with a tendency for complementary relationships. This research emphasized the importance of developing a joint strategy that ensures the trade policy of leading vegetable oil exporting countries based on increasing productivity and exchange rate stabilization policy rather than land expansion.

Key words: competitiveness, market share, seemingly unrelated regression, sustainable development

INTRODUCTION

The development of the biofuel market increases the demand for vegetable oils as raw materials for biofuels, thereby creating competition between the usage of vegetable oils for food and energy (Wang et al. 2015). The rising demand of vegetable oils as raw material for biofuels also affects the trade balance in the world vegetable oil market, thereby causing fluctuation in world vegetable oil prices with an upward trend (Alam et al. 2019). However, vegetable oil development is often associated with environmental problems, such as biodiversity loss, climate change, and other environmental problems (Bentivoglio et al. 2018). The increasing importance of vegetable oils in the world economy and their connection to sustainability issues have drawn considerable attention (Montania et al. 2021).

Three types of vegetable oils are dominantly traded on the international market in 2022: palm oil, sunflower oil, and soybean oil, with a market share of 28.92%, 27.86% and 20.40%, respectively. Meanwhile, the other 22.82% is the combined trade value of other types of vegetable oils, including

peanut oil, olive oil, cottonseed oil, coconut oil, linseed oil, corn oil, canola oil, castor oil and sesame oil. The leading palm oil exporting countries are the ASEAN countries Indonesia and Malaysia, with 56% and 26% shares of international palm oil exports, respectively. The central exporting countries for non-palm vegetable oils are situated in Europe and America. During the 1997-2022 period, the central exporting countries for soybean oil are Argentina and Brazil, with 49% and 18% shares of total world soybean oil exports, respectively. Ukraine and Russia are the leading exporting countries of sunflower oil with 40% and 12% market shares of total world sunflower oil exports, respectively (UNCOMTRADE 2024).

Earlier studies were limited to the correlation between crude oil and one type of vegetable oil, e.g., soybean oil (Nicola et al. 2016) and palm oil (Bergmann et al. 2016; Obadi and Korcek 2014). Several studies examined the relationship between the world's leading vegetable oils, e.g., palm-soybean oil (Bentivoglio et al. 2018; Sanders et al. 2014; Santeramo and Searle 2019) and palm-soybean-rapeseed-sunflower oil (Brummer et al. 2015; Santeramo et al. 2021). A research study on the trade in sunflower oil between countries was also conducted (Hamulczuk et al. 2021) and another on the trade in palm oil between leading palm oil exporting countries (Bentivoglio et al. 2018). The relationship between exporting countries for palm oil, soybean oil, rapeseed oil, and sunflower oil in terms of price volatility was also studied (Brummer et al. 2015). Previous studies by Arsyad et al. (2020); Cetrangolo et al. (2002); Filassi and De Oliveira (2022); Novindra et al. (2018); Paula et al. (2018); Pilorge (2020); Ramadhani and Santoso (2019); Silitonga et al. (2016); Yanita et al. (2019); and Zimmer (2010) delved into the competitiveness of Indonesian palm oil, comparing it with Malaysia, and explored sunflower oil in Argentina and globally, along with Brazilian soybean. Production costs were compared (Zimmer 2010), while RCA (revealed comparative advantage) and CMS (constant market shares) were used to gauge the competitiveness of Brazilian soybean exports (Paula et al. 2018). However, these studies were limited in scope, focusing on specific vegetables oils or countries (Paula et al. 2018; Zimmer 2010).

A recent research scrutinized Indonesia's position in the global vegetable oil trade. It highlighted the necessity for updated assessments of Indonesia's standing in this market. Nevertheless, this study employed descriptive methods and overlooked the potential impact changes in competitiveness among leading exporters of specific vegetable oil types on others, both within the same category and across different types (Husin et al. 2023). Policies implemented by a country that is a major exporter of vegetable oil can influence other major exporters (Taheripour and Tyner 2020). An increase in demand for certain types of vegetable oil will encourage not only an increase in the price of that type of vegetable oil but also the demand for other types of vegetable oil with more competitive prices (Thompson et al. 2010). Moreover, the world's main vegetable oils are substitutes for use in food, energy and other industries (Priyati and Tyers 2016). Thus, changes in the policies of each leading exporting country and changes in the world economy can change the factors that shape a country's competitiveness, resulting in a change in the competitiveness of this country and other leading vegetable oil exporting countries. Cross-country research regarding the competitiveness of the leading exporting countries for these three types of vegetable oils is essential to develop policies that can balance export promotion and reduce the environmental impact of the vegetable oil trade.

This study sought to analyze relative export competitiveness and export market share of leading exporting countries of vegetable oil, the key factors determining the competitiveness of leading exporting countries of vegetable oil as cross-country comparison, and their linkage in the global trade system. This research complements existing research by analyzing factors that influence the competitiveness of leading exporting countries of vegetable oil as cross-country comparison, one of which is related to land expansion, which can be linked to sustainable development. Although the development of biofuels made from vegetable oil is driven by its potential as an environmentally friendly energy source compared to fossil fuels (Nakamya 2022), land expansion for vegetable oil production is often associated with environmental problems (Montania et al. 2021).

Changes in the world economy, especially after the Russian invasion of Ukraine, which is the world's main exporter of sunflower oil, caused changes in the competitiveness and role of these two countries, as well as other leading vegetable oil-exporting countries in the world vegetable oil trade. The Russia-Ukraine war caused an increase in world crude oil prices (World Bank 2022), thereby driving an increase in world demand and prices for vegetable oils. This research makes cross-country comparisons by examining how changes in one country's competitiveness affect other countries. This research provides complete information regarding the dynamics of competitiveness by considering the relationship between countries for 26 years, which is where the novelty of this research lies. The research results showed the extent to which the main vegetable oil exporting countries rely on the abundance of resources (factor endowment), namely land as a determining factor of competitiveness and also other determining factors of competitiveness. The results of this research can provide guidance to the main vegetable oil exporting countries regarding which countries whose vegetable oil production complements and competes with the vegetable oil it produces. Thus, it is expected that the information produced by this research may help leading vegetable oil exporting countries to formulate competitive and sustainable vegetable oil development policies.

METHODS

Data types and sources. The research was conducted from 2023 to 2024 which used various sources of secondary data ranging from 1997 to 2022, including land and yield (Food Agricultural Organization), exchange rate (United Nations Conference on Trade and Development), gross domestic product (GDP) per kapita, foreign direct investment (FDI), and crude oil price (World Bank), trade freedom index (The Global Economy), export value of vegetable oil and export value of all goods (UNCOMTRADE). This research used the HS (harmonized system) code for crude vegetable oil, including crude palm oil, 151110, crude soybean oil, 150710, and crude sunflower oil, 151211.

Relative export competitiveness. The Relative Export Competitiveness (REC) Index was used as competitiveness indicator in this research. The total export of each type of vegetable oil in the leading exporting country was excluded from the calculation of total exports both in each country and world exports. The REC index in this research showed the competitiveness of each significant exporting country for a type of vegetable oil (i.e., palm oil, soybean oil, or sunflower oil) relative to its market share for other goods in the world. If the REC index value was > 1, then the leading vegetable oil exporting country had relative competitiveness in the world market and vice versa.

$$REC_{pit} = \frac{\left(X_{pit} \times HX_{pit}\right) \Big/ \sum_{w,w\neq i} NTX_{pwt}}{\sum_{s,s\neq p} NTX_{sit} \Big/ \sum_{s,s\neq p} \sum_{w,w\neq i} NTX_{wt}} \quad (1)$$

Variable notation:

RECpit	=	The Relative Export Competitiveness of the vegetable oil p of the country i in the year t
Xpit	=	The quantity of exports of the vegetable oil p of the country i in the year t (t)
HXpit	=	The price of exports of the vegetable oil p of the country i in the year t (US$/t)
NTXpwt	=	The total value of the global exports of the vegetable oil p in the year t (US$)
NTXsit	=	The total value of exports of all goods of the country i in the year t (US$)
NTXwt	=	The total value of the global exports of all goods in year t (US$)
S	=	All goods of each major vegetable oil exporter except product p
W	=	All over the world except the country i

Export market share. The export market share (EMS) index was used to measure the competitiveness of each country that is the world's leading exporter of vegetable oil. The EMS index used in this research is as follows:

$$EMS_{pit} = \frac{X_{pit}}{X_{wt}} \quad (2)$$

Variable notation:

EMS_{it} = EMS index of the vegetable oil p of country i in the year t
X_{pit} = The quantity of exports of the vegetable oil p of the country i in the year t (t)
X_{wt} = The quantity of world major vegetable oil export in the year t (t)
p = palm oil, soybean oil, sunflower oil
i = Indonesia, Malaysia, Argentina, Brazil, Ukraine, Russia

Cross-country linkages. The factors influencing competitiveness used in this research include land area (Kea et al. 2020; Montania et al. 2021; Narayan and Bhattacharya 2019), productivity (Montania et al. 2021; Narayan and Bhattacharya 2019), exchange rate (Blanchard and Johnson 2013; Montania et al. 2021), per capita income (Blanchard and Johnson 2013; Kea et al. 2020; Montania et al. 2021; Narayan and Bhattacharya 2019), foreign direct investment (OECD 2002), trade freedom (Pilinkiene 2016; Squalli and Wilson 2011), and crude oil price (Pal and Mitra 2018). Cross-country linkages were examined by analyzing how changes in one country's competitiveness can influence the competitiveness of other countries (Montania et al. 2021).

The market share value was then used to analyze the factors influencing the competitiveness of leading vegetable oil exporting countries and the linkages between these leading exporting countries. The model used in this research was adopted from the research by Montania et al. (2021) to show the linkages between leading exporters of vegetable oils and detect whether the relationship patterns were competitive or complementary. The estimation method for estimating the coefficients in the model used seemingly unrelated regression (SUR) estimations with iteration. The contemporaneous correlation test on the SUR model was carried out using the Breusch-Pagan Langrange Multiplier test statistical formula (Halunga et al. 2017), as follow:

$$BP^{LM} = \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \frac{\frac{1}{\sqrt{T}} \sum_{t=1}^{T} \hat{\varepsilon}_{it} \hat{\varepsilon}_{jt}}{\sqrt{\left\{\frac{1}{T} \sum_{t=i}^{T} \hat{\varepsilon}_{it}^2\right\}\left\{\frac{1}{T} \sum_{t=i}^{T} \hat{\varepsilon}_{jt}^2\right\}}} \quad (3)$$

The SUR model is the appropriate model to use if there is a contemporaneous correlation in the model. The rejection criteria of Ho is if $> X^2_{db=\frac{1}{2}N(N-1)}$, it means that there is a contemporaneous correlation in the model. The analysis technique was carried out in STATA 16 software. The research model is as follows and the explanation of variables can be seen at Table 1:

$$Ln\, EMS_{pit} = \beta_0 + \beta_1\, Ln\, LAND_{pit} + \beta_2\, Ln\, YIELD_{pit} + \beta_3\, Ln\, EXRATE_{it} + \beta_4\, Ln\, GDP_{it} + \beta_5\, FDI_{it} + \beta_6\, LnTFI_{it} + \beta_7\, Ln\, CO_t \sum_{k=1}^{n-1} \beta_8\, Ln\, EMS_{pi,t-1} + \mu_{it} \quad (4)$$

Table 1. Operational definition of variables

Notation	Description	Hypothesis
EMS_{pit}	The EMS index of the leading exporting country i for the vegetable oil p	
$LAND_{pit}$	The vegetable oil harvest area in country i (Ha)	+
$YIELD_{pit}$	The productivity of the vegetable oil p in the country i (Kg/Ha)	+
$EXRATE_{it}$	Exchange rate (Currency/USD)	+

Notation	Description	Hypothesis
GDP_{it}	GDP per capita (Constant 2015 US$)	+
FDI_{it}	Foreign Direct Investment (net inflow % of GDP)	+
TFI_{it}	Trade Freedom Index	+
CO_t	Crude oil price (US$/Barrel)	+
$EMS_{pi,t-1}$	The EMS index of the leading exporting country i for the vegetable oil p in the year t-1	+ (complementary) - (competitive)
μ_{it}	Error term	
Subscript notation:		
p	Vegetable oil; PO (palm oil), SO (soybean oil), SFO (sunflower oil)	
T	Years 1997 - 2022	
I	Leading exporting country i; I (Indonesia), M (Malaysia), AR (Argentina), BR (Brazil), U (Ukraine), R (Russia)	

RESULTS AND DISCUSSION

Competitiveness of leading vegetable oil exporting countries. The REC value of Indonesian palm oil was the highest before 1998, the REC value of Argentinian soybean oil was the highest in 1998-2008, and the REC value of Ukrainian sunflower oil was the highest in 2010-2022. The REC value for Indonesian palm oil reached its highest figure in 1997 (294.52), then fell during the global economic crisis in 1998 to 42.34. Indonesia's palm oil exports decreased at a time when world palm oil exports increased during the global economic crisis. It caused the REC value of Indonesian palm oil in 1998 to be the lowest in the period from 1997 to 2020.

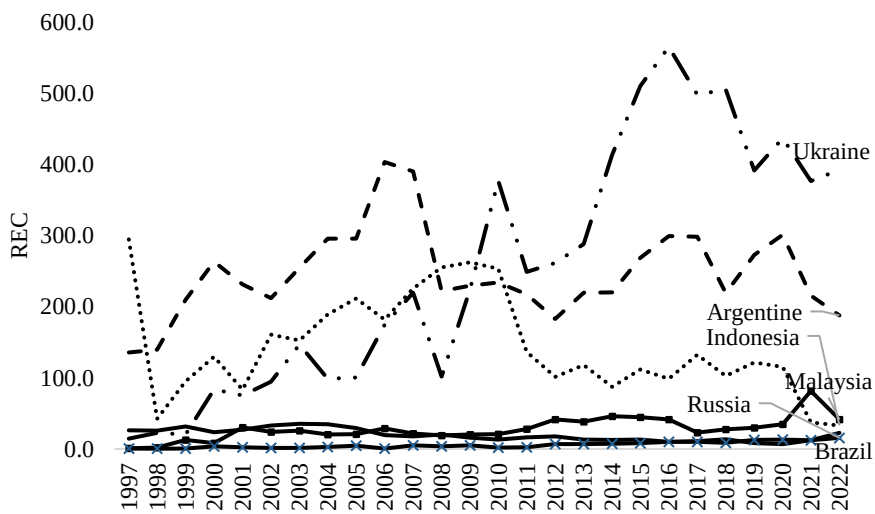

Figure 1. Competitiveness index of the world's leading vegetable oil exporting countries

From 1997 to 2020, the REC value of Indonesian palm oil was higher than that of Malaysia, but in 2021, the REC value of Malaysian palm oil (81.52) was higher than that of Indonesia (37.30). Indonesia's REC value in 2021 was lower than it was during the 2019 and 2020. It indicates that after the COVID-19 pandemic, there was a shift in competitiveness and roles of these two countries in the global palm oil trade. It also indicates a change in export orientation from crude palm oil to palm oil derivative products and the development of downstream industries. Research results showed an increase in the competitiveness (RSCA value) of Indonesian palm oil derivative products, while the competitiveness of Malaysian oleochemicals had decreased (Tandra 2023). Figure 1 presents the competitiveness index values of the world's leading vegetable oil exporters.

The REC value of Argentina's soybean oil reached its highest figure in 2006, namely, 403.17. In 2006, Argentina implemented a differential export tax. Argentina's export taxes on soybeans were the highest (23.5%) compared to soybean foods (19.3%) and soybean oil (20%). A higher export tax value for soybean as raw material of soybean oil can incentivize the development of the processing industry, so that soybean oil exports increase (Deese and Reeder 2008). Argentine soybean oil producers are good agricultural managers, having turned to contract labour and on-farm storage alternatives to increase efficiency (Rojas 2006). Soybean plants in Argentina also have easy production and sound risk management, as well as practice intercropping of soybean plants. Even though the REC value of Brazilian soybean oil was lower than that of Argentina, Brazil's role in the trade in soybean oil raw materials is very important. Brazil is the soybean market leader, and its share of soybean exports is complementary to other soybean exporters, except Ukraine (Montania et al. 2021).

The REC value of Ukrainian sunflower oil reached its highest figure in 2016, namely, 564.91. International economic structures control most Ukrainian sunflower oil producers, in which business of Ukrainian sunflower oil was managed by international investor (Zavorotny and Bilyk 2017). Their management by international investors provides easy access to global markets. In 2014, Ukraine agreed with the EU, which provided duty-free preferences for almost 83.4% of Ukrainian agricultural and food product exports. Ukraine's REC value after 2016 fluctuated downward until it reached 376.49 in 2021. Russia's invasion of Ukraine in 2014 hurt sunflower oil production (Zavorotny and Bilyk 2017). In addition, there were devaluation of Ukrainian currency by more than four time and commercial bank liquidation, leading to economic transformation in Ukraine (Parubets et al. 2023). The REC value of Ukrainian sunflower oil and Russian sunflower oil rose slightly after the Russia-Ukraine war in 2022, which resulted from increased sunflower oil prices.

Table 2. Market share of the world's leading vegetable oil exporting countries.

Year	Indonesia	Malaysia	Argentine	Brazil	Ukraine	Russia
1997-2007	0,18	0,06	0,26	0,11	0,04	0,01
2008-2013	0,30	0,12	0,16	0,05	0,09	0,02
2014-2020	0,21	0,13	0,15	0,04	0,15	0,05
2021	0,09	0,17	0,16	0,05	0,17	0,07
2022	0,12	0,13	0,14	0,09	0,14	0,06

Table 2 shows changes in market leaders during the 1997-2022 period. Argentinian soybean oil dominated the world vegetable oil market from 1997 to 2007. Indonesian palm oil dominated the world vegetable oil market during 2008-2020. Meanwhile, Ukraine's share of sunflower oil has rapidly increased. Ukraine has become one of the world's three leading vegetable oil exporters since 2014. The share of Ukrainian sunflower oil exports continues to increase until 2021. The share of Ukrainian sunflower oil exports along with Malaysian palm oil was the highest, respectively 17% of world vegetable oil exports for each country in 2021, but the share of Ukrainian sunflower oil decreased after the Russian-Ukraine war. Changes in the market position of each country as the world's leading exporters of vegetable oil, can be linked to the market structure of each country. In the on-farm aspect, data from the Ministry of Agriculture Republic Indonesia (2022) showed that the area of oil palm plantations comprise large private plantations (55 per cent), smallholder plantations (41 per cent), and large state plantations (4 per cent). The low productivity of smallholder oil palm plantations (2.58 tons per ha) causes its contribution to palm oil production to be lower than its contribution to land. Smallholder farmers in Indonesia also face organizational, financial, legal and sustainability challenges (Glenday and Paoli 2015). Meanwhile, from the off-farm side, the decline in industrial concentration in the Indonesian palm oil market structure can be linked to a decline in company efficiency (Septiani and Setiawan 2023). Indonesia is also implementing policies to develop palm oil derivative products. This policy causes a trade-off between the interests of palm oil exports and the use of palm oil as a raw material for domestic industry.

Argentina's ability to maintain a significant market share in the world vegetable oil trade can be attributed to its involvement in the global food value chain (Regunaga 2010). From the farm side, 70 per cent of soybean production in Argentina has implemented a new production model. There is high consolidation from on-farm to off-farm, and it is easier to apply new technology. Soybean production and commercialization in Argentina are highly concentrated (high monopolization and foreignization), where 2.6 per cent of producers control 50 per cent of total production (Sly 2017). From the off-farm side, the Argentine crushing industry is recognized as the most modern and competitive industry in the world; most of the industry is located in ports, applies modern technology, and has the largest processing capacity in the world, with an export focus on protein meal and crude soybean oil. Argentine crushing industry is highly concentrated and involves local and international companies (Regunaga 2010). There are ten leading exporters, most of whom are transnational companies, of which six control 93% of the crushing industry capacity in Argentina (Sly 2017).

The increase in Ukrainian sunflower oil competitiveness was driven by reduced export taxes, which reorientated exports from sunflower seeds to sunflower oil (Makarchuk and Kuts 2022). Sunflower seeds are classified as the most profitable compared to the production of other agricultural commodities in Ukraine (Zavorotny and Bilyk 2017). The average profit growth from sunflower cultivation in Ukraine was 72.31% in 2018-2019 and 167.66% in 2019-2020. Ukrainian sunflower production is mainly controlled by agricultural enterprises (74%), followed by farms (16%) and households (10%) (Voliak 2021). From the off-farm side, 75% of Ukraine's sunflower oil production and exports are concentrated in eight market players (Zavorotny and Bilyk 2017).

Factors of competitiveness. Table 3 shows the high R-square values of the six competitiveness equations for the central vegetable oil exporting countries, in which one equation has an R-square value in the range of 70-80 percent, one equation has an R-square value in the range of 80-90 percent, and four equations have an R-square value more than 90 percent. Other measures of the model's goodness are a small RMSE value (close to 0) and the significance of the F statistical p-value. The six equations have small RMSE values (close to 0). The statistical P-value of F obtained from the model estimation results of the six equations is significant at the 1 percent absolute level.

The research results showed that the most influencing factor of the competitiveness of the world's leading vegetable oil exporters are land, productivity, exchange rate, GDP per capita, and trade freedom index. Land expansion significantly affects the competitiveness of Indonesian palm oil and Malaysian palm oil positively. The availability of commodity-specific resources, including land area, can influence competitiveness (Abdullahi et al. 2021; Kea et al. 2020; Narayan and Bhattacharya 2019). Land area is a natural endowment from the input side (Porter et al. 2008) that can influence competitiveness through increasing production (Kea et al. 2020; Montania et al. 2021). The abundance of resources (factor endowment) was still one of the critical factors for Indonesia and Malaysia. FAO (2024) shows that the growth rate of Indonesia's oil palm area is higher than that of any other major vegetable oil exporting country, namely 9.80 per cent per year from 1998 to 2022. However, Indonesia's oil palm area is the third largest after Brazil's and Argentina's soybean areas.

The expansion of Indonesian oil palm land has garnered world attention regarding the issue of environmental sustainability (Bogheiry et al. 2023; Masitah et al. 2023). Therefore, Indonesian government policies should be based on inclusiveness and environmental preservation (Purba et al. 2023). Even though Indonesia and Malaysia have different land uses, they are interrelated. Varkkey and Choiruzzad (2018) said that the commitment to maintaining forest sustainability encourages Malaysia’s government to focus on technology-based intensification and controlled expansion. Thus, the level of capital mobility and opportunities to invest in Indonesia encourage companies in Malaysia to invest in Indonesia. Although land area was a significant factor influencing the competitiveness of Indonesian and Malaysian palm oil during the analysis period, both two countries have demonstrated a commitment to reducing the growth rate of vegetable oil land area over the last four years. FAO data (2024) shows

that the growth rate of Indonesia's oil palm land area decreased from 25.42 per cent in 2016-2017 to 1.26 per cent in 2020-2022. The growth rate of Malaysia's oil palm land area decreased from 3.63 per cent in 2014-2015 to -0.92 per cent in 2020-2022. However, land area significantly affect the competitiveness of Ukrainian sunflower oil and Russian sunflower oil negatively. Polevoy et al. (2013) said that failure of crop rotation and land expansion in dry areas impact Ukraine's sunflower oil production.

Productivity significantly affect the competitiveness of Malaysian palm oil, Argentinian soybean oil and Russian sunflower oil positively. This research results align with the empirical study conducted by Montania et al. (2021) on soybean commodities in Argentina and Brazil. FAO data (2024) shows that the growth trend in Argentina's soybean productivity was higher than those of other major vegetable oil exporting countries (4.33%/a). The increase in the competitiveness of Argentine soybean oil is significantly influenced by increased productivity, where the increase in productivity results from the ease of using massive technology packages because farmers have switched from traditional practice to new production system management. This agricultural model allows Argentine farmers to apply biotechnological innovations, information technology and production technology that can meet consumer desires (Regunaga 2010). In theory, technological progress can be divided in two equivalent ways: technological progress either reduces the amount of input needed to produce a certain amount of output or increases the output that can be produced with a certain amount of input (Blanchard and Johnson 2013). Technological progress, investment, trade, and organizational progress or change can increase productivity (Cali et al. 2019; Enterprise Research Centre 2019). Productivity is positively related to competitiveness (Matkovski et al. 2019).

The exchange rate significantly affect the competitiveness of Malaysian palm oil, and on the competitiveness of Ukrainian and Russian sunflower oil positively. The results of this research align with the results of research by Purba (2019), which explains that significant exchange rate depreciation caused an increase in Malaysian palm oil exports. Trade performance is influenced by exchange rates (Blanchard and Johnson 2013; Salvatore 1997; Tweeten 1992). If the exporting country's exchange rate depreciates, the price of a vegetable oil in the exporting country becomes lower on the international market. When the export price of the vegetable oil in the exporting country falls due to depreciation, demand for the vegetable oil will increase, assuming there is no change in income abroad (supply and demand in the importing country remain constant). As a result, the vegetable oil exports in the exporting country increase (Tweeten 1992).

On the other hand, the exchange rate significantly affect the competitiveness of Indonesian palm oil negatively. It is because the depreciation of the Rupiah exchange rate could increase exports of Indonesian palm oil derivative products (Tandra and Suroso 2023). The increase in the palm oil derivative products export had implications for increasing the need for domestic palm oil as a raw material, thereby reducing the competitiveness of Indonesian palm oil. The exchange rate affects vegetable oil exports in crude form for Malaysia, Ukraine and Russia, but in the form of palm oil derivative products for Indonesia.

GDP per capita significantly affect the competitiveness of Ukrainian and Russian sunflower oil positively (Zavorotny and Bilyk 2017). Russia is the countries with the first highest GDP per capita growth (3.37%/a), while Ukraine is the second highest GDP per capita growth (2.77%/a) among leading vegetable oil exporting countries in the periode of 1997-2021 (World Bank 2024a). It means that the GDP per capita was a critical factor in strengthening the supply power of Ukraine and Russia for sunflower oil. On the other hand, GDP per capita significantly affect the competitiveness of Indonesian and Malaysian palm oil negatively. The vegetable oil referred to in this research is crude vegetable oil, which can be exported directly or used as raw material for palm oil derivative products, including food, non-food, and energy. More production of palm oil derivative products was used to meet increasing

domestic needs along with an increase in GDP per capita (Tandra and Suroso 2023), thereby increasing domestic consumption of palm oil as a raw material and reducing palm oil export.

In an open economy, some of the domestic output is sold abroad, and some of the domestic expenditure is in the form of purchases of foreign goods (Dornbusch et al. 2008). If an increase in domestic income causes an increase in domestic over foreign goods, then imports increase (Blanchard and Johnson 2013). Therefore, the results of this study proved that GDP per capita indicate domestic supply of Ukrainian and Russian sunflower oil, which also indicated demand capacity of Indonesian and Malaysian palm oil.

Although Brazil's FDI inflow percentage was the second highest among vegetable oil exporting countries (World Bank 2024b), this research showed that FDI affected significantly the competitiveness of Brazilian soybean oil negatively. The role of FDI in increasing exports depends on whether the country can utilize FDI to integrate the economy into international trade flows, transfer technology, develop human resources, increase competition, and promote business development (OECD 2002). Thus Brazil's unfavourable image, uncertainty in the economic environment and the shift from investment to financial speculation with no transforming of capital into products affected FDI performance (Previdelli and Souza 2019). FDI also affects negatively the competitiveness of Russian sunflower oil. The unstable macroeconomic conditions, poor institutions and international sanctions hamper FDI inflow in Russia (Dominguez-Jimenez and Poitiers 2020). The dynamics of FDI inflow in Russia are influenced by international sanctions, other economic problems, and the slight use of FDI inflow in the modernization and formation of Russian fixed assets (Galeeva and Kadeeva 2021).

Trade freedom affect significantly the competitiveness of Ukrainian and Russian sunflower oil positively. Trade freedom can create suitable conditions for achieving economic growth and competitiveness (Pilinkiene 2016). Countries implementing less restrictive trade policies can achieve higher export and import growth and be integrated with the world economy (Ng and Yeats 1999). Ukraine was the country with the highest average trade freedom (77.04), significant exporters during 1997-2022 (The Global Economy 2024). On the other hand, trade freedom affects significantly the competitiveness of Argentinian and Brazilian soybean oil negatively. Data from The Global Economy (2024) shows that the trade freedom index value for Argentina and Brazil is lower than other major vegetable oil exporting countries, namely 64.69 (Argentina) and 65.15 (Brazil) from 1997-2022.

Crude oil prices impact significantly the competitiveness of Argentine soybean oil negatively. Argentina's biofuel production started in 2005, namely 0.2 mb/d. Argentina's biofuel production grew to reach 51 mb/d in 2021 (US Energy Information Administration 2023). The increase in crude oil prices could encourage an increase in Argentina's biofuel production made from soybean oil, thereby reducing the competitiveness of Argentina's soybean oil. On the other hand, crude oil prices also significantly influence the competitiveness of Malaysian palm oil and Ukrainian sunflower oil positively. Malaysia and Ukraine are not the world's leading biofuel producer. So increasing crude oil prices can increase exports of Malaysian palm oil and Ukrainian sunflower oil as a raw material for biofuel in other countries.

This research shows that only three of the world's six leading exporters of vegetable oils have their competitiveness significantly influenced by crude oil prices. The development of the world biofuel industry can also be driven by increased awareness of environmental sustainability. Biofuel is one solution to overcome the energy crisis, encourage economic development, especially in developing countries, reduce greenhouse gas emissions (Boly and Sanou 2022; Sobszak and Golebiewski 2022), reduce global warming and depletion of the ozone layer, and encourage energy sustainability (Canabarro et al. 2023). Energy policy through mandatory biofuels targeted a gradual increase in the use of biofuels in several countries, including the European Union (EU), the United States of America (USA), Indonesia, and Malaysia.

Table 3. The estimated results of factors that influenced the competitiveness of the leading vegetable oil exporting countries.

Variable	Palm oil		Soybean oil		Sunflower oil	
	Indonesia	**Malaysia**	**Argentine**	**Brazil**	**Ukraine**	**Russia**
LnLand	1.551*	3.824***	0.196	-0.301	-0.637****	-1.653**
	(0.589)	(2.275)	(0.140)	(0.524)	(0.426)	(0.665)
LnYield	-0.583	3.038**	0.560*	-0.701	-0.244****	2.144*
	(1.030)	(1.310)	(0.122)	(0.696)	(0.158)	(0.567)
LnExrate	-0.746*	5.423*	-0.009	0.041	0.975*	0.526**
	(0.263)	(1.292)	(0.026)	(0.315)	(0.152)	(0.229)
LnGdp	-2.306**	-8.032*	0.141	0.005	1.609**	6.178*
	(0.972)	(1.347)	(0.245)	(2.803)	(0.779)	(1.709)
FDI	-0.013	0.046	0.009	-0.134**	-0.019	-0.096***
	(0.058)	(0.054)	(0.017)	(0.059)	(0.022)	(0.058)
LnTFI	-2.567	-1.135	-0.497****	-2.771**	1.163**	1.071***
	(2.007)	(2.385)	(0.324)	(1.083)	(0.527)	(0.644)
LnCo	-0.163	1.162*	-0.164**	0.122	0.224****	0.004
	(0.249)	(0.353)	(0.070)	(0.293)	(0.146)	(0.329)
$LnHI_{t-1}$	0.364**	-0.240	0.054	-0.057	0.265***	0.209
	(0.142)	(0.201)	(0.060)	(0.152)	(0.143)	(0.254)
$LnHM_{t-1}$	0.048	0.097***	-0.029**	0.0008	-0.014	-0.038
	(0.042)	(0.056)	(0.014)	(0.041)	(0.027)	(0.055)
$LnHA_{t-1}$	0.712***	-0.753****	0.468*	0.586****	-0.458***	0.619
	(0.367)	(0.499)	(0.099)	(0.398)	(0.233)	(0.482)
$LnHB_{t-1}$	0.667**	-0.191	0.121****	0.187	-0.304***	-0.064
	(0.307)	(0.316)	(0.083)	(0.296)	(0.172)	(0.303)
$LnHU_{t-1}$	0.134	1.032*	-0.238*	0.387****	-0.679*	-1.053*
	(0.277)	(0.362)	(0.077)	(0.261)	(0.140)	(0.311)
$LnHR_{t-1}$	0.146	-0.171	0.125*	-0.159	0.050	0.280****
	(0.154)	(0.195)	(0.047)	(0.131)	(0.091)	(0.184)
Constanta	21.376	-25.086	-6.942	21.179	-14.258	-55.906
	(13.407)	(31.215)	(2.964)	(21.068)	(4.788)	(11.183)
RSquare	77.11	90.79	94.05	83.2	97.51	93.97
RMSE	0.220	0.287	0.069	0.208	0.128	0.282
P Value	0.000	0.000	0.000	0.000	0.000	0.000

Note:

(1) *) significant at 1%, **) significant at 5%, ***) significant at10 %, ****) significant at 15%;

(2) Standard errors (SE) are in brackets

Linkages among leading exporting countries. Linkages between major exporting countries can be one of the driving factors for changes in the competitive position of leading vegetable oil exporting countries in the world vegetable oil market (Table 3 and Table 4). The competitiveness of Ukrainian sunflower oil and Argentinian soybean oil influences significantly the other four main exporting countries. Based on the number of countries affected by their competitiveness, it can be concluded that

the competitiveness of Ukrainian sunflower oil and Argentinian soybean oil was the strongest influencer the competitiveness of other major vegetable oil exporting countries.

It is interesting to note that the two leading soybean oil exporters (Argentina and Brazil) have a complementary relationship. The competitiveness of Argentinian soybean oil significantly influences the competitiveness of Brazilian soybean oil vice versa positively, where increasing the competitiveness of Argentinian soybean oil can increase the competitiveness of Brazilian soybean oil and vice versa. Meanwhile, there is a competitive relationship between the two central exporting countries of sunflower oil. The competitiveness of Ukrainian sunflower oil shows a negative correlation with Russian sunflower oil, where increasing the competitiveness of Ukrainian sunflower oil can reduce the competitiveness of Russian sunflower oil. The competitiveness of Indonesian and Malaysian palm oil are positively affected by their own competitiveness in the previous year, meaning that increasing the competitiveness of Indonesian and Malaysian palm oil in the previous year can increase their competitiveness.

Table 4 shows the nature of relations between the world's leading vegetable oil exporters. As a country whose vegetable oil competitiveness strongly influences the competitiveness of other countries' vegetable oils, Ukraine shows a balance between competitive relationships (Argentinian soybean oil and Russian sunflower oil) and complementary relationships (Indonesian and Malaysian palm oil) with other leading vegetable oil exporting countries. On the other hand, Argentine in its soybean oil trade showed more complementary relationships with other major vegetable oil exporting countries. Argentine in its soybean oil trade showed complementary relationship with Indonesian palm oil, Brazilian soybean oil, and Russian sunflower oil, while competitive relationship with Malaysian palm oil and Ukrainian sunflower oil.

Table 4. Relationship among leading vegetable oil exporting countries.

		Palm oil		**Soybean oil**		**Sunflower oil**	
		I	**M**	**AR**	**BR**	**U**	**R**
Palm oil	I					+	
	M			-			
Soybean oil	AR	+	-		+	-	
	BR	+		+		-	
Sun flower oil	U		+	-	+		-
	R			+			

Note:

I	=	Indonesia	BR	=	Brazil	-	= Competitive relationship
M	=	Malaysia	U	=	Ukraine	+	= Complementary relationship
AR	=	Argentine	R	=	Russia		

CONCLUSIONS

Ukraine, Indonesia and Argentina are market leaders in the world vegetable oil trade in terms of REC value and EMS index, but the strongest influencer to the competitiveness of other major vegetable oil exporting countries are Ukraine and Argentine. There were three periods of competitive leadership based on REC value, namely before 1998 (Indonesian palm oil), 1998-2008 (Argentinian

soybean oil), and 2010-2022 (Ukrainian sunflower oil). If cross-country comparisons are made of the same type of vegetable oil, the competitiveness of first leading exporting countries still outperforms that of second leading exporting countries. Meanwhile, changes occurred in palm oil competitiveness, where the competitiveness of Malaysian palm oil surpassed that of Indonesia in 2021. In terms of market penetration, as reflected by the EMS index, Argentine soybean oil had the largest market share before 2008. Indonesian palm oil owned the largest share in 2008-2020. Malaysia, with its palm oil trade, Ukraine and Russia, with its sunflower oil trade, are three countries that consistently increase their market share, but decrease after Russia-Ukraine war.

The key factors influencing the competitiveness of the leading vegetable oil exporting countries are land, productivity, exchange rate, GDP per capita, and trade freedom. Depreciation of the exchange rate can more strongly encourages an increase in exports of palm oil derivative products so that palm oil exports decrease because palm oil is more widely used as raw material for the domestic palm oil derivative product industry, as in the case of Indonesia. On the other hand, more substantial exchange rate depreciation encourages exports of crude vegetable oil to Malaysia, Ukraine and Russia, potentially reducing the supply of crude vegetable oil for the domestic industry. Thus, the leading vegetable oil exporting countries need to pay attention to macroeconomic policies related to exchange rate stabilization in order to balance exporting crude vegetable oil or using it as raw material for the vegetable oil derivative product industry, such as biofuel.

Since the competitiveness of Indonesia and Malaysia is significantly influenced by land expansion, and the land use of these two countries is interrelated, these two countries can open discussions and develop a better relationship to reduce international trade pressure on land expansion. The competitiveness of these two countries is also significantly influenced by GDP per capita negatively. So, it needs to be addressed with policies to increase productivity rather than land expansion in meeting the increase in domestic demand along with the increase in GDP per capita. Policies to increase productivity include replanting productive plants with new plants using superior seeds and production efficiency through optimizing installed capacity. However, these productivity improvement policies must be implemented together with the efforts to balance the achievement of meeting domestic vegetable oil needs and meeting export interests. Thus, the rising demand for palm oil by the domestic palm oil derivative product industry due to increased GDP does not disrupt palm oil exports.

The limitation of this research is that it has yet to include tariff and non-tariff variables in the model. For further research, it is recommended to look at the relationship between the competitiveness of vegetable oils across countries and see the impact of changes in tariff and non-tariff policies in one country. The impact of tariff and non-tariff policies can be seen from both the exporting and importing country's policy perspectives. Further research is needed to examine how export taxes and the development of derivative product industries made from domestic crude vegetable oil can affect the competitiveness of these significant exporting countries. Further research is also needed to examine how the impact of import tariff, import quota policies and import bans imposed by major importing countries can affect the competitiveness of significant vegetable oil exporting countries.

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