Determinants of Fisheries Trade Competitiveness: The Case of Malaysia

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Abstract

Fisheries constitute one of the most globalised food industries and significantly contribute to a nation's socioeconomic development and international food security. Malaysia is a small open economy endowed with fisheries resources; however, the rapid growth of international trade has changed the patterns of fish trade dependence. It has now become a fish importer and experienced a critical fish trade deficit since 2009, implicating eroding trade competitiveness of Malaysian fisheries in the global market. The existing empirical studies on competitiveness conclude that Malaysia loses the competitive status in the international fish market, but the Trade Competitiveness Index (TCI) and its determinants have not been thoroughly explored. Hence, this present study aims to examine the short and long run effects of trade openness, the exchange rate and fishery employment on the TCI of Malaysian fisheries during 1976–2018, using an Autoregressive Distributed Lag (ARDL) approach. The findings conclude that Malaysia has lost its trade competitiveness in terms of TCI in the global fishery market. The ARDL results show that an appreciation of the exchange rate as well as more trade openness and fishery employment enhance the TCI in the short run (i.e., a few years), but have negative effects in the long run. To ameliorate trade competitiveness, higher restrictions on fish imports are recommended, as well as more adoption of science and technology in fisheries in the long run, given the nature of the exchange rate, appreciation policies are proposed in the short run.

Keywords: fish trade, fishermen, short and long run, socioeconomics, trade competitiveness index

Introduction

Fisheries play a central role in enhancing food security and socioeconomic upliftment, for example, in rural communities through trading with other countries (Miao and Wang, 2020). There has been a growing body of scientific evidence regarding the health benefits of fish consumption in reducing the risk of stroke, depression, Alzheimer's disease, and other chronic conditions. Eating fish is an essential source of omega-3 fatty acids and keeps our heart and brain healthy, in which there are two omega-3 fatty acids found in fish, namely, EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) (Institute of Medicine, 2011; Harvard, 2014; Zhang et al., 2018). This makes fisheries amongst the most traded food commodities in terms of value and the commodity most subject to competition from imported products. Hence, competitive, inclusive, resilient and sustainable fisheries are indeed important, particularly for the Association of Southeast Asian Nations (ASEAN) as identified in the Strategic Plan of Action on ASEAN Cooperation on Fisheries 2021–2025 (Southeast Asian Fisheries Development Centre, 2020).

The dominant trend in global trade development has been the increasing importance of developing countries as exporters of primary commodities such as fisheries since the 1970s given their resource endowment and biodiversity. Malaysia has large natural resources such as fisheries, oil and gas reserves in its maritime zones, thus making exports more commodities readily feasible and has a comparative advantage for electrical and electronic products, refined petroleum products, liquefied natural gas, palm oil and palm oil-based products, crude petroleum, timber and timber-based products, natural rubber, cocoa beans, dried stems and fisheries (Department of Statistics Malaysia, 2022a, 2022b). In 2020, Malaysia was identified as one of the leading producers of marine products, and fisheries ranked 13th in the world and 8th in Asia (Table 1). Malaysia has been also amongst the top producers of, particularly, crustaceans which are the 12th in the world and 9th in Asia, as well as aquatic algae which are 7th in the world and Asia. This also implies that Malaysia faces stiff competition from other Asian countries, especially China, Indonesia and the Philippines with their status as the dominant fish producers (FAO, 2022b).

Malaysia exports high-quality fish commodities, particularly, in the aquaculture sector for export earnings, and utilises the foreign exchange acquired for the imports of relatively cheap and low-quality fishery products. However, the fish export earnings have not been sufficient to pay the fish import expenditures, thus leading to a negative fish trade balance in Malaysia since 2009 (Table 2). The increasingly greater gap in the trade balance implies that Malaysia may lose from lacking trade competitiveness in the international fishery market (Soh and Lim, 2020; Soh et al., 2021, 2022a, 2022b), coupled with the fact that the issue is getting more critical, in which trade competitiveness tells the relative success or failure of the efforts of a nation to sell more domestically produced goods and services in other nations than its purchase of foreign goods from other nations.

Table 1. Marine capture and aquaculture production: Major producing countries and territories in 2020.

Rank	Marine capture production			Aquaculture production					
				Crustaceans			Algae		
	Country/ territories	Million tonnes	% of total	Country/ territories	Million tonnes	% of total	Country/ territories	Million tonnes	% of total
1st	China ^{A}	11.77	15	China ^{A}	1.80	27	China ^{A}	20.8	59
2nd	Indonesia ^{A}	6.43	8	Vietnam ^{A}	1.10	16	Indonesia ^{A}	9.6	27
3rd	Peru	5.61	7	India ^{A}	0.90	13	Republic of Korea ^{A}	1.76	5
4th	Russian Federation	4.79	6	Indonesia ^{A}	0.89	13	Philippines ^{A}	1.47	4
5th	United States	4.23	5	Ecuador	0.76	11	Democratic People's Republic of Korea ^{A}	0.60	2
6th	India ^{A}	3.71	5	Thailand ^{A}	0.39	6	Japan ^{A}	0.40	1
7th	Vietnam ^{A}	3.27	4	Mexico	0.19	3	Malaysia ^{A}	0.18	1
8th	Japan ^{A}	3.13	4	Bangladesh ^{A}	0.09	1	United Republic of Tanzania	0.09	0.26
9th	Norway	2.45	3	Philippines ^{A}	0.09	1	Russian Federation	0.02	0.06
10th	Chile	1.77	2	Brazil	0.06	1	Chile	0.02	0.05
11th	Philippines ^{A}	1.76	2	Myanmar ^{A}	0.06	1	Vietnam ^{A}	0.01	0.04
12th	Thailand ^{A}	1.52	2	Malaysia ^{A}	0.05	1	Madagascar	0.01	0.02
13th	Malaysia ^{A}	1.38	2	Iran ^{A}	0.05	1	Solomon Islands	0.01	0.02
14th	Republic of Korea ^{A}	1.36	2	Saudi Arabia ^{A}	0.05	1	India ^{A}	0.01	0.01
15th	Morocco	1.36	2	Venezuela	0.05	1	-		
	Other	24.25	31	Other	0.17	3	Other	0.02	0.06
	Total	78.79	100	Total	6.70	100	Total	35.00	100

Note: ^{A} indicates Asian countries. Source: FAO (2022b).

Malaysia is also a great per capita fish consumer, in a good record of trade openness leads it to have higher fish exports and fish imports than the rest of the world to meet both rising local and global demand. With a trade openness index that is always above 100, Malaysia showed a far higher per capita fish consumption (i.e., 56.1 kg from 20.4 kg during 1961–2019) than the world level and has transcended Japan as one of the biggest fish consumers since 2007 (FAO, 2022b). A country's trade is always closely linked to its exchange rate in which the currency changes can substantially affect the earnings, expenditures and trade competitiveness of fisheries that are highly traded (Asche, 2014). The Malaysian Ringgit (MYR) appreciated from 2009 to 2011 and then depreciated until 2017, appreciated again in 2018 and depreciated again until 2020, and lastly appreciated again in 2021. An appreciating ringgit makes local goods more expensive to export and conversely makes foreign goods cheaper to be imported. This reduces the fish exports and raises the fish imports; hence fish trade balance becomes negative or vice versa. The opposite applies when the ringgit depreciates - local goods are cheaper to export and foreign goods are more expensive

Table 2. Malaysian fish trade balance, trade openness, exchange rate and number of fishers and culturists in 2009-2021.

Year	Fish export earnings (USD million)	Fish import expenditures	Fish trade balance	Trade openness (Percentage)	Exchange rate (MYR/USD)	Fishers and culturists (Persons)
2009	542.290	583.088	-40.80	162.6	3.523	167,766
2010	698.789	683.401	15.39	157.9	3.218	175,859
2011	769.851	862.143	-92.29	154.9	3.056	184,701
2012	679,843	905.456	-225.61	147.8	3.086	188,787
2013	622.914	887.968	-265.05	142.7	3.149	191,708
2014	676.855	961.546	-284.69	138.3	3.270	190,495
2015	505.436	785.305	-279.87	131.4	3.904	185,144
2016	517.473	777.129	-259.66	126.9	4.137	170,163
2017	509.590	811.989	-302.40	133.2	4.298	162,282
2018	537.379	888.149	-350.77	130.4	4.031	161,309
2019	649.179	965.008	-315.83	123.0	4.142	162,419
2020	619.296	919.948	-300.65	116.4	4.203	155,809
2021	680.921	1,111.872	-430.95	130.7	4.144	152,834

Sources: Fish export earnings and fish import expenditures are collected from FAO (2022a); fish trade balance is based on author's own calculations (i.e., fish export earnings minus fish import expenditures); trade openness is obtained from World Bank (2022); exchange rate from Federal Reserve Economic Data (2022) while fishers and culturists from Department of Fisheries Malaysia (2021).

to import. In fact, the high per capita fish consumption of Malaysia also means the possibility of overfishing or over-exploitation of fisheries resources to meet such high demand, thus deteriorating fish stock (i.e., has a long run effect on lowering income opportunities) (Smithrithee et al., 2020; Sarkodie and Owusu, 2023). The declining fish stock may cause fishers to catch less fish, and even force some fishers to quit the industry. Since 2013, an overall decrease in fishers may directly or indirectly reduce production (i.e., may be due to decreasing fish stock) and export but increase fish imports, eventually resulting in the negative fish trade balance.

Given the high exposure to trade competition of fish production coupled with the trade deficit issue, the analysis of trade competitiveness determinants is becoming a central preoccupation among developed and developing countries, in which developed (developing) countries have been the main importers (increasingly relying on fish trade as a source of income)(Soh and Lim, 2020; FAO, 2022a, 2022b). In addition, in the case of Malaysia, its main fisheries policies are currently driven by mere consideration of the level of fish trade, often ignoring some underlying factors such as trade openness, the exchange rate and fishery employment (Soh and Lim, 2020; Soh et al., 2022a). Higher fish trade (i.e., the summation of fish exports and fish imports) does not guarantee greater trade competitiveness since higher fish imports will worsen the competitiveness globally. Important factors such as trade openness, the exchange rate and fishery employment should be highlighted to enhance trade competitiveness. As mentioned earlier, Malaysia has a good record of trade openness under the flexible exchange rate regime but still experiences a critical trade deficit in its fisheries that are relatively labour-intensive.

One of the widely employed trade competitiveness measurements is the Relative Trade Advantage (RTA) which measures the level of trade (dis)advantage only of a country. Unlike the trade balance and RTA, the Trade Competitiveness Index (TCI) measures the level of trade competitiveness in terms of the trade balance based on the total trade of the country, thus providing relatively more accurate outcomes in terms of the development stage and growth rate of a country in trade globally, although the indicators incorporate both export and import sides are consistent with the theory of comparative advantage and the real-world phenomenon of two-way trade (Khai et al., 2016). Key to the variables underpinning the drivers of the TCI are domestic demand and supply shifters such as trade openness, the exchange rate and fishery employment where their effects may differ in the short and long run. (Please note that reasons for excluding other factors such as the state of the fish stock, the level of technological advancement in aquaculture and the increase in income level, are explained in the Materials and Methods).

Within the international trade literature, the Ricardian comparative advantage and the Heckscher-Ohlin (H-O) theories (or natural resource abundance theory) have been amongst the most powerful propositions of trade theory in determining the pattern of international trade. Based on Ricardo (1817, cited in Soh et al., 2022a), it is beneficial for countries to engage in trade with one another, exporting goods that they have a relative advantage in producing, leading to a mutual increase in welfare. Later, Heckscher and Ohlin (1991, cited in Huo, 2014) redefined the Ricardian comparative advantage by associating it with relative factor endowments to accomplish competitive specialisation. The H-O theory highlights that with free trade, a country will export the commodity that makes intensive use of a relatively abundant factor of production and will import the commodity that it makes intensive use of the relatively scarce factor of production.

Over the past decade, there has been a lack of attention on the trade competitiveness of developing countries, especially Malaysian fisheries and its determinants. The main findings of pivotal studies are as follows: Soh et al. (2022b) provided strong evidence of Malaysian fisheries lacking competitiveness in terms of RTA and Revealed Competitiveness in the global market during 2009-2018. Sawyer et al. (2017), centring on China's primary, secondary and tertiary sectors, found that West and Central China had a trade advantage in terms of RTA in some sectors such as agriculture/mining. It also claimed that human capital and government spending enhanced the RTA, whereas industrial loans and taxes, along with provincial trade barriers, impaired it in 1992-2007 based on the fixed effect method. By using additional TCI and random effect methods to investigate relatively recent data on China agricultural products, Zhou and Tong (2022) reached a different conclusion — the products had a weak trade competitive strength in terms of RTA and TCI, in which farmers' agricultural input and land productivity positively influenced RTA and TCI, yet, trade openness and agricultural income adversely affected RTA and TCI, respectively, during 2001-2019.

Moreover, Ndlangamandla et al. (2016) found that the sugar industry in Swaziland was competitive in terms of RTA globally, in which the global sugar prices had a negative effect, but the exchange rate and local sugar exports favourably affected the RTA from 1994 to 2011 based on the least squares method. After adopting the panel-corrected standard errors method, Balogh and Fertő (2015) proclaimed that domestic income and exchange rates had a negative effect, while agricultural employment, harvested grape area and World Trade Organization memberships positively affected RTA of 38 wine exporter countries (excluding Malaysia) in 2000-2013. They found traditional, the New World and developing wine producer countries had a strong trade advantage. The TCI has also been adopted in measuring the trade competitiveness of Turkey's aquaculture sector (Demir and Aksoy, 2021), Indonesian crab fishery (Khasanah et al., 2019), the selected top ten countries' (excluding Malaysia) fisheries (Saricoban and Kaya, 2017) and Indonesian seaweed (Damelia and Soesilowati, 2016) but none of them has examined its determinants. In short, studies on TCI and its determinants in Malaysia are obviously lacking and inconclusive without assessing the short and long run effects since the above studies focused mainly on foreign countries and analysed the trade performance in terms of RTA.

The present study aims to (1) calculate the Trade Competitiveness Index (TCI) for Malaysian fisheries; and (2) test and quantify the role of selected determinants through an econometric technique on time series data, with particular interest in the short run relationships. The short run and long run are terms often used in economics. The short run, which is a period during which wages and some other prices do not respond to changes in economic conditions, plays a relatively central role in exchange rate policies since changes in exchange rate policies tend to have an immediate impact. Unlike the short run, the long run is a period during which wages and prices are variable, in which trade and fisheries policies can greatly support the fisheries nations' conservation and sustainable use of the resources in the long run. To our best knowledge, this is the first study on Malaysian fisheries to apply the TCI and investigate its determinants. The fisheries sector of Malaysia is likely to benefit due to the nature of trade, exchange rate and fisheries policies in which the findings of this study contribute to fisheries literature and policies by extending the scope of existing studies on trade competitiveness with short and long run relationships. This study recommends several approaches and interventions that could help policymakers, traders, conservationists and other scientists in shaping the future development of the fisheries and creating strategies to strengthen its sustainable development and trade performance.

Materials and Methods

Ethical approval

No live animals were used in this study. Therefore, no Institutional Animal Care and Use Committee (IACUC) approval was required.

Data collection

The present studies on the TCI, which considers the entire fisheries aggregate, and its determinants (i.e., trade openness, the exchange rate and fishery employment) have utilised the collection of secondary data. Annual data for the variables throughout 1976–2018 (43 years) are collected from several sources. The data for fish export and fish import is from the Food and Agriculture Organization Fishery Statistics database (FAO, 2022a), the trade openness index from the World Bank's official website (World Bank, 2022), exchange rates from Federal Reserve Economic Data (2022) while the number of fishers and fish culturists are from Department of Fisheries Malaysia (2021).

Overall, exports and imports of fish from Malaysia have been relatively from 1976 to 1995, ranging from USD~100 to 400 million (Fig. 1). Malaysia was a net fish importer (i.e., when fish exports were lower than fish imports) until 2002, after which exports were marginally greater than imports until 2008 (USD~700 million). It has been a net importer since 2009 and the annual value of imports was >USD1000 million and exports <USD~900 million during this time (Fig. 1).

Table 3 displays the descriptive statistics of the variables. The distributions of $TCI, OPEN, FEMPLOY$ and $EXCH$ are almost symmetrical because their values of the mean and median are close, also implying a normal distribution.

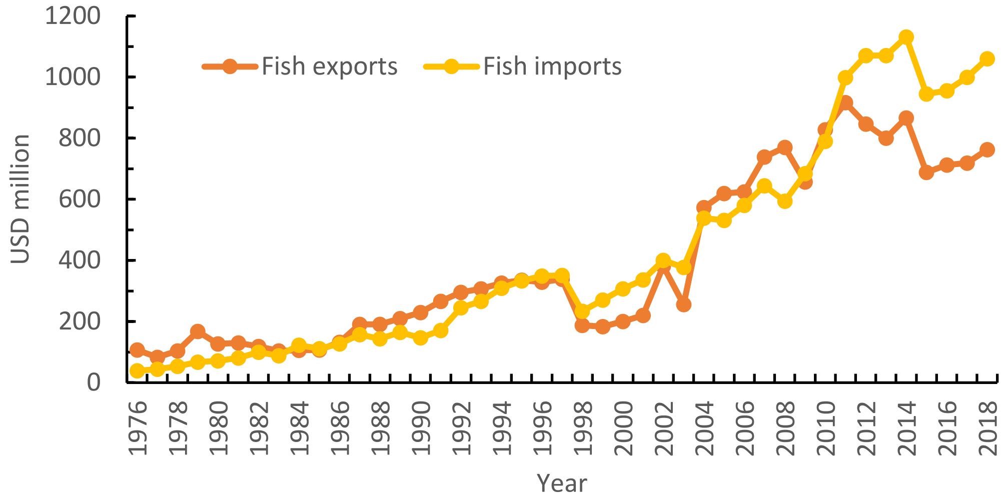

Fig. 1. The value (USD) of exports and imports of Malaysian fisheries from 1976 to 2018. Source: FAO (2022a).

Table 3. Descriptive statistics of trade competitiveness index (*TCI*), trade openness (*OPEN*), the exchange rate (*EXCH*) and fishery employment (*FEMPLOY*).

	TCI	*OPEN*	*EXCH*	*FEMPLOY*
Mean	0.033	151.706	3.059	129524.400
Median	0.023	147.842	2.817	122373.000
Maximum	0.469	220.407	4.298	191708.000
Minimum	-0.210	92.546	2.177	91513.000
Standard deviation	0.170	39.507	0.644	30711.210

Statistical analyses

The collected data were tabulated into Microsoft Excel and were analysed using the Eviews 12 statistical package.

Firstly, the computation of the Trade Competitiveness Index (TCI) (Balassa and Noland, 1989, cited in Saricoban and Kaya, 2017; Vu et al., 2019; Dewi and Xia, 2022) is presented as follows:

$$TCI = \frac{X - M}{X + M}$$

where X *and* M represent the export and import value of Malaysian fisheries, respectively. $TCI > 0$ shows that the country enjoys a trade competitiveness globally and tends to be an exporter where exports are more significant for the country. Contrarily, $TCI < 0$ indicates a lack of competitiveness and the country is likely to be a net importer (Damelia and Soesilowati, 2016; Saricoban and Kaya, 2017; Vu et al., 2019). The closer the index is to 0, the closer the level of competitiveness is to the average, (TCI ranges from -1 to 1). The TCI also provides other useful information in terms of the growth rate of fisheries in international trade which is divided into the following five stages (Dewi and Xia, 2022): (i) $-1 \leq TCI \leq -0.5$ shows an introduction stage where an industry (forerunner) from a new country exports its new products to other countries, (ii) $-0.5 < TCI \leq 0$ implies an import substitution stage where a country imports more certain commodities than exports, because of low domestic productivity which is smaller than domestic demand, (iii) $0 < TCI \leq 0.8$ means a growth stage where a country begins to increase its export production and ultimately to improve the supply for that commodity in the domestic market, (iv) $0.8 < TCI \leq 1$ implies a maturity stage where the country acts as a net exporter, and (v) when the index again decreased in the range 1 to 0, the country steps back to import stage where the commodity produced by the country is unable to compete in the domestic market with the same commodity from other countries, and domestic production is even less than domestic demand.

Next, in order to examine the determinants of the TCI of the Malaysian fisheries, the trade competitiveness model in this study closely follows Rose and Yellen (1989, cited in Soh and Lim, 2020), Balogh and Fertő (2015) as well as Zhou and Tong (2022). It can be written as follows:

$$TCI_t = a + b\,logOPEN_t + c\,logEXCH_t + d\,logFEMPLOY_t + \varepsilon_t \quad (1)$$

where TCI_t is the Malaysian fish trade competitiveness, $logOPEN_t$ is trade openness, $logEXCH_t$ is the exchange rate, $logFEMPLOY_t$ is the fishery employment, ε_t represents the error term and t is time. The coefficients for $logOPEN_t$, $logEXCH_t$ and $logFEMPLOY_t$ are *b*, *c* and *d* respectively. Please note that $EXCH$ (MYR/USD) is a more appropriate measure of the exchange rate than Real Effective Exchange

Rate (REER). In this study, REER is used for robustness checking. REER compares a nation's currency value against the weighted average of a basket of other major currencies and it is measured as an index. Unlike $EXCH$, the decrement of REER means depreciation and vice versa. Other factors, such as the state of the fish stock, the level of technological advancement in aquaculture and the increase in income level, are not included in this study since fish stock is unmeasurable and technological advancement is not documented in Malaysia (Winstanley-Chesters, 2021; Pattarapongpan et al., 2022), while higher income is insignificant and/or fails to provide a stable model when being tested in pre-analysis.

The coefficient *b* is expected to be negative since more trade openness (or free trade) should induce more imports to cater to Malaysia higher demand for fish. Yet, the coefficients *c* and *d* are expected to be positive. A rise in the exchange rate (or depreciation) should expand fish exports and concurrently reduce fish imports. Similarly, higher fishery employment in terms of fishers and fish culturists should expand fish production for exports. As Malaysia is confronting an absence of trade competitiveness in fisheries, lower trade openness, depreciation of the exchange rate and more fishery employment are expected to improve the trade competitiveness.

To capture the short and long run effects, the task is now reduced to converting (1) into an Auto-regressive Distributed Lag (ARDL) model such as the one outlined by equation (2) below. Following Pesaran et al. (2001), an error-correction term (ECT) is applied to estimate the linear relationship:

$$\begin{aligned}
&\Delta TCI_t \\
&= \alpha + \sum_{k=1}^{n1} \beta_k TCI_{t-k} + \sum_{k=0}^{n2} \delta_k \Delta\, logOPEN_{t-k} \\
&+ \sum_{k=0}^{n3} \phi_k \Delta logEXCH_{t-k} \\
&+ \sum_{k=0}^{n4} \gamma_k \Delta\, logFEMPLOY_{t-k} + \lambda_0 TCI_{t-1} \\
&+ \lambda_1\, logOPEN_{t-1} + \lambda_2 logEXCH_{t-1} \\
&+ \lambda_3\, logFEMPLOY_{t-1} + \mu_t + ECT_t \qquad (2)
\end{aligned}$$

ECT is based on Pesaran et al. (2001), who proposed employing the standard F-test to establish the joint significance of lagged level variables as a sign of cointegration. Once there is at least a cointegration, long run effects are inferred by the estimates of $\lambda_1 - \lambda_3$ normalised on λ_0. The short run effects of each variable are deduced by the coefficients' estimate attached to the first-differenced variable. For instance, the short run effect of trade openness is judged by the estimates of $\delta_k's$.The F-test would be used to test the null hypothesis of no cointegration against the alternative of the existence of a long run relationship. The F-statistic would be compared to the two critical values, which included the upper and lower bounds, in the bound test (Pesaran et al., 2001). If the value of the F-statistic exceeds the critical value of the upper bound, then the null hypothesis is rejected.

Some diagnostic tests were run to confirm the goodness of fit of the model. The Ramsey Regression Specification Error Test (RESET) (Brown et al., 1975) was used to test if nonlinear combinations of the fitted values can describe the dependent variable whereas the cumulative sum (CUSUM) of the recursive residuals and the cumulative sum of squared (CUSUMSQ) recursive residuals tests (Brown et al., 1975) assess the stability of the short and long run coefficients.

Results

The Trade Competitiveness Index (TCI) of Malaysia was the highest at 0.469 in 1976 but showed an overall decline to -0.163 in 2018 (Fig. 2). From 1976–1995, Malaysia has been a net exporter of fish and enjoyed a trade competitiveness in the international fisheries market given the positive value of TCI. Also, the TCI has lied between 0 and 0.8, indicating a growth stage where Malaysia has begun to expand its fish export production and improve the supply of fisheries in the domestic market. Then, Malaysia has become a fish net importer and lost its trade competitiveness globally till 2003 given the negative TCI value. Since the TCI has lied between -0.5 and 0, it implicates an import substitution stage- the domestic fish begins to replace imported fish, so the value of fish imports (exports) starts to decline (increase) in Malaysia. Next, the fisheries turned into the growth stage and tighter trade competitiveness globally till 2008 but stepped

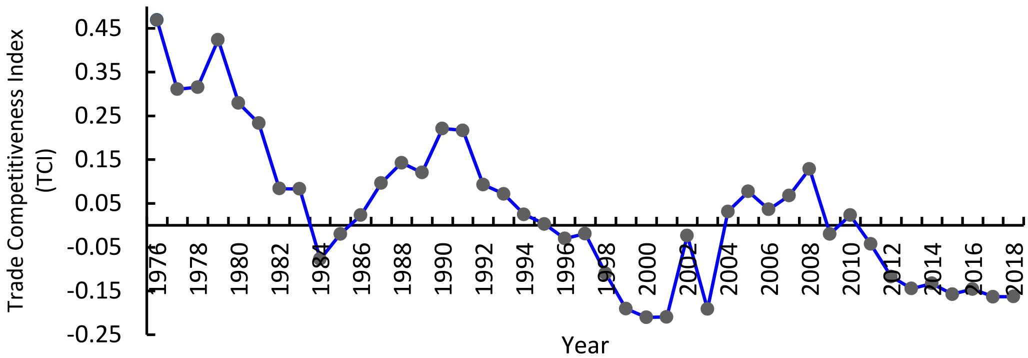

Fig. 2. The trade competitiveness index (TCI) of Malaysian fisheries from 1976 to 2018.

back to import substitution stage and suffered from trade competitiveness since 2009. The index decreased dramatically from 2010 to 2013, then it fluctuated at around -0.15. The import substitution stage also implies that Malaysia imported more fisheries than exports due to lacking domestic production that was less than domestic demand. The findings are supported by Damelia and Soesilowati (2016), Saricoban and Kaya (2017), Khasanah et al. (2019), Demir and Aksoy (2021) and Soh et al. (2021, 2022b).

The cointegration test based on the ARDL bounds testing approach, had an F-statistic of 6.704, which exceeds the upper critical values at the 1 % significance level (4.66). It also means that the null hypothesis of no cointegration is rejected. It confirms the long run relationship among the variables.

Since ARDL is sensitive to lags, ARDL (2,3,4,3) specification was chosen in this study. Referring to the Schwarz Bayesian Criteria that is a consistent model-selector, this study chooses two (four) as the maximum order of lag for the dependent (independent) variable in providing the best-fit and stable ARDL model since all observations are annual and the number of observation years is 43 (Pesaran et al., 2001; Eviews, 2017; Soh et al., 2022a). In the long run, trade openness carries a significant -0.6954 coefficient, at the 1 % significance level, indicating that a 1 % increment in trade openness worsens the trade competitiveness by 0.695 units (Table 4). This finding follows the theory of comparative advantage (Ricardo, 1817 cited in Soh et al., 2022a; Saricoban and Kaya, 2017) and is in line with Soh and Lim (2020) as well as Zhou and Tong (2022) that Malaysia gained from trade since openness increases the availability of relatively cheaper imported fish.

On the other hand, enhanced restrictions on fish import could improve trade competitiveness in the long run. The exchange rate exerts a positive sign and significant estimate at the 5 % level, which means that 1 % of depreciation results in the betterment of the trade competitiveness by 1.025 units (Table 4). This follows the comparative advantage (Abbas and Waheed, 2017) and is consistent with Ndlangamandla et al. (2016) where ringgit depreciation makes the Malaysian fish exports relatively cheaper and more competitive, concurrently raising the price of fish imports, hence promoting (reducing) the exports (imports). Also, the significant and negative sign of fishery employment implies that a 1 % rise in fishery employment deteriorates the trade competitiveness by 0.696 units. The negative association is supported by Bojnec and Fertő (2017). In Malaysia, marine fisheries constitute more than 70 % of the total fish production (FAO, 2022a). An increase in fishery employment means more fishing effort, which may worsen the phenomenon of overexploitation, hence reducing production and export, and lastly decreasing competitiveness (Smithrithee et al., 2020; Department of Fisheries Malaysia, 2021; Soh et al., 2022a). Thus, transitioning from labour-intensive methods to capital-intensive or innovation-driven approaches could be a strategy to sustain the development of the fisheries industry.

Since every variable exhibits at least one significant coefficient, all variables seem to have short run effects (Table 5). All variables have opposite outcomes in the short run, compared to the long run. In addition, all lagged variables do affect trade competitiveness. It is a common observation that Malaysian fisheries have connected through transportation networks encompassing the maritime sector with time lags. Plus, with the rapid expansion of world trade (i.e., given globalisation) and some unprecedented situations (e.g., the Asian financial crisis, SARS, subprime mortgage crisis etc.), it takes even longer times (e.g., months) to process exports and imports after the traders' negotiation and agreements on sale contracts (Gani, 2017; Federal Agricultural Marketing Authority, 2021). Specifically, the second lagged trade openness registers a positive effect on the trade competitiveness, at the 10 % significance level. This outcome is supported by Balogh and Fertő (2015) and Ndlangamandla et al. (2016), who concluded that more trade openness, for example through participation in World Trade Organization and broadening the exports of goods, was likely to heighten the competitiveness globally. The first to third lagged depreciation of the exchange rate exerted a negative effect on the trade competitiveness, at the 1 % significance level. When the first lagged exchange rate depreciates by 1 %, the trade competitiveness will contract by 0.802 units. The unexpected correlation is in line with Balogh and Fertő (2015) who explained that an appreciation can help the efficiency of production through technology investment and infrastructure enhancement, and lastly the sector becomes more competitive.

Table 4. Autoregressive distributed lag (ARDL) long run estimates of trade openness (OPEN), the exchange rate (EXCH), fishery employment (FEMPLOY) and constant for 43 years.

Variable	Coefficient	Standard error	t-statistic	Probability
$log\ OPEN$	-0.6954	0.2121	-3.2779	0.0033***
$log\ EXCH$	1.0249	0.4027	2.5452	0.0181**
$log\ FEMPLOY$	-0.6957	0.2473	-2.8134	0.0099***
Constant	10.5504	3.4494	3.0587	0.0056***

Note: ***, ** and * denote level of significance at 1 %, 5 % and 10 %, respectively.

Table 5. Autoregressive Distributed Lag (ARDL) short run estimates of Trade Competitiveness Index (TCI), trade openness (OPEN), the exchange rate (EXCH), fishery employment (FEMPLOY) and error-correction term (ECT).

Variable	Coefficient	Standard error	t-statistic	Probability
Constant	-0.0001	0.0111	-0.0101	0.9920
ΔTCI_{t-1}	-0.2313	0.1249	-1.8526	0.0753*
$\Delta logOPEN_{t}$	-0.0157	0.2289	-0.0687	0.9458
$\Delta logOPEN_{t-1}$	0.3193	0.2570	1.2422	0.2253
$\Delta logOPEN_{t-2}$	0.4184	0.2130	1.9642	0.0603*
$\Delta logEXCH_{t}$	0.0363	0.1638	0.2214	0.8265
$\Delta logEXCH_{t-1}$	-0.8018	0.2066	-3.8805	0.0006***
$\Delta logEXCH_{t-2}$	-0.5062	0.1817	-2.7856	0.0098***
$\Delta logEXCH_{t-3}$	-0.7561	0.2006	-3.7686	0.0009***
$\Delta logFEMPLOY_{t}$	-0.0442	0.2061	-0.2146	0.8317
$\Delta logFEMPLOY_{t-1}$	-0.0138	0.2253	-0.0613	0.9516
$\Delta logFEMPLOY_{t-2}$	0.4581	0.2052	2.2321	0.0344**
ECT_{t-1}	-0.6130	0.1009	-6.0779	0.0000***

Note: ***, ** and * denote level of significance at 1 %, 5 % and 10 %, respectively.

Furthermore, the sign of second lagged fishery employment is positive and statistically significant at 5 % level. This finding is consistent with Balogh and Fertő (2015) and obeys the H-O theorem. Given fisheries are relatively labour-intensive, more fish culturists indicate better endowments in fishery employment can, through more production, improve the exports and, subsequently the competitive strength of Malaysian fisheries globally (Liew et al., 2021).

After constructing ECT_{t-1}, it registers a negative value, which is less than one in absolute terms and is significant at the 1 % level (Table 5). Thus, the long run estimates are valid and supported by the above-mentioned bound test. The coefficient of ECT_{t-1} also implicates the speed at which the disequilibrium will be corrected in the system yearly, which is 61.30 %. Moreover, the residuals of the ARDL model are free from functional form and normality problems because the two tests null hypothesis cannot be rejected which means this model is efficient and consistent (Table 6).

The plots of both the cumulative sum and cumulative sums of squares of recursive residual tests lie within their critical bounds at the 5 % significance level, which shows that the model is stable over the period examined (Fig. 3).

When $EXCH$ was replaced with $REER$ in the long-run estimated ARDL model, the $REER$ has an expected negative sign (Table 7), which is opposite to the expected positive sign of $EXCH$. The signs of the variables in Table 7 are identical to those in the main estimation (Table 4). However, the estimated coefficients of all variables in Table 7 were not significant, which increases the confidence in the main estimation.

Discussion

Since the Malaysian fish trade deficit is a contemporary problem (i.e., generally persistent since 2009), the lack of existing literature on fish trade competitiveness motivated this study. This study contributes to new knowledge on fish trading on the short and long effects of selected variables in the fisheries of Asian countries (i.e., Malaysia) and identifying gaps in current knowledge.

First, this study showed that the Malaysian fisheries experience a serious competitive weakness problem (i.e., reflected by an overall decreasing trend of TCI coupled with an absence of trade competitiveness due to the negative value of TCI) at the international level. This issue may have resulted from a deficit in fish production (FAO, 2022a), in conjunction with the persistent reliance on fish imports, given the Malaysian consumers' preference (Chan, 2017; Wong, 2021). This has likely led to lower fish exports and the fish trade deficit (Soh and Lim, 2020).

Secondly, this study found that all variables examined i.e. trade openness, the exchange rate and fishery employment, were significant in affecting the TCI. In the long run, trade openness and depreciation of the exchange rate carried a negative and positive effect on TCI, respectively, thus following predictions from the

Table 6. Diagnostic tests results for normality and specification.

Test statistics	Test	Values (Probability)
Normality	Jarque-Bera	3.5913 (0.1660)
Specification	Ramsey RESET	1.2029 (0.2846)

Note: ***, ** and * denote level of significance at 1 %, 5 % and 10 %, respectively.

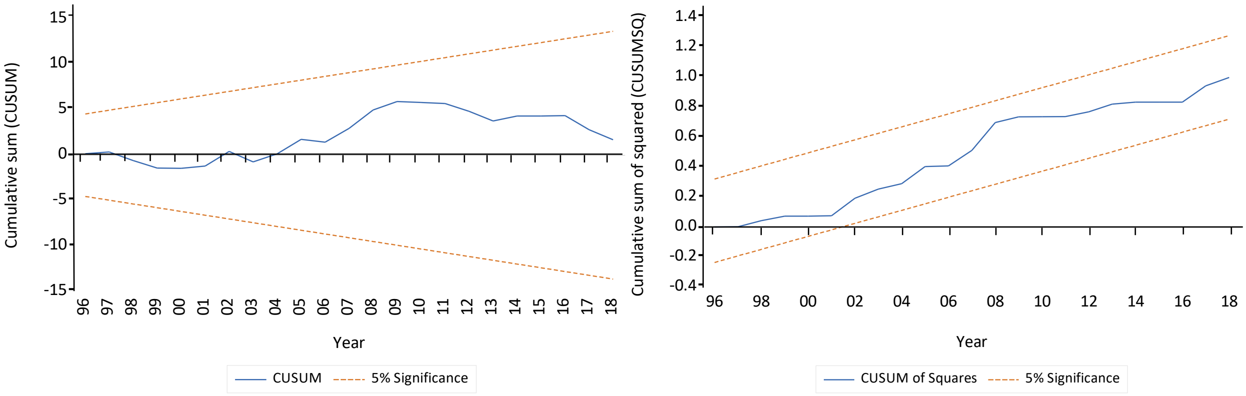

Fig. 3. Plot of cumulative sum (CUSUM) of the recursive residuals and the cumulative sum of squared (CUSUMSQ) recursive residuals.

Table 7. Autoregressive distributed lag (ARDL) long run estimates of trade openness (OPEN), another proxy of the exchange rate (REER), fishery employment (FEMPLOY) and constant for 43 years.

Variable	Coefficient	Standard error	t-statistic	Probability
$log\ OPEN$	-0.7056	0.8185	-0.8620	0.3945
$log\ REER$	-0.5506	1.1324	-0.4863	0.6298
$log\ FEMPLOY$	-1.0557	0.8610	-1.2262	0.2283
Constant	18.5196	18.1968	1.0177	0.3158

Note: ***, ** and * denote level of significance at 1 %, 5 % and 10 %, respectively.

theory of comparative advantage. Unexpectedly, fishery employment reported a negative effect on the TCI in the long run; an economic downturn may cause unemployed workers to participate in fisheries which consists of marine capture fisheries and aquaculture sectors (Department of Fisheries Malaysia, 2021; International Labour Organization, 2023), indicating more fishing effort has been employed. Aquaculture production has increased while marine landings, which dominate the whole fisheries sector, continues to decrease due to deteriorating fish stocks (Smithrithee et al., 2020; Department of Fisheries Malaysia, 2021; Sarkodie and Owusu, 2023). Thus, fisheries production and export go down and eventually the TCI falls. In the short run, all the variables exerted an opposite effect from their effects in the long run. The positive effect of fishery employment on the TCI followed the H-O theorem. Unexpectedly, trade openness and depreciation of the exchange rate reported a positive and negative effect on the TCI, respectively. Malaysia continues to maintain its good record of trade openness by receiving more orders of fisheries from other countries, particularly, China, Singapore, Korea and Thailand, which accounted for ~64.7 % of the total Malaysian fish export in 2021 (International Trade Centre, 2023). Although the depreciation of the Malaysian ringgit makes imported fish more expensive, Malaysian consumers continue to show high demand for imported fish, such as prawns and shrimp, especially during the festive season (Chan, 2017; Wong, 2021; Soh et al., 2021, 2022a). The consumer preference then makes the ringgit depreciation more daunting and boosts the fish import value, and worsens the trade competitiveness (Soh et al., 2021, 2022a).

In summary, Malaysian preferences for imported fish have resulted in the ongoing dependence on fish imports, which then greatly worsens the trade competitiveness.

Conclusion

These empirical findings provide valuable information on trade competitiveness of fisheries for Malaysia. To our best knowledge, this study is also the first attempt to reveal the determinants of trade competitiveness in Malaysia fisheries (and aquaculture). Malaysia lacks trade competitiveness in the global fishery market, and this issue is significantly affected by the exchange rate, followed by fishery employment and trade openness, in both the short and long runs. In the short run, the exchange rate exerts a negative effect on trade competitiveness, but trade openness and fishery employment exhibit a positive effect on it.

However, they exert an opposite effect in the long run. Given the nature of the variables, it is important to consistently maintain appropriate trade, exchange rate and fisheries policies to ensure the stability of the existing market in the short and long run. Policies such as higher restrictions on fish imports and more adoption of science and technology in fisheries, are recommended in the long run, while currency appreciation policies are recommended for the short run. These policies, may be framed by involving the

Government and all stakeholders, including the scientists and non-governmental organisations, for effective trade and more extensive export of fisheries in sustainable ways.

First, trade policies on fisheries products should be reviewed regularly where the Government should impose moderate export duties and lower transportation taxes on fish exports and/or adopt stricter control on fish imports, especially from the aspect of safety and quality (e.g., rigorous examination on high-risk fish imports from Japan to filter out radioactive elements). With effective implementation, these measures are likely to enhance trade competitiveness.

Second, currency appreciation policies should be implemented in the short run to enable local fish exporters to benefit from lower production costs, especially fish feed that contains imported protein extract and other important raw materials, in developing the capacity of export-oriented fisheries.

Lastly, greater adoption of science and technology, as well as application of artificial intelligent (AI), particularly in deep sea fisheries and indoor fish farming are proposed in the long run, since they greatly help in fish stock assessment, predictive analytics, production efficiency, resource conservation and mitigating the impact of declining fishery employment. These measures are likely to lead to modernise existing fisheries and develop new fisheries with the adoption of higher value-added practices and products. A transformation of capture fisheries workers to explore aquaculture should be encouraged for more sustainable and resilient culturists' livelihood practices. Policymakers, conservationists and fish scientists have demanded comprehensive regulation, monitoring, and control of the fish trade, hence these policy implications are likely to be long overdue and require immediate implementation.

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Author contributions: Bee Hui Soh: Methodology, software, formal analysis, investigation, data curation, writing- original draft, writing- review and editing, visualisation. Ghee-Thean Lim: Conceptualisation, methodology, validation, resources, writing- review and editing, visualisation, supervision, project administration. Soo Y. Chua: Conceptualisation, resources, writing- review and editing, supervision, project administration.

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