Research article

On the duration of trade competitiveness: the case of the Malaysian palm-based oleochemical industry

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ABSTRACT

The Covid-19 pandemic has led to a surge in demand for oleochemicals, due to the increased demand for cleaning and disinfectants products. Since Malaysia is one of the world’s largest palm oil producers, the demand for oleochemicals will be a key driver supporting the Malaysian palm oil industry. Palm oil is used in millions of products, from foods to soaps, personal care products cosmetics, and biodiesel feedstock. Currently, palm oil related exports are still highly dependent on the upstream segments such as crude palm oil (CPO), with a total contribution to the overall industry of 81.4%. In comparison, that downstream contribution is still low at about 18.6%. It is thus important to expand the production and export of high-value-added palm oil downstream products, including oleochemicals products. Therefore, this study aims to assess Malaysia’s relative competitiveness in oleochemical products as compared to the main oil and fat producing countries - namely Indonesia, China, the European Union (EU) member states, the United States and Argentina. We examine the trade competitiveness by using the Revealed Trade Advantage (RTA) developed by Vollrath (1991) and utilizing yearly data spanning from 1999 until 2019. We also analyze the duration of comparative advantage using Kaplan-Meier Analysis. The results indicate that Malaysia has higher and more stable trade advantages relative to other main producers of oleochemical products.

1. Introduction

1.1. Oleochemicals contribution to Malaysia’s economy

Oleochemicals are chemicals derived from oils and fats. The term ‘natural oleochemicals’ often refers to oleochemicals derived from vegetable and animal oils and fats to differentiate them from ‘synthetic oleochemicals’ derived from petroleum (Ismail et al., 2014). Feedstock for oleochemicals includes Soybean, Palm, Rapeseed and Sunflower oils. The oleochemical industry in Malaysia, which began in the early 1980s and now accounts for 20% of worldwide capacity, is one of the largest in the world (MIDA, 2021). Processed palm oil, palm stearin, and palm kernel oil are the primary feedstock for those oleochemicals. Due to the consistent availability of palm kernel and palm oil, Malaysia's oleochemical industry has been expanding.

Oleochemicals from palm oil can be processed to make various consumer goods, including emulsifiers and vitamin E. Additionally, there is a tonne of potential for non-food applications of intermediate and final oleochemicals, such as soap, detergents, cosmetics, personal care, and industrial goods. In 2020, there were 20 oleochemicals plants in Malaysia with production capacities totaling 2.62 million tonnes (Table 1). Selangor contained the highest number of plants in operation (8 plants), followed by Johore (7 plants).

Fatty acids, fatty methyl esters, fatty alcohols, fatty amines, and glycerol are a few examples of the fundamental oleochemicals that are frequently categorized. Fatty acids can be used directly in candle and cosmetics production. In comparison, fatty methyl esters are used for pharmaceuticals, cosmetics, plastics, textiles, and other industries. Fatty alcohol derivatives are used broadly in the production of washing and cleaning products. Finally, fatty amines are mainly used in the mining industry as an anti-caking agent and in road building. Polyurethane is also one of the unique oleochemical products which can be used in insulating materials for carpet underlay, freezers and refrigerators, ceiling panels, flower foam, and seat cushions. The various uses of oleochemicals have led to increasing export demand (Szczepańska et al. (2022)).

The trend of Malaysia's oleochemicals exports is shown in Figure 1, which indicates the increase from 2000 to 2020. However, there was a
and insignificant in the country (Othman et al., 2021). Even though Malaysia is the second largest palm oil producer after Indonesia, the country's palm oil exports remain highly biased toward the upstream segments. Thus, Malaysia could easily be affected and experience an economic slowdown if there is a fall in commodity prices, since exports are a major component constituent of its GDP.

Instead of palm oil, other primary raw materials such as lauric oil, soybean oil, and tallow are also used as feedstock for oleochemicals. Therefore, the competitive position of palm oil within the global oil and fat market was influenced by the increasing application of oleochemicals. Figure 3 shows the world's major producer of 17 oils and fats in 2007 and 2020. Indonesia became the top producer within this period, while China surpassed the EU as the second largest oil and fat producer in 2020. Malaysia maintains its position as the fourth largest producer, followed by the USA and Argentina. These top 6 major producing countries have cover around 70% of the world's total production of oils and fats since 2007.

The production of palm oil in Malaysia may soon hit its peak, and it is anticipated that Malaysia's position as the world's top producer of crude palm oil will decline in the future due to land shortages, reliance on foreign labor, and comparably higher input prices mixed with competition from palm oil replacements and palm oil-producing nations like Indonesia (Alam et al., 2015). Moreover, by relying more on downstream activities like oleochemicals, the business can lessen the risk of changes in the price of crude palm oil (CPO) on a worldwide scale. Oleochemical production has the potential to absorb the surplus market supply of palm oil upstream products and stabilize prices. Current export patterns show that Malaysia is losing market share to rivals, particularly those from Indonesia (Yusop et al., 2022). Lack of competitiveness is one factor contributing to this subpar export performance. It is anticipated that Malaysia's downstream palm oil product exports will continue to decrease, given its current local production. Considering that oleochemicals are one of Malaysia's downstream palm oil products, it is crucial to consider their trade competitiveness.

This study aims to investigate the trade competitiveness of Malaysia's oleochemical products. The study first investigates the level of trade competitiveness of palm-based oleochemicals. Second, the research looks at the trade competitiveness of palm-based oleochemicals compared to major vegetable oil-producing countries. Third, this study investigates the duration of comparative advantage for Malaysian oleochemical product exports compared to other countries. This study contributes to the existing literature in three important ways. First, it examines the trade competitiveness of oleochemical products using RTA. In so doing, the double counting issue that can lead to biased index values (Vollrath, 1991) can be avoided. Second, unlike previous studies, the study takes into account the relative importance of Malaysia's major competitors such as the United States, Argentina, China, and the European Union (comprising Germany, the United Kingdom, the Netherlands, Spain, Italy, France, Portugal, and Poland) in explaining the change in oleochemical trade competitiveness as they have cover 70% of the world’s total production of oils and fats since 2007. Third, the study employs the Kaplan-Meier survival function to examine the duration of comparative advantage for the exports of oleochemical products in Malaysia and the probability of a trade relationship surviving for a given period.

The rest of the paper is structured as follows. Section 2 briefly reviews previous literature that considers the oleochemical trade competitiveness. Section 3 explains the data and methodology procedures. Section 4 presents the results. Finally, section 5 summarizes the findings of this study and concludes.

2. Empirical studies on palm oil trade competitiveness

Studies on the trade competitiveness of palm-based products are largely focused on the upstream sector, such as Crude Palm Oil (CPO)
and Processed Palm Oil (PPO). A study by Subramaniam (1997) used constant market share (CMS) to assess the competitiveness of Malaysian and Indonesian CPO millers. The result of the CMS analysis for the market size showed that Malaysia is unable to cope with world palm oil demand compared to Indonesia. Some studies analyze the competitiveness of the palm oil industry in larger markets such as China (Sinaga, 2007), ASEAN (Sari, 2010), and India (Dewanta et al., 2016). Sinaga (2007) compared the competitiveness of palm oil exports of Indonesia and Malaysia in the Chinese market from 1999 to 2005. The study concluded that Indonesia has high competitiveness in the Chinese market. However, the competitiveness of Malaysian palm oil is relatively higher than that of Indonesian palm oil. Sari (2010) used the RCA and CMS to capture the competitiveness of Indonesian palm oil products in the ASEAN market for four years from 2004 to 2008. The results revealed that the RCA of Indonesian palm oil for every commodity was greater than one, indicating that Indonesia had a comparative advantage in the ASEAN market. These studies used the traditional method, but their results indicate Indonesia has trade competitiveness in palm oil upstream products.

Traditional international trade performance has been employed as the primary indicator of global competitiveness in most empirical studies of the palm oil industry. These include the research projects carried out by Hassanpour and Ismail (2010), Rifin (2010), Arip et al. (2013), and Salleh et al. (2016). Hassanpour and Ismail (2010) used the RCA and Revealed Symmetric Comparative Advantage (RSCA) indices to evaluate the competitiveness of Malaysian palm oil exports compared to other industrial plantation goods in a subset of ASEAN nations and China. The findings show that Malaysia has a competitive advantage in palm oil and palm kernel oil. Additionally, Malaysia was in second place in terms of the competitiveness of palm oil goods, while Indonesia placed top. Although this study is of great significance, it needs to consider higher value-added products from the palm oil industry in its consideration of product categories. Using the CMS, Rifin (2010) examined how competitive palm oil exports from Malaysia and Indonesia were in three geographic areas: Asia, Europe, and Africa. According to the findings, Indonesia has increased its market share relative to Malaysia in Asia and Africa, while Malaysia’s share is more prominent in the EU market. The study’s product selection is restricted to the upstream segment of the
palm oil industry, which includes CPO and processed palm oil (PPO)
only.

Along with this research, the empirical analysis by Arip et al. (2013)
used RCA to evaluate the comparative advantage of items connected
to palm oil in Indonesia and Malaysia. Their research shows Malaysia is
more competitive than Indonesia in most industries associated with palm
oil downstream. However, their study only examined 20 palm oil-related
items and concentrated on the output volume. According to Saleh et al.
(2016), there is limited empirical research on the relative competitiv-
ness of palm oil export products in downstream industries. They, there-
fore, examined the comparative advantage of CPO and PPO exports
between the Malaysian and Indonesian palm oil sectors and five other
important markets, namely China, India, the European Union (EU),
Pakistan, and the USA. The RCA index from 1999 to 2014 was utilized in
the study. According to their findings, Indonesia has a more tremendous
comparative advantage than Malaysia in the EU, China, and India.

Malaysia, however, enjoys a considerable comparative advantage over
Indonesia in the United States and Pakistan. The study’s shortcoming is
that the downstream sector’s goods are restricted to PPO.

The context of sustainability has also been considered in recent
empirical studies on trade competitiveness, such as Othman et al. (2021);
Zuhdi et al. (2021); Maretna et al. (2021); Majerova et al. (2020) and
Popescu et al. (2017). Othman et al. (2021) examine the impact of energy
taxes imposed by EU countries on the competitiveness of Malaysia’s
downstream palm oil trade. The study employs panel data analysis and
uses relative trade advantage to measure competitiveness. Results show
that sustainability significantly impacts Malaysia’s downstream palm oil
trade competitiveness. Zuhdi et al. (2021) examine the competitiveness
of Indonesian crude palm oil (CPO) in global exports using the annual
data from 1993 to 2017. They used the Revealed Comparative Advantage
(RCA) method to analyze the comparative advantage of Indonesian palm
oil in the international market. The results showed that the export per-
formance of Indonesian palm oil increased in 2017. Indonesia is palm oil
competitive due to increased palm oil exports to major importing coun-
tries such as India, Pakistan, and Europe. Maretna et al., 2021 investigate
the role of RSPO membership in a company’s decision to export and
develop the downstream palm oil industry. The study used secondary
data from annual reports of 18 Indonesian and 32 Malaysian palm oil
companies and analyzed it using binary logistic regression. According
to the findings of this study, RSPO-certified and larger firms are more likely
to exporters. They concluded that the RSPO certificate is still valuable
for in promoting palm oil export, particularly in maintaining its positive
image regarding its sustainability initiative.

Arshad et al. (2020) assessed the competitiveness of palm oil products
in international trade between Indonesia and Malaysia by applying the Revealed Comparative Advantage (RCA) and product
mapping methods. The results show that the RCA of Indonesian CPO
has a negative trend, but it is still higher than Malaysia, which has a
positive trend. However, Indonesian RBD palm olein and PFAD show a
positive trend compared to Malaysia. The product mapping method shows that both countries’ palm oil products were in the group,
indicating that the products have a comparative advantage and specialized
for export. As a result, both countries require strategic policies to support
downstream palm oil activities. This will increase the produc-
tion of derivative products, allowing them to meet demand in
international trade. Recent study by Othman et al. (2020) compare the
competitiveness of Malaysia’s palm-based biodiesel industry to that of
major palm oil producers countries such as Indonesia, the United
States, Brazil, Germany, France, Thailand, and Spain using the Relative
Trade Advantage (RTA) indices. Two biodiesel commodities
(HSC271020 and HSC382600) were included in the study using
annual data from 2012 to 2016. According to the findings, while
Malaysian biodiesel export trends have fluctuated over the year, the
RTA index indicates growth potential. In addition, Tandra et al. (2022)
have recently studied the competitiveness in the international trade of
palm oil. Their finding of stability and duration revealed that

Indonesia and Malaysia are more competitive in the palm oil market
globally. However, the product coverage is only available for upstream
palm oil.

It can be observed from the discussion above that the limitations of
previous research are threefold. First, previous studies did not focus on
oleochemical industries. Even though Arip et al. (2013) assessed the
comparative advantage of palm oil-related products, their study is
limited to 20 palm oil-related products and only focuses on production
at the micro-level. Secondly, most previous palm oil studies focus on
competitiveness at the production level (Alias et al., 2006; Shri Dewi,
Alias & Ali, 2007; Talib et al., 2007) using traditional methods to assess
competitiveness. Comparative studies estimating palm oil competitive-
ness have only been limited to Malaysia and Indonesia. Third, an
analysis of sustainable- Kaplan Meier is missing. Liu et al. (2021) con-
ducted a recent study in which Kaplan-Meier survival analysis was used
to examine the export trade relations of Chinese wooden flooring. Their
findings show that the continuous average export period of Chinese
hardwood flooring is relatively lengthy, at roughly 14 years. The present
study fills the gaps mentioned above and assesses the competitiveness
of oleochemical industries in Malaysia. It assesses the trade competitive-
ness of oleochemical sectors between Malaysia and other major vege-
table oil producer, including Indonesia, the USA, Argentina, China, and
the EU.

3. Research methodology

3.1. Revealed trade advantage (RTA)

The Balassa index, often known as the B-index (Balassa, 1989), has
several significant limitations, including the asymmetric value problem
and the logarithmic transformation (De Benedictis and Tamberi, 2004).
Nevertheless, the index is still widely used in trade research. By sub-
tracting the Relative Export Advantage (RXA) index from the Relative
Import Penetration (RMP) index, Scott and Vollrath (1992) expanded the
B index (Balassa, 1989). They created the Revealed Trade Advantage
(RTA) index, which considers export and import operations. Due to the
unique ability of RTA to prevent the double counting problem that might
result in biased index results, the RTA index has gained more popularity
than the B index (Vollrath, 1991). The discussion that follows provides a
thorough explanation of this.

The RXA index measures a nation’s contribution to global exports of
all other goods compared to its share of exports of a specific product to
the international market. The RMP index, in contrast, is characterized as
the proportion of a country’s share of global imports of all other com-
modities to its imports of a specific commodity on the international
market. Eqs. (1) and (2) show the formulas for RXA and RMP,
respectively.

$$RXA_{ij} = \left( \frac{X_{di} \sum X_{dj}}{\sum X_{di} \sum X_{dj}} \right)$$

$$RMP_{ij} = \left( \frac{X_{di} \sum X_{dj}}{\sum X_{di} \sum X_{dj}} \right)$$

Subscripts i and n in Eq. (1) and (2) stand for the focus country and the all
countries, respectively, and X is the export value. The oleochemical
products and a set of product groups are indicated, respectively, by the
subscripts j and t. The value of a product group's world exports $X_{dt}$, is
used as a benchmark. The exports of product groups by ith country, denoted by
the symbol $X_{di}$, and world export of oleochemical products, denoted by
the symbol $X_{di}$, are not included in the calculation of the $X_{dt}$, which is a
distinctive feature of the RTA index and prevents the double counting
problem. Additionally, the country of interest is taken out of the equation
for world product group exports ($X_{dt}$ is excluded from $X_{di}$). Consequently,
$n \neq i$ and $t \neq j$ in Eq. (1). If RXA value is more than 1, it denotes that the
country has a relative export advantage in oleochemical products on the
global market.

Eq. (2) illustrates the RMP index.
\[ RMP_j = \left( \frac{M_i}{\sum_{j=1}^{n} M_j} \right) \times \left( \frac{\sum_{j=1}^{n} M_j}{\sum_{i=1}^{n} \sum_{j=1}^{n} M_{ij}} \right) \]  

(2)

In equation (2), \( M \) indicates the import value, \( i \) and \( n \) represent the focal country and all other countries, respectively. Subscripts \( j \) and \( t \) stand for the oleochemical product and a group of product categories, respectively. Subscripts \( M_{ij} \) serves as a benchmark and represents the total value of imports for the product group in the world. The \( i^{th} \) country is not included in the total imports for the product group calculation in order to eliminate the double counting issue (\( M_i \) is deducted from \( M_{ij} \)). The imports of the product group to the \( i^{th} \) country (\( M_{ji} \)) and the difference between \( M_{ij} \) and \( M_{ji} \) are not included in the world imports of the product group (\( M_{in} \)). Consequently, \( n \neq i \) and \( t \neq j \) are also valid in Eq. (2). If the RMP index value is less than one, it shows a relative comparative import penetration advantage in palm oil oleochemical goods, and vice versa if the RMP is more than one. Table A2 in the appendix indicates the detail information about the sample countries, world countries, and oleochemical products employed in this study's calculations for Eqs. (1) and (2).

Vollrath (1991) explained the RTA index as shown in Eq. (3). It takes into account exports and imports simultaneously and is calculated as the difference between the RXA and RMP indices.

\[ RTA_j = RXA_{ij} - RMP_j \]  

(3)

If RTA is greater than zero, it indicates a relative revealed trade advantage in palm oil oleochemical products and vice versa if RTA is less than zero. As far as the RTA index is concerned, it considers both export and import activities rather than considering them in isolation. These indices were first introduced by Scott and Vollrath (1992). RTA index gained more importance due to high intra-industry trade in the global market. In the case of an import ban or high import tariff, this measure indicates a high level of competitive advantage and in the absence of import taxes, the competitive advantage reduces.

3.2. Robustness analysis: revealed symmetric comparative advantage (RSCA)

Results based on trade data are not always necessarily consistent. Therefore, there is a need for a robustness check with other indices to confirm the outcome. The various methods of revealed comparative advantage quantification provide the basis for the robustness analysis. The index of revealed comparative advantage (B index) is firstly taken into account. It was first published by Balassa (1965) and is shown in Eq. (4).

\[ B_{ij} = RCA_{ij} = \left( \frac{X_{i}}{X_{i}} \right) / \left( \frac{X_{ij}}{X_{i}} \right) \]  

(4)

The subscripts have similar representations as explained in Eqs. (1) and (2). \( X \) indicates exports, \( i \) and \( j \) denote country and the oleochemical products respectively, \( t \) stands for product group and \( n \) represents the world. The B-index has been criticized because of its asymmetric values that reveal the index extends from one to infinity if a country enjoys a comparative advantage from a product; however, in the case of comparative disadvantage varies between zero and one, which overestimates the relative weight of a sector. Due to these critiques, this study uses the Revealed Symmetric Comparative Advantage (RSCA) index, developed by Dalum et al. (1998), thereby tackling the problems of the B index. The RSCA index is a transformed B-index shown in Eq. (5).

\[ RSCA_{ij} = \frac{RCA_{ij} - 1}{RCA_{ij} + 1} \]  

(5)

The RSCA takes values between -1 and 1, where values between 0 and 1 indicate a comparative export advantage and values between -1 and 0 reflect a comparative export disadvantage. While the value of 0 indicates that comparative advantage is at the neutral point (Manonman, 2018). Since the RSCA distribution is symmetric around zero, a potential bias in the regression coefficients is avoided (Dalum et al., 1998; Jambor, 2013; Othman et al., 2020). However, as trade structure, especially imports, is always impacted by different state interventions, and trade limitations and B-index seems to neglect the effects of such policies, the transformed Balassa-index in Eq. (5) also shows this issue. Therefore, RSCA only considers export values, as imports are more likely to be influenced by policy interventions.

3.3. Duration analysis

Martin et al. (1991) provided another perspective and defined competitiveness as a sustained ability to profitably gain and maintain market share. The next step is to examine the duration of comparative advantage for the exports of oleochemical products in Malaysia. The survival function gives the probability of a trade relationship (e.g., exports) surviving for a given time (Nicta et al., 2013). This study follows the approach used by Bojnec and Ferto (2008), who employed the Kaplan Meier survival function for this purpose. A product is said to have survived if it maintains its comparative advantage consistently and continuously for ‘t’ number of years.

The survival function for this study focuses on the RSCA index across palm oil oleochemical product groups and the index is estimated in a nonparametric way by computing the number of the product group that survives as a fraction of the total number of spells that are at risk after ‘t’ time periods. It is assumed that a sample contains ‘n’ independent observations denoted by \( t_i \) and \( c_i \), whereby \( t_i = 1, 2, \ldots, n \), \( t_i \) is the survival time and \( c_i \) is the dummy variable taking a value of one if the failure occurred for the \( i^{th} \) observation and zero otherwise. Moreover, it is assumed that there are \( m < n \) recorded times of failure. The rank ordered survival time is then denoted as \( t(1) < t(2) < \ldots < t(m) \) (Bojnec and Ferto, 2009; Cleves et al., 2008). The Kaplan Meier survival function estimation is shown in Eq. (6).

\[ \hat{S}(t) = \prod_{t_{ij}} \frac{n_i - d_i}{n_i} \]  

(6)

Where \( n_i \) denotes the number of product groups at risk of failing at \( t(j) \) while \( d_i \) denotes the number of observed failures with the convention that \( \hat{S}(t) = 1 \) if \( t < t(1) \). Given that many observations are censored, the Kaplan Meier function is robust to censoring and uses information from both censored and non-censored observationsFinally, the log-rank and Wilcoxon signed-rank tests are applied to check the equality of survival functions for the RSCA index of oleochemical product groups (Bojnec and Ferto, 2008; Jambor and Gibba, 2017). The application of the Kaplan Meier function in trade competitiveness analysis is rather limited. Nevertheless, it is widely employed in other disciplines such as life sciences. This can provide better information when conducting non-econometric comparative analyses on trade specialization.

This study employs a disaggregated trade dataset to identify relative trade advantages across main exporter countries-namely, Malaysia, Indonesia, the United States, Argentina, China and the EU (comprising Germany, the United Kingdom, the Netherlands, Spain, Italy, France, Portugal, and Poland). The empirical analysis is conducted using detailed trade data from the UN Comtrade database across 40 years from 1990 to 2019. The oleochemical products consist of 18 items at the six-digit level in the Harmonized System Codes (HSC).

Secondary data are utilized in order to compute RTA and RSCA indexes. The data of exports (on FOB price) and imports (on CIF price) for oleochemical products are based on HS six-digit codes retrieved from the UN Comtrade database, spanning 21 years from 1999 to 2019. The details of selected palm oil oleochemical products are obtained from the Malaysia Revision of customs tariff codes for oil palm products published by MPDOB (2013). All 18 oleochemicals products listed under HS six-digit codes are shown in Table A1 in the appendix.
4. Results and discussion

4.1. Trade competitiveness analysis

The RTA index shows the competitiveness of oleochemical products among the top oils and fats exporters. An index greater than zero shows that a country experiences a comparative advantage, whereas a value of less than zero reflects a comparative disadvantage. If RTA is equal to zero, this implies a break-even point without relative comparative advantage or disadvantage. The analysis takes into account 18 products listed under HS six-digit codes, as these specifically represent oleochemical products. The period for the analysis covers 21 years from 1999 to 2019.

Figure 4 shows that Malaysia has the highest RTA index among its competitors from 1999 until 2019, although the trend has been declining since 2007. China, and the EU (comprising Germany, the United Kingdom, Poland, the Netherlands, Spain, Italy, France, and Portugal). The rest countries, such as the USA, Argentina, China, and the EU, recorded lower RTA index values throughout the study period than Malaysia and Indonesia.

Figure 5 compares the RTA index for Malaysia and its competitors between 2006 and 2019. It can be seen that Malaysia maintained its position as the country with the highest comparative advantage in the oleochemicals product group. Indonesia is ranked second after Malaysia, and it also maintained its position in the stated time period. The EU can be ranked third in having a comparative advantage for the oleochemical product group in 2006, followed by the USA, which also recorded a positive RTA index. However, in 2019, the RTA index in the EU declined so much that the region lost its comparative advantage in the oleochemical product group and gave the edge to the USA, which witnessed an increase in the competitiveness ranking as a result. One of the reasons for this reduction of the RTA index in the EU was the implementation of the renewable energy policy.

Consequently, the EU faced shortfalls in raw materials for the oleochemical industry. Animal fats and vegetable oils were increasingly used for biofuel production to gain incentives under the Emission Trading Schemes to promote biofuels or renewable energy. Both Argentina and China showed a negative RTA index in 2006 and 2019. China’s industrial oils and fats mainly relied on imported oil, and price fluctuations in the world oil market made it difficult for China to sustain its competitiveness in the oleochemical industry. Furthermore, the import tariff on oils and fats also hurt the oleochemical enterprises.

In Malaysia’s oleochemical product group, it can be seen in Table 2 that oleic acid (HSC 382312), stearic acid (HSC 382311) and palmitic acid, stearic acid, their salts and esters (HSC 290570) had the highest shares in the world market in 2019. Regarding competitive advantage, both the RTA index in 2019 and the average of the RTA index from the period of 1999–2019 show that oleic acid, stearic acid and lauralcohol demonstrated the most substantial competitive advantage among all products. Unfortunately, Table 2 also shows that Malaysia significantly lost its competitiveness in 2019 compared to the average competitiveness from 1999 to 2019, and its world market share deteriorated for the Palm Fatty Acid Distillates (PFAD) (HSC 382319) in 2019. Overall, within oleochemical products, Malaysia had a competitive advantage in 12 products in 2016 and a competitive edge in 13 products on average from 1999 to 2019.

4.2. Duration of comparative advantage

Regarding the duration of competitiveness in global oleochemical exports, the non-parametric Kaplan-Meier estimator was employed on the revealed symmetric comparative advantage (RSCA) from 1990 to 2019. A more extended period is necessary to understand the survival pattern more clearly. The estimated results of Eq. (6) showed that the survival patterns are generally not persistent over time. Survival changes of 99% at the beginning of the period fell to 2.6% by 2019, suggesting that fierce competition existed in the global oleochemicals market. Results also varied by country, with Malaysia gaining the highest survival time for oleochemical exports over time. The equality for survival functions across countries is checked using two non-parametric tests, Wilcoxon and log-rank tests. The outcome shows that the hypothesis of equality across survival functions is rejected at the 1% significance level, which means that the duration of comparative advantage varies significantly across major oil and fat exporters.

Figure 4. The relative trade advantage (RTA) for oleochemicals group among competitor, 1999–2019.
Source: Authors’ own calculations on UN Comtrade data
This analysis compared the duration of the RSCA index at both the aggregate trade level (used as a benchmark) and the country level. The Kaplan-Meier survival function is employed to check issues due to vertical specialization and evaluate the RSCA index's duration. Table 3 presents the survival rates achieved at the end of the years 1990, 1999, 2009, and 2019 at both the aggregate trade and the country levels for oleochemicals. The duration of the RSCA index for the oleochemical product group is generally relatively quite high, particularly in Malaysia, whereby Kaplan-Meier survival rates of 10% have been recorded. The value is above the Kaplan-Meier survival benchmark rate of 2.69%, indicating the significant sustainability of the oleochemical trade from Malaysia in the global market. Indonesia also obtained 11% and 6% survival rates, respectively, which are also higher than the benchmark survival rate. However, for the United States, Argentina, China, and the EU, the survival rates were below the benchmark.

Figure 6 illustrates the Kaplan-Meier survival rates for the RSCA index in oleochemical product group for 30 years from 1990 to 2019. It can be seen that 97%-99% survival chances fell between 0% and 10%, suggesting that fierce competition existed in the global market for oleochemicals. Malaysia has higher survival rates in the RSCA index than the other major oil and fat exporting countries for the oleochemical product group. The Malaysian survival rates are approximately 10% followed by Indonesia with a rate of 3% and the USA with a survival rate of 0.34% in the 30th year of the time period being analysed. Figure 6 also shows that Indonesia is a strong competitor of Malaysia. Its survival rate has steadily increased over time, reflecting the improving competitiveness of the Indonesian oleochemical industry in the global market.

From the discussion above, it can be argued that Malaysia has the highest comparative advantage in the global oleochemicals trade. The duration analysis also showed strong survival rates, indicating that the competitiveness in the oleochemical industry is sustained in the global market. Malaysia's survival rate surpassed Indonesia's survival rate after the 19th year, indicating the success of the Malaysian policy of including high-value-added products and improving its competitiveness.

In order to sustain the competitiveness of palm oil downstream products, Malaysia must make prompt decisions to ensure that the development of oleochemicals in the country is within the boundaries of sustainable development and to develop policies to control the level of environmental degradation. The Malaysian Sustainable Palm Oil (MSPO) Certification Scheme should be made compulsory among the major producers to ensure the sustainability and competitiveness of Malaysian palm oil products. The study by Lazaroiu et al. (2019) demonstrates the current trend of consumer behavior and intentions to buy environmentally friendly products.

Part of the strategic thrust of the palm oil Entry Point Projects (EPP) introduced under the Malaysian National Key Economic Areas (NKEA) is to develop downstream applications for palm oil. The downstream EPPs will capture the lucrative downstream segment, which can be rationalized by focusing on developing finished segments that generate high value, including oleo-derivatives and selected food and health-based segments. The processing and production plants are strategically located and close to major ports, namely in the industrial areas of Prai, Pulau Pinang and Pasir Gudang, Johor are available in the country. Currently, the IOI Oleochemical Industries Bhd is the major producer of fatty acids based on vegetable oils. They have established their operation...
in Prai, Penang due to the good port facilities and availability of palm kernel oil and conducive business environment. IOI Esterchem is an oleochemical plant based in Prai, Pulau Pinang that obtains allocations under the palm oil NKEA and produces oleochemical derivatives for the production of consumer products such as cosmetics, detergents and environmentally friendly lubricants. Therefore, there is great potential for the development of the oleochemical industry in Pulau Pinang to contribute indirectly to the socio-economic growth of the state in the long term.

5. Conclusions and Recommendations

This study aims to assess the trade competitiveness of oleochemicals for Malaysia and other major producer countries. Findings from the Revealed Trade Advantage (RTA) show that Malaysia has the highest comparative advantage in the global oleochemical trade. The results also show that Malaysia has a higher survival rate in the RSCA index than the other major oil and fat exporting countries for the oleochemical product group. The government must accelerate the growth of the oleochemical industry and focus on the high-value-added products since Malaysia has abundant palm oil resources. Companies in the industry should pool their resources and increase their investments in high-value-added products such as pharmaceuticals and nutraceuticals. Other opportunities that can amplify the demand for oleochemical products worldwide also need to be explored. Although challenging, Malaysia needs to leverage its current position by developing more specialized oleochemical products with higher added value. Dependence on basic palm oil products such as crude palm oil (CPO) can no longer continue due to increased competition from Indonesia, especially as the latter has greater potential for economies of scale and other cost advantages. Malaysia can improve its export competitiveness of palm oil downstream through the efficiency of its oleochemical production. This can be realized by improving the technology used, raising the volume production, and achieving economies of scale to minimize the cost and thus improve the competitiveness of palm oil downstream products.

Declarations

**Author contribution statement**

1) conceived and designed the experiments; Dr. Norashida Othman, Dr. Mohd Subri Tahir & Dr. Leylawati Joremi.

2) performed the experiments; Dr. Norashida Othman & Dr. Mohd Subri Tahir.

3) analyzed and interpreted the data; Dr. Norashida Othman.

4) contributed reagents, materials, analysis tools or data; Dr. Norashida Othman & Dr. Leylawati Joremi.

5) wrote the paper; Dr. Norashida Othman, Dr. Mohd Subri Tahir & Dr. Leylawati Joremi.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Appendix

Table A1. List of Oleochemical Products under the HS-6 Digit Code.

| Product Code (HS 6 digit) | Product definition |
|--------------------------|--------------------|
| 290516                   | octanol (cetyl alcohol) and isomers thereof |
| 290517                   | dodecan-1-ol (lauryl alcohol), hexadecan-1-ol (cetyl alcohol) and octadecan-1-ol (stearyl alcohol) |
| 290519                   | other saturated monohydric alcohols |
| 290539                   | other diols |
| 290545                   | Glycerol |
| 290559                   | other halogenated, sulphonated, nitrated/nitrosated derivatives of acyclic alcohols |
| 291539                   | other esters of acetic acid |
| 291570                   | palmitic acid, stearic acid, their salts and esters |
| 291615                   | oleic, linoleic, or linolenic acids, their salts and esters |
| 291732                   | dioctyl orthophthalates |
| 291734                   | other esters of orthophthalic acid |
| 291739                   | other aromatic polycarboxylic acids, their anhydrides, halides, peroxides and peroxyacids and their derivatives |
| 382311                   | stearic acid |
| 382312                   | oleic acid |
| 382319                   | palm fatty acid distillates (PFAD) |
| 382370                   | industrial fatty alcohol in the form of wax |
| 382490                   | other chemical products and chemical preparation (ester) |
| 382490                   | other chemical products and chemical preparation (ester) |

Table A2. Explanation of the Subscripts in Eqs. (1) and (2).

| Subscript | Countries and products |
|-----------|------------------------|
| Subject country (i) | Malaysia, Indonesia, United States, Argentina, China, European countries (the Netherlands, Spain, Italy, France, Portugal, Germany, United Kingdoms, Poland) |
| World (n) | 294 countries defined in United Nations Comtrade Database |
| Subject oleochemical products (j) | Oleochemical products (HS 6 digit code) |
| Set of products groups respectively (t) | Use combination of Oleochemicals product under HS 2 digit code: HS15 + HS 29 |

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