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Determinants of Seafood Trade in Sri Lanka

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ABSTRACT

This paper examines the determinants of the seafood trade and their nature of relationship in Sri Lankan context. The analysis was done using a comprehensive panel data set covering 107 importing countries for time period 2001-2017. The economic sizes of the importer and Sri Lanka have a positive influence on seafood export values while the physical distance, tariff rate, non-tariff measures, and population of importer have a negative impact. There was no long-run association among those variables but seafood exports have shown a short-run causality with GDP of importing countries, tariff and non-tariff measures.

Keywords: *Causality, Gravity model, Seafood, Trade, Zero-inflated Negative binomial model*

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Introduction

Being an island nation fisheries sector plays a massive role in the socioeconomic development of Sri Lanka. It provides livelihood for around 2.7 million people in the country in direct and indirect way. Importantly fisheries satisfy the 60% of animal protein necessity of the individuals of Sri Lanka (NARA, 2018). Fisheries sector has recorded 1.3% contributions to the country's GDP in 2017 (MFARD, 2017). Sri Lanka is well known as a high-quality tuna exporter in the global seafood market. But the contribution of the fish and fishery products exports to the total merchandize exports of the country was just 2.2% in 2017 (Sandaruwan and Weerasooriya, 2019).

By possessing an Exclusive Economic Zone (EEZ) of eight times of its total terrestrial area and 1,700 Km long coastal belt, Sri Lanka has a huge potential to expand its fish exports. The United Nations (2018) has specified the importance of the blue economy concept as one of the best approaches to achieve sustainable development goals of Sri Lanka. Keesing and Irvine (2005) has emphasized the potential of Sri Lanka's to grow its fisheries sector and supply the world seafood market with differentiated seafood products. De Melo and Shepherd, 2018 has stated that in order to augment the export-oriented fisheries industry in Sri Lanka it should have a sound understanding regarding the economic effects of various trade regulations, and plan to reduce unintentional economic costs, and other market forces if any.

Then, need of an appropriate trade analysis arises and it is believed to be supported by the economic and econometric concepts. The gravity model is known as the typical and successful approach for analyzing bilateral trade which has been formulated using the Newton's equation of gravity. Gravity model of trade is popular as the best tool to explain the trade flows using importer and exporter characteristics jointly with the variables which might support or limit the trade (Nankwenya, 2018).

The use of the gravity model in trade has a wide array of purposes. One of the most important applications is that identification of the determinants of trade flows between partner countries in different export-oriented industries. Nguyen (2010) has implemented a gravity model analysis to find the determinants of export flows of Vietnam and has found that export growth is positively correlated with importer's income growth and negatively link to the distance between trading partners. Ali and Sami, 2011 has examined the determinants of Tunisia's exports and revealed that the economic conditions, export openness and foreign direct investment show a positive impact on Tunisia's exports while distance has a negative effect. Elshehawy et al. (2014) have investigated the factors influence to Egypt's exports. They have found that the GDPs of trading partners, population, regional trade agreements, and the common border have a positive correlation and distance has a negatively link to the export. Nankwenya et al. (2018) have attempted to disclose the fish trade determinants of Africa. They have found that the economic conditions of partner countries, populations, common border and exporter's fish production are positively linked to the exports whereas the fish production of importer and distance between partners are acted as barriers for fish trade of Africa.

The gravity model is being analyzed using different statistical techniques including Ordinary Least Square method (OLS) (Pass and Tafenau, 2005; Baier and Bergstrand, 2006; Elshehawy, 2014), Poisson Pseudo Maximum Likelihood estimator (PPML) (Silva and Tenreyro, 2006), Tobit model (Soloaga and Winters, 2001; Rose, 2004; Kareem, 2013) and modified Poison methods such as negative binomial (NB), zero-inflated Poison (ZIP) and zero-inflated negative binomial (ZINB) (Burger et.al., 2009) model. The choice of the best model depends on the nature of the data profile and error structure of the model (Kareem et al. 2016). Linders and De Groot (2006) suggested that the estimation technique of gravity model should be precise with economic and econometric concepts.

Majority of literature have used gravity approach or general equilibrium approach to assess the elasticity of each variable which are determined the exports of a particular product, but very few of them have extended the analysis to understand the nature of the relationship. The specific relationships between exports and its determinants have a major policy concern for government planners and policy makers (Alaoui, 2015).The literature provides conflicting views on the nature of relationship between exports and its different related factors. Ajmi et al. (2013) have found that there was no significant causal link between the export and economic growth of South Africa while Liu et al. (2002) stated that there was a causal link between the same variables in Chinese scenario. Jung and Marshall (1985) have found that a unidirectional causality happen from export to economic growth of Indonesia, Egypt, Ecuador, and Costa Rica. To this end, it is very fascinating to know the specific relationships and direction of causality between the seafood export and its determinants as well.

In the Sri Lankan context there is very little or none of the studies have been carried to assess seafood trades determinants of Sri Lanka. World seafood market is very competitive (FAO, 2018) and many internal and external forces drive the performance of individual countries at this competition. Therefore, it is essential to identify the factors influencing the trade and their impact on trade performances. During last decade, Sri Lankan seafood export was experiencing sudden shocks; for instance, loss of GSP+ tariff concession in 2009 and fish ban imposed by European Union (EU) on Sri Lanka's seafood exports during 2015-2016. After the EU ban period many technical barriers for trade (TBT) including issuing of catch certificates, labelling standards and pre-shipment inspections and sanitary and phytosaniatry (SPS) barriers were enforced and strengthen. Row products are more regulated by imposing NTMs than processed seafood to maintain the food safety. These occurrences also have emphasized and alarmed the importance of studying the influential factors for fish trade, their magnitudes and directions of its significance. It will support to exploit the benefits attached to fish trade, to develop and manage the strategies, to mitigate the potential risks and putting up remedies before something adverse happened.

Therefore the significance of this study stems from the following elements. Firstly, the research tried to find the seafood trade determinants of Sri Lanka using the most appropriate statistical approach by adopting the gravity model of trade. Secondly, this paper investigates the nature of the relationship, i.e. the existence of the short-run and/or the long-run relationship, and the determination of causality direction between these variables which enable to implant suggestions for extracting real benefits from seafood trade to Sri Lankan economy.

Materials and Methods

Data Sources and Types of Data Gathered

Main commodity of this study was fish, exported under harmonized system code 03 (HS 03) and data were gathered up to 4 digit level. Types of data gathered and data sources were listed in Table 01. All data were collected annually from 2001 to 2017 and were arranged into panel data structure with 107 country cross sections and 17 time periods.

Table 01: Gathered data and data sources

Variable	Data source
seafood export values of Sri Lanka (Dependent variable)	United Nations Commodity Trade Statistics Database (COMTRADE)
GDP data of importing country and Sri Lanka	World Development Indicators (WDI)
Exchange rates	World Development Indicators (WDI)
Population data (Sri Lanka and importing countries)	World Development Indicators (WDI)
Bilateral distance between Colombo and the capital cities of importing countries	Institute for Research on the International Economy (CEPII)
Tariff rates	World Trade Organization (WTO) and World Integrated Trade Solutions (WITS)
Nontariff Measures (NTM)	Trade Analysis Information System (TRAINS)

Since there were zero values in tariff and NTM variables, these variables were modified as Tariff rate+1 and NTM+ 1 (Wilson and Otsuki 2004, Wei et al., 2012; Thuong, 2017). All the independent variables were converted in to natural logarithm as per the gravity model equation before carrying out further analysis. The Gravity model specification used in this study is as follows.

$$lnX_{ijt} = \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnDIS_{ij} + \beta_4 ln\left(1 + T_{ijt}\right) + \beta_5 \ln(1 + NTM_{ijt)} + \beta_6 \ln Pop_{ijt} + \varepsilon_{ijt}$$

where X_{ijt} is the fish export value to the ith importing country from jth exporting country (jth exporting country = Sri Lanka) at time t, GDP_{it} is the gross domestic product of ith importing country at time t, GDP_{jt} is the gross domestic product of Sri Lanka at time t, DIS_{ij} is the distance between the capital of the ith import country and capital of Sri Lanka, T_{ijt} is the tariff rate imposed by country i for fish products from Sri Lanka,NTM_{ijt} is the number of NTMs imposed by i^{it} country on the exported fish products from Sri Lanka and ε_{ijt} is the error term.

The stationary condition of all variables was checked using panel unit root test namely; Levin, Lin and Chu. (Levin *et al*., 2002). Variance Inflation Factor (VIF) (Wissmann et al., 2007; Vatcheva et al., 2016) was used to detect the multicollinearity and VIF value greater than 10 was considered as the sign of multicollinearity among at least two variables (Vatcheva et al, 2016). One variable from each highly correlated variable pair was removed from the study to avoid the multicollinearity issue. Prior to move on to estimation techniques the cointegration relationship between variables were assessed using Pedroni's Engle-Granger based panel cointegration test (Engle-Granger, 1987) which holds the null hypothesis of no cointegration and alternative of presence of cointegration. Pedroni has suggested a cointegration concept that permits for heterogeneous intercepts and trend coefficients across cross-sections as per Equation 01.

$$y_{i,t} = \alpha_i + \beta_{1i}x_{1i,t} + \beta_{2i}x_{2i,t} + \cdots + \beta_{Mi}x_{Mi,t} + \epsilon_{i,t} \quad (1)$$

Where, T is the number of observations over time, N represents the number of individuals in the panel and M is the number of independent variables. Moreover, $ß_{1i}$…$ß_{Mi}$ are the slope coefficients and α_i is the intercept.$\epsilon_{i,t}$ is the error term.

t= 1 ,…, *T*; *i*=1, …., *N*; *m*=1 ,…., *M*; Where, *y* and *x* are assumed to be integrated of order one.

After satisfying all the prerequisites PPML test was performed and likelihood ratio test for over dispersion (α) (Thuong, 2017) was done to check whether dependent variable is over dispersed. Negative binomial models have the capability of handling over-dispersion. ZINB is one of the modified versions of NB model which has been designed to handle both over-dispersion and zero inflation. The probability mass function of ZINB model is given by (Ridout et al.2001)

$$\Pr(Y_i = y_i | \mu_i,\ \omega_i, a| = \begin{Bmatrix} \omega_i + (1-\omega_i)(1+a\mu_i)^{-a^{-1}} & y_i = 0 \\ (1-\omega_i)\dfrac{\Gamma(y_i + a^{-1})}{y_i!\,\Gamma(a^{-1})}(1+a\mu_i)^{-a^{-1}}(1+a^{-1}\mu_i^{-1})^{-y_i}, & y_i > 0 \end{Bmatrix} \quad (2)$$

where ω is a zero-inflation parameter and *a* signifies the dispersion parameter

Variance (Equation 03) {Var (Yi)} shows that the ZINB exhibits over dispersion when a>0 and ω> 0 and also it implies that the model can be used for handling both zero-inflation and further over-dispersion in count data.

$$Var(Y_i) = E(Y_i)(1 + a\mu_i + \omega_i\mu_i) \quad (3)$$

As advocated by Burger et al., (2009), ZINB model was performed in this study and the Vuongtest (Vuong, 1989) was carried out to affirm the adequacy of ZINB model. The obtained elasticity values of explanatory variables, their significance and the signs were evaluated to identify the seafood trade determinants of Sri Lanka.

The short-run relationship between the seafood trade and its determinants was tested using Granger causality test. This test was performed to see the short-run causality with the null hypothesis (H_0) of the lagged values of coefficient in each equation is zero. If the P-value is less than 5%, then the null hypothesis was rejected. The simple Granger causality test involving two variables can be written as in Equation 4.1 and 4.2.

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \emptyset_i Y_{t-i} + \sum_{i=1}^{q} \delta_i X_{t-i} + \varepsilon_t \qquad (4.1)$$

$$X_t = \beta_0 + \sum_{i=1}^{p} \pi_i X_{t-i} + \sum_{i=1}^{q} \lambda_i Y_{t-i} + \mu_t \qquad (4.2)$$

Where; α_0 and β_0 are Constant terms, $\emptyset$, δ, π and $\lambda$are estimated coefficients of lagged variables in the bivariate regression form and *p* and *q* represent the optimal lag of the series *Y* and *X*.

Results and Discussion

Data Stationary

The Levin, Lin and Chu test results were presented in Table 02 (in Annex 01) and all the variables have shown probability values less than 0.05. The results revealed that all the natural log transformed independent variables are stationary at level.

Identification of the Multicollinearity

The multicollinearity in the data was detected by using VIF test and results are presented in Table 03 (Annex 02). Only the GDP and population of Sri Lanka showed the VIF values greater than 10. It is an evidence of multicollinearity between these two variables. The GDP of exporter is one of the most important trade determinants in gravity trade model. Therefore, the population of Sri Lanka was removed from the further analysis.

Panel Co-integration Test

This study examined the long run equilibrium relationships exist between variables. The Pedroni's Engle-Granger based panel co-integration test results have summarized in Table 04 (Annex 03). There are seven main test statistics has been proposed by Pedroni (1999) to determine the presence of the cointegration in panel data namely; panel v-statistic, panel rho-statistic, panel PP-statistic (nonparametric), panel ADF statistic (parametric), group rho-statistic, group PP statistic (nonparametric), and group ADF-statistic (parametric) (Abidin, 2016). The first statistics is a type of non-parametric variance ratio statistics. The second is a panel version of a non-parametric statistics which is similar to the Phillips Perron rho-statistics. The third statistics is also a kind of non-parametric test and it is comparable to the Phillips and Perron Statistics. The fourth statistics is equivalent to augmented Dickey-Fuller statistics. The other three statistics are based on a group mean approach. The panel data series is considered to be co-integrated if the majority of these tests become statistically significant. In this study only two statistics (Group PP-Statistics and Group ADF- Statistics) were statistically significant at 5% level. Therefore, there is no long run equilibrium found between variables.

Since there was no co-integration relationship among variables further analysis was done using panel regression techniques. The most popular PPML model was performed along with the test for over-dispersion. The value of likelihood ratio test for over-dispersion (α) was 990.98 and was statistically significant. This result was in favour of over-dispersion exists in seafood trade value series of Sri Lanka. Since the over-dispersion is present in trade series it violates the one of the main properties of Poisson distribution where the conditional mean expected to be equal to the variance. Therefore, ZINB model was performed and the results have been summarized in Table 05 (Annex 04). The Vuong test result was statistically significant which confirmed the adequacy of zero inflated models instead of non-zero inflated NB regressions. All the variables have shown statistically significant coefficient/ elasticity values.

The results of ZINB model indicated that 1% increase in GDP of importing country will increase the fish trade value of Sri Lanka by about 2.44%. Sri Lanka’s GDP also has a positive effect on fish trade value and it was around 1.11%. Geographical distance has a significant and negative effect on Sri Lanka’s fish exports and this leads to a 2.5% decrease in fish trade as expected by many trade analyses. Distance has been incorporated in the gravity model as a means to grab the cost associated with the trade. An argument is arising against the expectation of negative and significant elasticity value of distance on trade performance. Deregulation and technological improvement believe to have the capability to bridge the “distance cost” (Wu, 2015). But, in the Sri Lankan context distance is still a limiting factor for seafood trade.

Apart from GDPs and distance, tariff and NTMs are critical for the international trade because those are acting as a trade barrier (Sandaruwan and Weerasooriya, 2019). Fish is considered as a highly perishable commodity and therefore fish trade is highly regulated by non-tariff measures (Fugazza, 2017). The literature highlighted that the NTMs have become dominant as a trade barrier over tariffs with the time (Niu et al., 2018). NTMs have shown both positive and negative impacts on trades in different conditions, but for developing countries, it has a greater chance to generate a negative impact. For instance, compliance with regulatory requirement is costly and consume time and subsequently increase the trade cost which finally reduce the trade as the same as tariffs (UNCTAD, 2015). De Melo and Shepherd, 2018 also have stated that from the buyer’s perspective, products which have to be compliant for some NTMs leads to an increase in the unit value of the particular product and subsequently not affordable. In favour of above arguments this research has found that a 1% increase in tariff rate and NTM will lead to a decrease in the seafood trade of Sri Lanka by 6% and 0.2% respectively. Moreover, in Sri Lankan context tariff rates have more negative impacts more than the NTMs on the seafood trade.

The population of importing countries has shown a significantly negative impact on the fish trade performance of Sri Lanka. It indicates that a 1% increase of importing countries’ population will drop the Sri Lankan fish export value by 1.3%. It was rather contradictory with the expected sign, but the same results have been experienced by previous researchers as well (Giorgio, 2004; Rindayati and Kristriana, 2018). Giorgio (2004) has explained this phenomenon by stating that the population causes for decreased per capita income and consequently decrease the import. Further, Rindayati and Kristriana (2018) have interpreted that, this situation happens when an exporter trades their commodity as a raw material for manufacturing industries of an importer. Additionally, they stated that the substitution effects also have a negative move to the importation of a particular product irrespectively the increase in population.

Causal Relationship between Seafood Trade Determinants and Trade

The findings obtained from the causality test are shown in Table 06 (Annex 05). The results show that (i) a unidirectional causality run from the GDP of importing countries and NTMs to seafood trade, (ii) bi-directional causality between tariff rate and seafood trade and (iii) no-directional causality exists from the GDP of Sri Lanka and population of importing country to seafood trade. Since the distance between trading partners were constant over time, it has not been considered for the causality analysis.

Conclusions

The objective of this study was twofold. This paper investigates seafood trade determinants of Sri Lanka and then their nature of the relationship. The econometric approach utilized in this research was the gravity model of trade while the ZINB model was adopted as the estimation technique. The GDP and population of importing country, GDP of Sri Lanka, tariff and non-tariff measures imposed on seafood trades of Sri Lanka, the distance between Sri Lanka and the importer are significant in determining the seafood trades of Sri Lanka.

The economic sizes of the importer and Sri Lanka have a positive influence on seafood export while the physical distance, tariff rate, non-tariff measures, and population of importer having a negative impact. Several fascinating findings were observed in analyzing the nature of the relationship between the seafood trade and its determinants. Firstly, there was no cointegration found between the variables hence can be concluded that there is no long-run association among these variables. Second, bi-directional causality exists between tariff rates imposed on seafood trades of Sri Lanka and the seafood trade value in the short-run. It implies that a feedback effect is presence between the tariff and seafood trade. It reveals that not only tariff rates determine the seafood trade, but also there is a hidden feedback mechanism between tariff and seafood trade of Sri Lanka. Thirdly, there is no causality existed from the GDP of Sri Lanka and population of importing country to seafood exports while both variables have shown a significant elasticity values in estimated gravity model using ZINB model. Based on the results of this study following recommendations can be suggested. There is a demanding importance of advanced transport network and infrastructure facilities to minimize the transportation cost incurred in seafood trade to mitigate the negative impact of geographical distance. There is an alarming need of engaging in effective trade agreements with individual countries and regions to moderate the negative impacts of tariff on seafood trade. Seafood exporters should inline their process flows and related activities to be compliance with sanitary, phyto sanitary and other relevant technical barriers. Moreover, government and relevant agencies should pay attention in reducing the compliance cost associated with seafood companies.

Since some variables have significant elasticity values in estimated model, but did not show any specific relationship with seafood trade, a proper path analysis should be implemented to identify the possible time independent causes behind this phenomenon. Finally, all partner countries' tendencies to export and import must be taken into account adequately and satisfactorily when trade policy is set along with the results of trade analysis itself.

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Annexures

Annex 01:

Table 02: Unit root test results (at 95% confidence level)

Variable	Levin, Lin and Chu (p value)	Results
ln (Export)	0.000	All variables are stationary
ln (GDP Importer)	0.0008	
ln (GDP Sri Lanka)	0.000	
ln (Distance)	0.000	
ln (Tarrif+1)	0.000	
ln (NTM+1)	0.000	
ln (Population Sri Lanka)	0.0104	
ln (Population importer)	0.000	

Annex 02:

Table 03: Variance inflation factors of independent variables

Variable	VIF	1/VIF
ln (GDP Importer)	1.45	0.69
ln (GDP Sri Lanka)	25.75	0.038
ln (Distance)	1.1	0.91
ln (Tarrif+1)	1.12	0.89
ln (NTM+1)	1.45	0.69
ln (Population Sri Lanka)	25.69	0.039
ln (Population importer)	1.46	0.68

Annex 03.

Table 04: Pedroni's Engle-Granger based panel cointegration test results

Statistic	Test statistics	P value
Panel v-Statistic	-5.268222	1.0000
Panel rho-Statistic	3.214251	0.9993
Panel PP-Statistic	4.983383	1.0000
Panel ADF-Statistic	4.485669	1.0000
Group rho-Statistic	9.121350	1.0000
Group PP-Statistic	-3.751365	0.0001
Group ADF-Statistic	-1.966766	0.0246

Annex 04:

Table 05: Results of ZINB model

Variable	ZINB
$\ln(GDP)_{it}$	2.44*
	(0.11)
$\ln(GDP)_{jt}$	1.11*
	(0.211)
$\ln(DIS)_{ij}$	-2.47*
	(0.174)
$\ln(1+T_{it})$	-5.764*
	(1.000)
$\ln(1+NTM_{it})$	-0.19*
	(0 .041)
$\ln(Pop)_{it}$	-1.34*
	(0. .090)
Constant	-5.055*
	(0 .443)
Log-likelihood	-1139.568
AIC	2299.135
BIC	2352.133
Vuong test (z)	12.0*

(* Significant at 5%, Figures in brackets are standard errors of estimates)

Annex 05:

Table 06: Granger causality test results

Null hypothesis	F-statistics	Prob.
GDP of importer does not granger cause seafood trade value	0.59	6E-12
Seafood trade value does not granger cause GDP of importer	26.29	0.550
GDP of Sri Lanka does not granger cause seafood trade value	1.52	0.218
Seafood trade value does not granger cause GDP of Sri Lanka	1.04	0.353
Tariff rates imposed on Sri Lanka's seafood export does not granger cause seafood trade value	4.809	0.008
Seafood trade value does not granger cause tariff rates imposed on Sri Lanka's seafood export	2.99	0.041
Number of NTM imposed does not granger cause seafood trade value	1.15	0.029
Seafood trade value does not granger cause number of NTM imposed	3.57	0.317
Population of importer does not granger cause seafood trade value	0.48	0.621
Seafood trade value does not granger cause population of importer	1.7	0.182