International Journal of Business and Society, Vol. 23 No. 1, 2022, 88-105

ASYMMETRIC EFFECTS OF TRADE OPENNESS ON MALAYSIAN FISH TRADE BALANCE

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ABSTRACT

Although Malaysia is a small open economy surrounded by the ocean, it still experiences a critical fish trade deficit. This study examines the nonlinear effects of trade openness on Malaysian fish trade balance from 1976 to 2016, using the Nonlinear Autoregressive Distributed Lag (NARDL) approach. The other independent variables applied in the model are the exchange rate and domestic income. Findings show that the variables are cointegrated. In the long-run, positive change in trade openness has a significant negative effect on the trade balance. The emphasis of the study is also placed on shreds of evidence of the long-run and short-run asymmetric effects of trade openness. Domestic income and depreciation of the exchange rate offer significant positive impacts on the trade balance. In the short-run, all the variables yield an opposite effect. The outcome of the exchange rate supports the J-curve effect and the Marshall-Lerner condition. This research may help the policymakers and traders to have a better understanding of the sector and thus develop suitable long-term strategies to improve the fish trade balance.

Keywords: Fishery, Malaysia, NARDL, Trade Balance, Trade Openness.

Received: 3 August 2020
Accepted: 3 March 2021
https://doi.org/10.33736/ijbs.4600.2022

1. INTRODUCTION

Globally, fish has contributed more than 17% of the animal protein intake, and there are emerging shreds of evidence on the health benefits of fish consumption (Yusoff & Arshad, 2017). In 2016, around 88% of 171 million tonnes of global fish production were utilized for direct human consumption which led to a high world consumption of 20.3 kg per capita (FAO, 2018). Over 31% of fish production is projected to be traded in 2030, for human consumption or inedible purposes (FAO, 2018). Malaysia has been one of the major producers in marine capture production as well as in farmed seaweed in 2016 (FAO, 2018).

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In Malaysia, the fishery sector is one of the main sub-sectors of agriculture (Department of Statistics Malaysia, 2018). It has been identified in the Eleventh Malaysia Plan as the main driver for economic transformation, as well as the gross domestic product (GDP) growth accelerator (Yusoff & Arshad, 2017). For instance, the agriculture sector recorded 8.2% of the total Malaysia GDP, which amounted to RM1,174.3 billion in 2017, where the fishery sector accounted for 10.5%, is the fourth contributor in the agriculture sector (Department of Statistics Malaysia, 2018). Fish trade not only plays a crucial role in sustaining fish consumption and food security but also in strengthening national economic growth.

Malaysia has faced a fish trade deficit (negative trade balance) since 2009 (Table 1). When Malaysia imports more fish than it exports, it negatively affects the GDP according to the Keynesian model. Exchange rate is always closely linked to a country's trade. As shown in Table 1, Malaysia Ringgit appreciated from 2009 to 2011, and then it depreciated until 2016. Ringgit appreciation causes domestic goods to be relatively more expensive, lowering the fish export and raising the fish import; hence fish trade balance becomes negative or vice versa. Furthermore, economic theory suggests that, when people have higher income, they generally demand more food. The demand for fish is also sensitive to the income level of consumers, thus changes in the domestic income will influence the demand for fish. As Malaysian income rose from 2009, it probably leads to higher demand for both local and imported fish, causing a fish trade deficit.

Table 1: Malaysian Trade of Fish and Fisheries Products, Exchange Rate and Constant GDP per capita, 2005-2016

Year	Trade of Fish and Fisheries Products, US$ 1,000		Fish Trade Balance (FX- FM)	Exchange Rate, RM/USD	Malaysian Income per capita, USD
	Fish Export (FX)	Fish Import (FM)			
2005	610,038	525,242	84,796	3.7869	7974.25
2006	614,930	575,528	39,402	3.6661	8255.29
2007	727,157	641,947	85,210	3.4354	8605.02
2008	757,839	590,388	167,451	3.3292	8850.01
2009	650,589	680,881	-30,292	3.5231	8559.23
2010	820,239	784,759	35,480	3.2175	9040.57
2011	910,021	991,549	-81,528	3.0564	9372.01
2012	840,761	1,060,341	-219,580	3.0862	9743.10
2013	798,688	1,059,701	-261,013	3.1488	10061.72
2014	865,202	1,124,009	-258,807	3.2697	10524.07
2015	678,212	934,052	-255,840	3.9041	10912.15
2016	702,092	941,035	-238,943	4.1372	11219.63

Source: FishStat (2019); FRED (2019); World Bank (2019a).

Over the last decade, the rapid growth of international fish trade has occurred due to globalization and large-scale world economy transformation, resulting from trade openness and technological advancement (FAO, 2018). Although Malaysia trade openness has been declining recently, it is still above 100% (Global Economy, 2019). Trade openness is measured by the summation of nominal exports and imports, divided by nominal GDP. Openness to trade is considered an essential tool for economic growth in both developing and developed countries (Dar & Amirkhalkhali, 2003; Idris et al., 2018). Moreover, a decrease in trade openness can lead to Ringgit appreciation (Lee & Law, 2013); in which another measure known as the real effective exchange rate (REER) index is generated to evaluate how a currency fluctuates against many others at once and is also practised in international trade assessments. Higher openness means the economy is more dependent on international demand (Koen et al., 2017), and it is also believed to have a positive impact on productivity, which in turn improves employment and real wages as a result of new investments (Krueger, 1985). It has been a strong fact that many countries open their economies for economic development and growth. For example, developing countries ought to induce their trade openness to further expand their market size (Ghani, 2009). Optimality has been highlighted in trade and trade openness, implying that openness has an asymmetric effect, especially on the Malaysian fish trade balance (Atici, 2012; Bouzas & Keifman, 2003).

Multilateral reforms that reduce distortions (which is related to trade barriers and to those that distort domestic support) in world fisheries markets including Malaysia, can enhance its agricultural trade, incomes and overall welfare (OECD/FAO, 2017). Although Malaysia has a good record of trade openness under the flexible exchange rate regime, it still experiences a critical fish trade deficit. Generally, trade openness benefits a nation (e.g. through increasing the trade balance). However, it is not always the case; for the longer term, more openness to trade, for instance, persistent and high dependency on (fish) imports, is likely to worsen the trade balance, in which fish trade deficit may imply the loss of competitiveness upon the sector. As stated by Bhat and Sharma (2018), trade openness can asymmetrically affect a nation's trade balance. In this context, this study attempts to examine the impact of macroeconomic variables (i.e. trade openness, exchange rate and domestic income) on Malaysian fish trade balance, with a particular interest in the asymmetric effects of trade openness. To our best knowledge, this is the first study to analyse the potential asymmetric effects of trade openness on a sectoral (i.e. fish) trade balance of Malaysia. To this end, our findings could contribute to fishery economics literature by helping authorities, policymakers and traders develop their long-term strategic plan for the fishery sector, ultimately better managing the fish trade balance.

The paper is organized as follows: Section 1 starts with the introduction and background of the study. Section 2 reviews the existing works of literature. Section 3 outlines the methodology and data resource. Section 4 presents and discusses the findings of the study. Finally, Section 5 concludes and recommends some policies based on the findings of the study.

2. LITERATURE REVIEW

2.1. Trade Openness and Trade Balance

Very little attention has been paid to the effect of trade openness on the fish trade balance. Although the majority of the past literature studied the effect of exchange rate on the sectoral trade balance, Asche (2014) stated that trade openness is a more important factor in determining the seafood trade flows compared to the exchange rate. Besides, many studies opined that trade openness is closely related to the growth of the fishery sector (Bayramoglu & Jacques, 2012; Erhardt, 2018; Hannesson, 2001). Later, Soh and Lim (2020) confirmed the prime role of trade openness on the Malaysian fish trade balance.

The relationship between trade openness and trade balance has been discussed in Adam Smith's absolute advantage theory (Myint, 1977; Soh and Lim, 2020) where one of its main idea of the theory is free trade. Later, the comparative advantage theory was developed by Ricardo (1817) when there was a condition that a country had an absolute advantage in both goods. According to Ricardo, it is beneficial for a country to specialize where it has a comparative advantage and to trade for the good on which it has a comparative disadvantage. This theory has been proven to be applicable in explaining the trade in the real world (Bernard et al., 2003; Macdougall, 1952). For example, Malaysia will gain from free trade with a rapidly growing economy of trading partners, and the growth of specialized sectors (Coxhead, 2007). Even if a country does not have an absolute advantage in any good, this country and its trading partners would still gain from trade. However, with high trade openness, the country's balance of trade might worsen.

Generally, several studies have explained the linear or symmetric effect of trade openness on the trade balance. For example, Chaudhary and Amin (2012) and Tufail et al. (2014) discovered the negative impact of trade openness on the Pakistan trade balance by employing linear Autoregressive Distributed lag (ARDL) and Vector Error Correction Model (VECM) models for the period 1980-2008 and 1972-2011, respectively. Trade openness was found affecting both exports growth and imports growth positively in both the short-run and long-run, however the import growth increased more than exports growth. The negative relationship was aligned with the VECM results of Soh and Lim (2020) in the case of the Malaysian fishery sector during 1976-2016, thus supporting the principle of absolute advantage. Yet, the fixed effects results of Alshubiri et al. (2020) found the contradicting result in the Gulf Cooperation Council (GCC) countries' marine sector during 1985–2016. The international trade agreements regarding fisheries as an initiative of trade openness has strengthened the GCC marine production and encouraged the exports of high-quality fish.

Ghani (2009) adopted the Random Effect, Least Square Dummy Variable (LSDV), Ordinary Least Squares (OLS) and the System Generalized Method of Moments (GMM) to investigate the effect of trade liberalization on the merchandise trade balance in selected developing countries. Their findings were different from the other studies. The trade liberalization resulted in improving their trade balance with industrial countries, but weakly worsened their trade balance with other developing countries. It also revealed that the deteriorating trade balance after liberalization was caused by their trade deficit with developing countries.

Only limited studies emphasized the importance of optimal trade liberalization (or openness) (Bouzas & Keifman, 2003; Li, 1997). In particular, Li (1997) stated that optimal openness provides maximum welfare. The asymmetric trade liberalisation was highlighted in some recent studies (Barattieri, 2016) in affecting the current account, which also consisted of the trade balance. Bhat and Sharma (2018) also tested the nonlinear or asymmetric nexus between the current account and its determinants in India, including fiscal deficit, trade openness and output growth. According to the results on NARDL and nonlinear cumulative dynamic multipliers, trade openness was cointegrated with the current account; although the linkage was asymmetrical in the short-run, it was symmetrical in the long-run.

2.2. Exchange Rate and Trade Balance

The most widely accepted theory in explaining the effect of the exchange rate on the trade balance is the Marshall Lerner condition (Friedman, 1957; Ng et al., 2008). It explained that depreciation increases the trade balance in the long-run if the sum of import and export demand elasticities exceed one. However, the initial effects of depreciation might lead to a higher trade deficit. The falling export values and rising imports values will worsen the trade balance, but over time as the quantity of export increases, the trade balance improved (Bahmani-Oskooee, 1985; Ng et al., 2008). This phenomenon is called the J-curve effect (Bahmani-Oskooee, 1985).

Two commonly used indicators are: (1) the (real) exchange rate, which means the number of domestic currency per unit of foreign currency, and (2) REER that compares a nation's currency value against the weighted average of a basket of other major currencies. Unlike the former, the decrement of REER means depreciation and vice versa. The crucial role of the exchange rate was highlighted in Gong and Kinnucan (2015) in influencing the United States (U.S.) agricultural trade balance. The domestic currency devaluation is a key driver in enhancing the trade balance in the long-run. Most studies also showed the existence of Marshall Lerner condition, such as in West African Economic and Monetary Union countries (Ousseini et al., 2017), Pakistan (Hassan et al., 2017; Khan et al., 2017; Waliullah et al., 2010), Laos (Kyophilavong et al., 2018), Thailand (Anh & Duc, 2016). In testing the relationship, Hassan et al. (2017) and Khan et al. (2017) employed ARDL based on annual data over the period 1972-2013 and 1982-2013 respectively, whereas Ousseini et al. (2017) adopted a Panel Vector Auto-Regression (VAR) technique for the data during 1980-2013. Besides foreign countries, Soleymani and Chua (2014) also showed Marshall Lerner condition existed in Malaysian bilateral trade balance with China using data from 52 industries over the period 1993Q1 to 2012Q4. Besides, by applying VECM and impulse response analyses, Ng et al. (2008) also had the same findings.

In contrast, depreciation of the exchange rate had a significant negative effect on the bilateral trade balance for Vietnam with its sixteen trading partners over the period 1999-2012 (Phan & Jeong, 2015). The same findings were also found in the Malaysian fishery sector (Soh & Lim, 2020), Pakistan (Ahad, 2017; Asif, 2014; Chaudhary & Amin, 2012) and India (Asif, 2014). According to Waliullah et al. (2010), depreciation of the exchange rate was positively related to the Pakistan trade balance in the short-run. The findings were similar to Guechari (2012). Interestingly, Chiu and Ren (2019) evinced the unfavourable (favourable) impact of Renminbi depreciation on China's bilateral trade balance with its high- (low-) income trading partners.

The J-curve hypothesis was applied widely in numerous studies in testing the nonlinear effects of exchange rate on trade balance. In particular, Bahmani-Oskooee and Fariditavana (2015) confirmed the existence of J-curve in more cases such as Canada, China, Japan, and the U.S. by implementing the NARDL approach. By using the same method, Bahmani-Oskooee and Kanitpong (2017) also found evidence of short-run and long-run asymmetric effects of exchange rate changes on the trade balance from most Asian countries, yet, Sivrikaya and Ongan (2019) came out with the short-run only. On the other hand, some earlier studies (Ng et al., 2008; Rose & Yellen, 1989) refuted the J-curve effect in Malaysia and the U.S., respectively.

Despite that, Har et al. (2014) as well as Sharif and Ali (2016), which employed the maximum likelihood GARCH model and OLS method respectively, even stated that exchange rate had no impact on trade balance. As proof, exchange rates are exogenous to the trade in commodities, even for fish meal in Peru (Tveterås & Asche, 2008).

2.3. Domestic Income and Trade Balance

According to Keynesian theory, domestic income is one of the determinants of the trade balance (Frenkel et al., 1980; Keynes, 1936). When the domestic income escalates, it boosts the nation import and lastly decreases its trade balance. For instance, this negative relationship was agreed on by some studies. This was due to an increment in domestic income and trade balance deteriorated in both the short-run and long-run (Guechari, 2012). Phan and Jeong (2015) revealed that Vietnam (domestic) income harmed its trade balance. Khan et al. (2017) also had the same findings by using Pakistan (domestic) income with the endogenous growth and the standard partial equilibrium trade theories.

Yet, Ng et al. (2008) came out with the opposite outcome, which concluded that domestic income has a long-run positive effect on trade balances. Some studies (Chaudhary & Amin, 2012; Ousseini et al., 2017; Tufail et al., 2014; Waliullah et al., 2010) also concluded that if any country experienced an increase in economic growth or domestic income, the trade balance improved. Hassan et al. (2017) affirmed that the rising economic growth caused the trade deficit to shrink significantly due to the increment in export in Pakistan, India and Bangladesh. The relationship is explained based on the theory of absorption approach (Alexander, 1952) to balance of trade, which describes how domestic spending on domestic goods changes relative to domestic output. When a country's output of goods and services expands by more than its absorption, the country's trade balance will improve. In a more recent study, Bardakas (2013) discovered the asymmetry of income changes influenced the import demand, which might widen the trade deficit, through the Johansen procedure and the general-to-specific method.

The above studies showed a mixed outcome on the effects of the macroeconomics variables on trade balance. The different techniques, the selection of variables, and the sample periods might influence the outcomes of studies. Since the Malaysian fish trade deficit is a contemporary problem, the lack of prior research studies on the fishery sectoral trade balance has motivated this research. It can act as an opportunity to introduce new findings and identify new gaps. This study contributes to filling these gaps in terms of asymmetric effects of trade openness in the fishery sector of an emerging economy (i.e. Malaysia) that have not been discovered by other studies.

3. METHODOLOGY AND DATA

3.1. Model

The basic model in this study closely follows Bahmani-Oskooee and Kanitpong (2017), Soh and Lim (2020), Duasa (2007), Ng et al. (2008) and Rose and Yellen (1989), with some modifications by employing trade openness (Sastre, 2005). It can be written as follows:

$$lnFTB_t = a + b\ lnEXCH_t + c\ lnDY_t + d\ lnOPEN_t + \varepsilon_t \tag{1}$$

where $lnFTB_t$ is the Malaysian fish trade balance, $lnEXCH_t$ is the exchange rate, $lnDY_t$ is the domestic income, $lnOPEN_t$ is trade openness and ε_t represents the error term. The coefficients for $lnEXCH_t$, $lnDY_t$ and $lnOPEN_t$ are *b, c* and *d* respectively. Please note that the EXCH

(RM/USD) is a more appropriate measure of the exchange rate than REER in this study, hence the REER index will be practised for robustness checking.

The coefficient *b* is expected to be positive since increases in the exchange rate (or depreciation) should expand fish exports and at the same time reduce fish imports. However, coefficients *c* and *d* are expected to be negative. The rising domestic income should encourage Malaysia to import more fish from other countries. Similarly, a higher trade openness (or free trade) should induce more import to fulfil Malaysian higher demand for fish, where a negative sign in a positive change of trade openness (higher openness) and/or its negative change (less openness). As Malaysia is facing the fish trade deficit phenomenon, depreciation of the exchange rate as well as lower domestic income and trade openness are expected to enhance the fish trade balance.

The lag structure is required to be imposed on the trade openness variable in order to test its asymmetry effects. To capture the short-run effect, the task is now reduced to converting (1) into an ARDL model such as the one outlined by specification (2) below. Following Shin et al. (2014), an error-correction term (ECT) is applied to estimate the linear relationship:

$$\Delta lnFTB_t = \alpha + \sum_{k=1}^{n1} \beta_k lnFTB_{t-k} + \sum_{k=0}^{n2} \delta_k \Delta\, lnEXCH_{t-k} + \sum_{k=0}^{n3} \phi_k \Delta lnDY_{t-k} + \sum_{k=0}^{n4} \gamma_k \Delta\, lnOPEN_{t-k} + \lambda_0 lnFTB_{t-1} + \lambda_1\, lnEXCH_{t-1} + \lambda_2 lnDY_{t-1} + \lambda_3\, lnOPEN_{t-1} + \mu_t + ECT_t \quad (2)$$

Models (2) are the ARDL model. 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 $\lambda_1 - \lambda_3$ normalized on λ_0. The short-run effects of each variable are deduced by the coefficients' estimate attached to first-differenced variable. For instance, short-run effects of the trade openness are judged by the estimates of $\gamma_k's$.

The next step in the modelling is to modify the specification in the model (2), in order to capture the asymmetry component of trade openness. It divides the $lnOPEN$ variable into two components where one will measure only highly open to trade and the other one only low openness. To this end, the changes in the variable are first formed as $\Delta lnOPEN$, which consist of positive changes reflecting high openness and negative changes reflecting low openness. Using these changes, the two new variables are established as the partial sum of positive changes denoted by POS and the partial sum of negative changes as NEG. More specifically the two variables are defined as:

$$POS_t = \sum_{j=1}^{t} \Delta\, lnOPEN_j^{+} = \sum_{j=1}^{t} \max\left(\Delta\, lnOPEN_j, 0\right);$$
$$NEG_t = \sum_{j=1}^{t} \Delta\, lnOPEN_j^{-} = \sum_{j=1}^{t} \min\,(\Delta\, lnOPEN_j, 0) \quad (3)$$

Next, replacing $lnOPEN$ variable by POS and NEG variables in the model (2) to become the following new specification (for estimating the asymmetric long-run and short-run relationship):

$$\Delta lnFTB_t = \alpha' + \sum_{k=1}^{n1} b'_k lnFTB_{t-k} + \sum_{k=0}^{n2} c'_k \Delta\, lnEXCH_{t-k} + \sum_{k=0}^{n3} d'_k \Delta lnDY_{t-k} + \sum_{k=0}^{n4} e'_k \Delta\, POS_{t-k} + \sum_{k=0}^{n5} f'_k \Delta\, NEG_{t-k} + \theta_0 lnFTB_{t-1} + \theta_1\, lnEXCH_{t-1} + \theta_2 lnDY_{t-1} + \theta_3\, POS_{t-1} + \theta_4\, NEG_{t-1} + \epsilon_t + ECT_t \quad (4)$$

The model (4), the NARDL is advanced by Shin et al. (2014) and is also considered to be an asymmetric extension of linear ARDL modelling (Pesaran et al., 2001). Nonlinearity in the specification in model (4) is introduced by the construction of POS and NEG variables.

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.

Several asymmetry hypotheses could be evaluated after estimating the ECT. First, there will be short-run adjustment asymmetry if ΔPOS and ΔNEG variables exhibit different lag orders. Second, there will be a short-run asymmetric effect if size or sign of e'_k is different than those of f'_k for each k value. Third, there will be a short-run cumulative or impact asymmetry if $\sum e'_k \neq \sum f'_k$. Lastly, there will be a long-run asymmetric effect of trade openness if the normalized long-run coefficient of POS is different than the one obtained for the NEG variable, that is, if $-\frac{\theta_3}{\theta_0} \neq -\frac{\theta_4}{\theta_0}$. While the former two asymmetries will be judged by visual inspection of the results, the latter two will be established through the Wald test.

3.2. Data

Annual data for the variables throughout 1976-2016 are collected from several sources. The fish trade balance is the log of the ratio of fish export to fish import (*FX/FM*); trade openness is the log of the sum of exports and imports of goods and services measured as a share of GDP; domestic income is the log of Malaysian GDP per capita (constant 2010 US$); the exchange rate is the log of Malaysian Ringgit to one U.S. Dollar (Not Seasonally Adjusted). The data for fish export and fish import is from the Food and Agriculture Organization Fishery Statistics database (FishStat, 2019), trade openness and domestic income from World Bank's official website (World Bank, 2019b, 2019a) while exchange rates are from Federal Reserve Economic Data (FRED, 2019).

Table 2 displays the descriptive statistics of the variables. The distributions of $FTB, OPEN, DY$ and $EXCH$ are almost symmetrical because their values of mean and median are indeed close, also implying very low variabilities.

Table 2: Descriptive Statistics

	FTB	$OPEN$	DY	$EXCH$
Mean	1.166	152.860	6277.624	3.005
Median	1.051	150.612	6360.656	2.750
Maximum	2.769	220.407	11219.63	4.137
Minimum	0.652	92.876	2718.844	2.177
Std. Dev.	0.468	40.060	2518.248	0.608

4. RESULTS AND DISCUSSION

The NARDL approach to cointegration is applicable when all the variables are between the order of zero and one (i.e., I(0) to I(1)). Therefore unit root tests are required to make sure that the variables are not I(2). The results of Augmented Dickey-Fuller (ADF) and Phillip and Perron (PP) are displayed in Tables 3 and 4. It reveals that all the variables are integrated of order one in levels, I(1) at the 1% significance level.

Table 3: Unit Root Test Results (Constant Without Trend)

Variables	Level		First Difference	
	ADF Test statistics	**PP Test statistics**	**ADF Test statistics**	**PP Test statistics**
$ln\,FTB$	-2.7945* (0.0681)	-2.7850* (0.0694)	-8.0406*** (0)	-7.8459*** (0)
$ln\,OPEN$	-1.7986 (0.3757)	-1.6403 (0.4531)	-3.7271*** (0.0074)	-3.7490*** (0.0070)
$ln\,DY$	-0.9795 (0.7514)	-0.9501 (0.7615)	-5.2287*** (0.0001)	-5.2287*** (0.0001)
$ln\,EXCH$	-0.6092 (0.8572)	-0.6092 (0.8572)	-4.8162*** (0.0004)	-4.7430*** (0.0004)

Notes: ***, ** and * indicate significant at the 1%, 5% and 10%, respectively. Parentheses are the p-values.

Table 4: Unit Root Test Results (Constant With Trend)

Variables	Level		First Difference	
	ADF Test statistics	**PP Test statistics**	**ADF Test statistics**	**PP Test statistics**
$ln\,FTB$	-3.0739 (0.1263)	-3.1343 (0.1125)	-7.9674*** (0)	-7.7872*** (0)
$ln\,OPEN$	0.4047 (0.9986)	0.2135 (0.9973)	-4.5474*** (0.0043)	-4.3390*** (0.0072)
$ln\,DY$	-1.9152 (0.6280)	-2.1017 (0.5292)	-5.2040*** (0.0007)	-5.2040*** (0.0007)
$ln\,EXCH$	-2.1099 (0.5248)	-2.3220 (0.4130)	-4.7873*** (0.0022)	-4.7218*** (0.0026)

Notes: ***, ** and * indicate significant at the 1%, 5% and 10%, respectively. Parentheses are the p-values.

Table 5 shows the results of the cointegration test based on the NARDL bounds testing approach, with the calculated value of the F-statistic (8.9032) being greater than the upper critical values at the 1% significance level. It also means that the null hypothesis of no cointegration is rejected. It confirms the long-run relationship among the variables.

Table 5: Bounds Test for Cointegration

Dependent Variable	F-statistic	
$lnFTB$	8.9032***	
Critical Value	**Lower Bound**	**Upper Bound**
1%	3.29	4.37
5%	2.56	3.49
10%	2.20	3.09

Notes: ***, ** and * indicate significant at the 1%, 5% and 10%, respectively.

The summary of the long-run coefficients based on NARDL is presented in Table 6. Since NARDL is sensitive to lags, NARDL (2,4,0,2,4) specification with long-run asymmetry is chosen in this study. The positive asymmetric changes of trade openness carry significantly a 6.7736 coefficient, at the 5% significance level. The estimated sign of the POS variable is expected as in the theory of comparative advantage where Malaysia gains from trade since openness increases the availability of (lower-priced) fish. Malaysia has not fully opened to trade until 1980 (Global Economy, 2019). When Malaysia has heightened its trade openness by implementing both import-substitution and export-orientation policies since the 1960s, positive change in trade openness worsens its fish trade balance since there are fewer restrictions on fish imports from any country, the import-substitution diverts resources away from the production of exportable (e.g. fish) and the local import-substitution (e.g. infant) industry had impeded the development of export industry (Department of Fisheries Malaysia, 2020; Global Economy, 2019; Okamoto, 1994). Bahmani-Oskooee & Fariditavana (2015) come out with the new definition of asymmetry effects, which is based on the significance of at least positive or negative change of a variable. On the other hand, the insignificant NEG variable (i.e. negative change in trade openness) on the trade balance could be explained by an overall gradual decrement in the trade openness that remains above 100% since 2000 (Global Economy, 2019), implicating that the export channel of Malaysia has been well developed and diversified. Regardless of the nonlinear manner, 1% of positive change of trade openness deteriorates the trade balance by 6.77%. This finding is supported by Soh and Lim (2020), Chaudhary and Amin (2012) and Tufail et al. (2014). Domestic income carries a positive sign and significant estimate at the 5% level. A 1% increase in domestic income leads to a 6.13% enhancement in the trade balance. The findings are also consistent with Hassan et al. (2017), Ng et al. (2008) and Waliullah et al. (2010), which claim that domestic income or economic growth enhances the trade balance. The expanding economy might be due to an increment in the production of substitute goods (Sivrikaya & Ongan, 2019), such as farmed milkfish at Kedah, resulting in less fish import. Then, the significant and expected sign of exchange rate, implies that 1% of depreciation leads to the improvement of the trade balance by 4.58%. This matches the Marshall Lerner condition, which is similar to the studies of Waliullah et al. (2010) and Ng et al. (2008). Ringgit depreciation makes the Malaysian exported goods (e.g. fisheries) relatively cheaper and more competitive, therefore stimulating the exports.

Table 6: NARDL Long-run Estimates

Variable	Coefficient	Std. Error	T-statistic	Prob.
$ln\,OPEN\_POS$	-6.7736	2.5520	-2.6542	0.0157**
$ln\,OPEN\_NEG$	1.9263	1.1927	1.6150	0.1228
$ln\,DY$	6.1302	2.7331	2.2430	0.0370**
$ln\,EXCH$	4.5755	1.5644	2.9248	0.0087***
Constant	-52.7558	23.0820	-2.2856	0.0339**

Notes: ***, ** and * indicate significant at the 1%, 5% and 10%, respectively.

Table 7 represents the NARDL short-run estimates. Since every variable carries at least one significant coefficient, all variables seem to exhibit short-run effects. The different lag orders of $\Delta lnOPEN\_POS$ and $\Delta lnOPEN\_NEG$ variables confirm the short-run 'adjustment asymmetry'. These findings are identical to the study carried out by Bahmani-Oskooee and Kanitpong (2017). Since a country's exports originate at home (whereas its imports originate in other countries) in general terms as well as different countries are subject to different rules and regulations, imports and exports will be adjusted differently to low trade openness as compared to high trade openness, defining the term 'adjustment asymmetry'. Likewise, traders are likely to have different expectations in the openness policies and may not adjust their trading patterns by the same proportion. Additionally, as the size and sign of most coefficients carried by $\Delta lnOPEN\_NEG$ variable are dissimilar to those carried by $\Delta lnOPEN\_POS$ variable, it also proves the short-run asymmetric effects.

All variables have opposite outcomes in the short-run, compared to the case in the long-run. In addition, all lagged determinants do influence the trade balance. It is a common observation that numerous interdependent production sectors (e.g. fisheries) of Malaysia have connected through a logistics system that includes ocean freight with time lags. Plus, due to the rapid expansion in international trade volume, it takes longer times (months) to process exports and imports after traders negotiate and fix the contract of sale (Federal Agricultural Marketing Authority, 2021; Gani, 2017). As proof, the signs of first until third lagged positive components of trade openness are positive and statistically significant at the 5% and 1% levels, respectively. Malaysia raises its openness to trade through more mass orders of agricultural products (e.g. fish) from other countries, especially China, Singapore, Korea and Japan in which they account for around 65.6% of the total Malaysian fish export in 2019 (International Trade Centre, 2019). When first lagged domestic income grows by 1%, the trade balance will contract by 4.33%, at the 1% significance level. This finding is in line with Ng et al. (2008) and satisfies the Keynesian theory on the trade balance. As the real income and purchasing power rise, consumers in Malaysia exert a higher willingness to pay for imported (and high-quality) food fish (Asche et al., 2015), namely salmon. Not only this, the first to third lagged depreciation of exchange rate exhibit a negative effect on the trade balance, at the 1% significance level. The negative relationship is aligned with Ahad (2017). The Malaysian preference for imported fish such as crustaceans- prawns and shrimps (although it is expensive due to Ringgit depreciation), especially during the festive season, boosts the import values, eventually weakens fish trade balance (Soh & Lim, 2020; Soh et al., 2021). The different effects of depreciation on the trade balance in both the short-run and long-run also validate the J-curve effect.

Table 7: NARDL Short-run Estimates

Variable	Coefficient	Std. Error	T-statistic	Prob.
Constant	-0.0092	0.0509	-0.1803	0.8586
$\Delta lnFTB_{t-1}$	-0.3343	0.1006	-3.3226	0.0031***
$\Delta lnOPEN\_POS_t$	0.5034	0.7130	0.7060	0.4876
$\Delta lnOPEN\_POS_{t-1}$	4.5474	0.9292	4.8939	0.0001***
$\Delta lnOPEN\_POS_{t-2}$	1.4962	0.7149	2.0930	0.0481**
$\Delta lnOPEN\_POS_{t-3}$	2.5114	0.6365	3.9460	0.0007***
$\Delta lnOPEN\_NEG_t$	0.8033	1.0557	0.7609	0.4548
$\Delta lnDY_t$	0.4312	0.7523	0.5731	0.5724
$\Delta lnDY_{t-1}$	-4.3325	0.9174	-4.7227	0.0001***
$\Delta lnEXCH_t$	0.3074	0.3948	0.7786	0.4445
$\Delta lnEXCH_{t-1}$	-3.7977	0.5566	-6.8226	0.0000***

Variable	Coefficient	Std. Error	T-statistic	Prob.
$\Delta lnEXCH_{t-2}$	-1.2690	0.3563	-3.5616	0.0017***
$\Delta lnEXCH_{t-3}$	-1.3977	0.3558	-3.9285	0.0007***
ECT_{t-1}	-0.5490	0.0696	-7.8904	0.0000***

Notes: ***, ** and * indicate significant at the 1%, 5% and 10%, respectively.

The results from Table 8 indicate the long-run and short-run asymmetric effects of trade openness at the 5% and 1% significance levels, respectively. The NARDL model does not reject the long-run asymmetry and short-run cumulative or impact asymmetry. The outcome supports the negative long-run but positive short-run effects of trade openness. The finding is similar to Bhat and Sharma (2018), which concluded the nonlinear effects of trade openness.

Table 8: The Results of Long-run and Short-run Asymmetric Effect of Trade Openness in Wald Tests

Wald Tests				
Test Statistics	**Chi-Square**	**Test stat.**	**F Version**	**F-stat.**
Long-run	*CHSQ(1)*	5.2715** (0.0217)	F(1,18)	5.2715** (0.0339)
Short-run	*CHSQ(1)*	18.5980*** (0)	F(1,22)	18.5980*** (0.0003)

Notes: ***, ** and * indicate significant at the 1%, 5% and 10%, respectively. Parentheses are the p-values.

Table 9 displays the results of some diagnostic tests. After constructing ECT_{t-1} (Table 7), it has a negative value, which is less than one in absolute terms and is significant at the 1% level. Hence, the long-run estimates are valid, with the support of the bound test in Table 5. The coefficient of ECT_{t-1} also implies the speed at which the disequilibrium will be corrected in the system annually, which is 54.90%. Moreover, the residuals of the NARDL model are free from autocorrelation and heteroskedasticity, and the optimum model is correctly specified. Both the LM version and F-version test probabilities are insignificant for all tests, at the 1% significance level. Thus, it fails to reject all the null hypotheses of no misspecification, no autocorrelation and no heteroscedasticity, respectively.

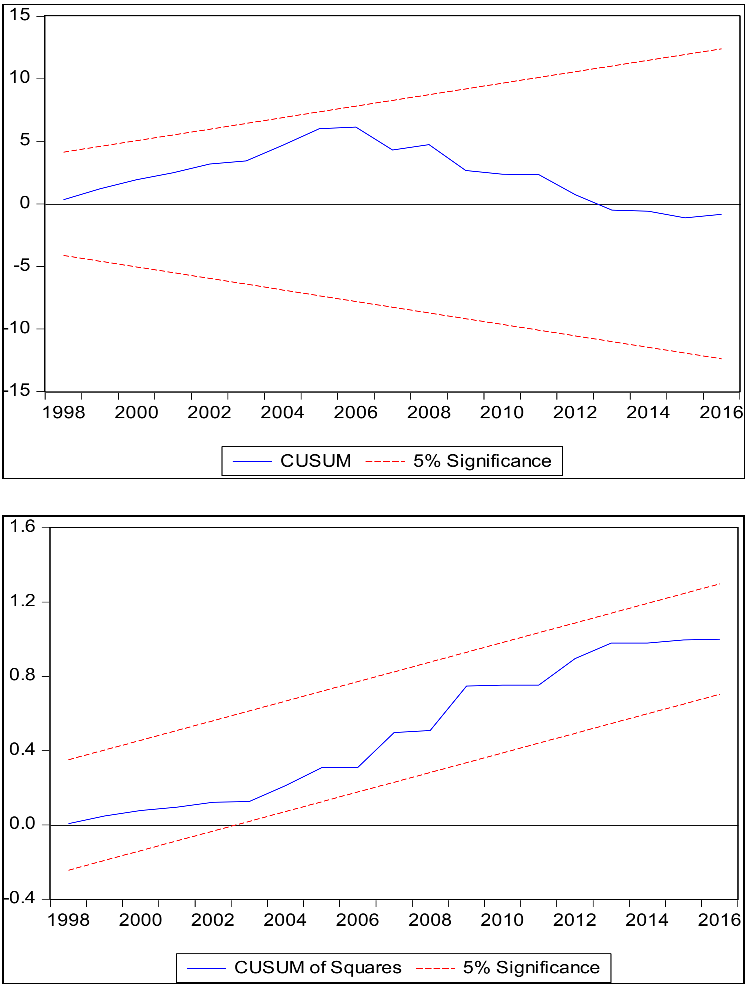
Table 9: Diagnostic Tests Results

Test Statistics	LM Version	Test stat.	F Version	F-stat.
Misspecification	NA	NA	*F(1,18)*	1.0154 (0.3270)
Serial Correlation	*CHSQ(2)*	3.7150 (0.1561)	*F(2,17)*	0.9781 (0.3962)
	CHSQ(4)	5.7901 (0.2154)	*F(4,15)*	0.7187 (0.5923)
Heteroskedasticity	*CHSQ(16)*	20.8178 (0.1856)	*F(16,19)*	1.6283 (0.1545)

Notes: ***, ** and * indicate significant at the 1%, 5% and 10%, respectively. Ramsey RESET tests for misspecification; Breusch-Godfrey serial correlation LM test; and Breusch-Pagan-Godfrey for heteroskedasticity test. Parentheses are the p-values.

Lastly, the CUSUM and CUSUMSQ tests are employed to determine the stability of all coefficient estimates. Figure 1 reports that the model is stable since the plots of both tests have lied within their critical bounds at the 5% significance level, with the outcome for each case by 'S' shape.

Figure 1: Plot of Cumulative Sum (CUSUM) and Cumulative Sum of Square (CUSUMSQ) of Recursive Residuals



4.1 Robustness Check

The long-run estimated NARDL model with the selection of REER is provided in Table 10. REER has been employed as a proxy for the exchange rate in many studies. The REER has an expected negative sign, which is opposite to the expected negative sign of EXCH. REER also does not observe the Marshall Lerner condition, just like EXCH in this study. Overall, the signs of the variables in Table 10 are in line with those in the main estimation (Table 6). Contrarily, the estimated coefficients of all variables in Table 10 are insignificant. This scenario increases the confidence in the main estimation.

Table 10: NARDL Long-run Estimates With REER

Variable	Coefficient	Std. Error	T-statistic	Prob.
$ln\, OPEN\_POS$	-0.4793	1.2568	-0.3814	0.7058
$ln\, OPEN\_NEG$	0.0874	0.8744	0.1000	0.9211
$ln\, DY$	-0.0003	1.3075	-0.0002	0.9998
$ln\, REER$	-0.1987	1.2151	-0.1635	0.8713
Constant	1.3695	9.6134	0.1425	0.8877

Notes: ***, ** and * indicate significant at the 1%, 5% and 10%, respectively.

5. CONCLUSION

In summary, the empirical findings demonstrate that the Malaysian fish trade balance is significantly affected by trade openness, followed by domestic income and exchange rate, in both the short-run and long-run. Domestic income and depreciation of exchange rate offer a negative effect on the trade balance in the short-run but have a positive effect in the long-run. Regarding trade openness, it yields the short-run and long-run asymmetric effects on the trade balance. These outcomes succeed to challenge the concept of comparative advantage (i.e. a linear nexus between trade openness and trade balance) by evincing a nonlinear linkage between them in the fishery sector that has not been mentioned by other studies.

In the short-run, the lagged depreciation of the exchange rate variable deteriorates the trade balance. However, depreciation of the exchange rate improves the trade balance in the long-run because the consumers can eventually adjust themselves to the new prices, thereby obeying the Marshall Lerner condition. It was also theoretically proven that both short- and long- runs satisfy the J-curve effect where depreciation might cause a higher trade deficit due to the increasing import values and decreasing export values at the early stage.

A few policy implications can be drawn from the findings. Firstly, the Malaysian Government should constantly revisit the trade policy with sustainable execution for having an optimal level of trade openness in order to ameliorate the trade balance. Secondly, the fish trade balance is highly dependent on domestic income or economic growth. Accordingly, the development of the fishery sector with consistent monitory is proposed to enhance the domestic fish production growth, fish export promotion, restrict imported fisheries products and fish import substitution. Lastly, the implementation of both depreciation and growth-driven policies could undoubtedly strengthen the trade balance in the long-run while for the short term, the appreciation policies enable local fish exporters in the developing sector to benefit from lower production costs (especially fish feed that contains imported corn protein extract and other important raw materials) thus higher fish production and export. It is indeed important to consistently maintain an appropriate exchange rate policy to ensure the stability of the existing market both in the short-run and long-run.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the funding from the Universiti Sains Malaysia short term grant (304/PSOSIAL/6313244).

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