https://doi.org/10.4038/tare.v26i3.5671

Tropical Agricultural Research & Extension 26 (3): 2023

RESEARCH ARTICLE

THE NEXUS BETWEEN COVID-19 AND FINFISH EXPORT FROM SRI LANKA TO ITS MAIN TRADING PARTNERS; THE UNITED STATES AND THE EUROPEAN UNION

De Silva DWLU[1]*, Bandara WAAM[1], Dilhani EVD[2] and Sadaruwan KPGL[1]

[1]National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka.
[2]Department of Economics, Faculty of Humanities and Social Sciences, University of Ruhuna, Matara, Sri Lanka.

Received: 31 July 2023, Accepted: 14 September 2023, Published: 30 September 2023

ABSTRACT

The Sri Lankan seafood sector has been seriously disturbed during the Covid 19 pandemic due to a bleak demand outlook as well as an array of supply challenges. Identification of the effects of this new challenge to the global fish trade is critical to take actions to sustain the market and manage resilience in such uncertain periods. Study aims to assess the impact of the Covid-19 outbreak on Sri Lanka's finfish exports to its key trading partners, the United States of America (USA) and the European Union (EU). The time series data were gathered from the United Nations commodity trade database between January 2017 and December 2022. Study used structural break point analysis of time series data, followed by time series regression with the Covid-19 impact as a dummy variable using EVIEWS statistical software. Compared to 2019, total finfish exports to the United States dropped by 56.5% in 2020 and 72.5% in 2021 while finfish exports to European market increased by 7% and 28% in 2020 and 2021, respectively. The Covid-19 dummy was statistically significant in the time series regression, with a coefficient value of -71.93 in USA trade flow which implies that Covid-19 has a negative impact on finfish trade to the USA. In contrast, statistically significant impact was not found in finfish trade to the EU during the pandemic and this mainly because European seafood market impacted due to Covid-19 yet imports from developing countries fell slightly and overall demand for seafood has remained largely stable throughout 2020. However, study suggested that future research should focus on the country-specific product sensitivity at the individual product level.

Keywords: Covid 19, Finfish, Fish trade, Sri Lanka, Structural change

INTRODUCTION

Global trade activities have faced unprecedented difficulties as a result of the COVID-19 pandemic outbreak. The World Trade Organization (WTO) reports that in 2020, a year in which the Covid-19 global pandemic emerged, global merchandise trade decreased by 5.3%. Due to a number of factors, such as a significant decrease in demand, price collapse, port closure, loss of access to cold storage, and increased freight costs, the supply of food has been seriously disrupted during this pandemic period (Hobbs 2020, Orlowski 2020).At the global level, Covid-19 responses are highly influential to Sri Lanka and other countries with small open economies that rely heavily on trade; the sum of the exports and imports (Wijayasiri 2019; Madhavika *et al*. 2022). Hence, Sri Lanka's export markets and products are highly concentrated, the country is extremely vulnerable to global market uncertainties and shocks (Roshana *et al*. 2020).

*Corresponding author: lasamiupsala@gmail.com

This situation was worsened by the fact that the country's major export destinations such as the European Union (EU), and the United States of America (USA) (Leal *et al*. 2016), as well as major import markets like India and China, among the countries that were severely hit by the Covid-19 outbreak. As a result of the Covid -19 pandemic, Sri Lanka has had to deal with supply chain distribution issues both in the short and medium term (Wijayasiri 2019). According to the Asian Development Bank, Sri Lanka's economic growth is 6.1% lower in 2020 which confirmed the direct impact of Covid-19 pandemic on the country's economy (Asian Development Bank 2021).

Fish and fishery products are receiving increased attention in global trade as they are among the most traded food commodities in the world (Valdimarsson 2007).The Covid-19 pandemic made the year 2020 extremely difficult for the fish industry (Zhang *et al*. 2021).According to the Food and Agriculture Organization (FAO), the pandemic situation has reduced at least one-third of global seafood demand (FAO 2021).The seafood industry is extremely vulnerable to social-ecological shocks that disrupt product flow and the livelihoods that rely on it (Cottrell *et al*. 2019; Stoll *et al*. 2020). The Covid-19 and subsequent measures such as lockdowns, social distancing, reduced production, tightened inspections and paralyzed transportation systems (Gosh *et al*. 2022; Zhang *et al*. 2021) have put a strain on global seafood export.

In the context of the economy, social development, and food security, the fishing industry is critical in Sri Lanka. It contributes 1.3% to the country's GDP and employs over 500 000 people in direct and indirect fisheries occupations while meeting 52.4% of the country's animal protein requirement (MFARD 2021).Seafood export is a lucrative business for Sri Lanka, which is well-known in the global seafood market for its unique delicacy (Export Development Board 2022). It contributed 1.5% of the country's national export earnings in 2019. (MFARD 2021). The Covid-19 made no exceptions for Sri Lankan fish exports. The total fish exports of Sri Lanka in 2020 have decreased by 26% in quantity and 25% in value (MFARD 2021).

There is also a growing interest in Covid-19 studies in the fisheries sector, particularly in fish trades. These studies discovered demand shifts in fish product choices, significant contractions in traded volumes of the world's leading seafood exporters, and even the complete absence of major importers, as well as an emphasis on searching for new potential markets to mitigate the risk of economic shocks (FAO 2021; White *et al*. 2020; Ragumaran *et al*. 2021; Zhang *et al*. 2021). In the Sri Lankan context, only few studies have been carried out to assess the effects of Covid-19 on the fisheries sector and are mostly limited to the national level (Amaralal *et al*. 2022; Lakshika *et al*. 2021; Nanayakkara *et al.* 2021). Almost all of these studies are based on primary data and adopted to qualitative approach to analyzing the impact. Moreover, the seafood trade is critical to the country's economy as well as the livelihood of the people engaged in the fisheries sector, but no study has focused on the influence of Covid-19 on Sri Lanka's seafood trade performance. Fish exporting countries have also been impacted to varying degrees. Individual countries' coping strategies and management practiced adopted determine whether they mitigate risk or worsen the situation (Hale *et al.* 2020). Examining the changes in the existing import trends of key export destinations of Sri Lanka as a result of the Covid-19 pandemic, as well as investigating the country specific and product specific impacts, are crucial in order to respond to future global emergencies. Unlike in the early stages of the pandemic, there is now a sufficient amount of data available hence studies can utilize those data to analyze the situation statistically. Hence the purpose of this research is to assess the impact of the Covid-19 outbreak on Sri Lanka's finfish exports to its key trading partners: the United States of America (USA) and the European Union (EU). The findings of this study serve as a benchmark in developing management strategies and to be used by policymakers and strategic planners to develop a solid resilience management plan for the seafood export sec-

tor in order for it to thrive in global challenging periods and secure a stable market.

MATERIALS AND METHODS

Data Collection

This research totally based on secondary data. The target commodity of this study is food fish (finfish) which is exported under three Harmonized System codes (HS) namely; HS 0302 (fish fresh or chilled), 0303 (Fish frozen) and 0304 (Fish fillets and other fish meats, fresh, chilled or frozen). Finfish category was chosen for this study since it is the most traded fish and fishery product category in Sri Lanka, accounting for approximately 70% of total fish and fishery product exports from the country (MFARD 2021). The target trading partners were the EU and the USA as they are the leading importers for Sri Lanka's finfish products and it is nearly 45% from the total fish and fishery product exports. On the other hand these two regions are among the seriously affected countries by Covid-19 pandemic. The finfish exported from Sri Lanka to the EU and the USA was collected in Metric tons (Mt) on monthly basis from January 2017 to December 2021 separately from the United Nations Cometrade database. Analysis was done by Eviews ver.10 statistical software.

Descriptive Data

Descriptive statistics for total finfish exports to the EU and the United States were also examined. Time series graphs were used to identify the trends and behavior of food fish exports data series during the study period. Visual analysis was performed on the composition of finfish exports to the EU and the United States.

Analytical Procedure

The procedure mentioned in this section was applied separately for the EU and the USA trade flows. Study utilized the time series data as it is crucial for identification of the stationary condition is a must. Augmented Dickey Fuller (ADF) test was used to test the stationary of the data series as it was the most commonly used tool by many researches with the hypothesis of, H_0; the series has unit roots/ the series is not stationary H_1; the series has no unit roots/ the series is stationary (Anderson *et al.* 2022; Lee and Chang 2008; Ajewole 2020).

The next attempt was to investigate the structural changes possible in the trade series. The stationary of the time series is a prerequisite of time series analysis. The stationary of the time series is depended on mean stationary, variance stationary, seasonal stationary and the effect of structural break as well. When the series is not stationary under the first three options mentioned above, then its open to test the structural changes in the series. There are some approaches to study about the structural changes in a time series variable. Chow test, Chow test with Toyoda mechanism, Quandt test, Andrews Sup F test, Bai-perron class of test, Sup Walt test and CUSUM of squared test are some of them (Maheswari and Muthuramu 2019). Therefore, a linear model was estimated for the variables with the constant (C) term. Then the stability of all model was checked using CUSUM square test as a recursive estimation (Maheswari and Muthuramu 2019). The insignificant CUSUM square test say there may be a breakpoint in the variable. After confirming the presence of structural beaks in trade series, the Bai-Perron test of L+1 vs. L test was employed to sequentially determine the breaks for both trade series (EU and USA) applied in this study. Since both series confirmed the structural breaks again the time series were subjected to ADF test with breaks to ensure the stationary with breaks.

As the trade series for the EU and the USA showed sequential break periods and interestingly they were after January 2020, Covid-19 impact was introduced to the data series as a dummy variable to test whether Covid-19 has been significantly responsible for the identified structural changes. The World Health Organization (WHO) declared the Covid-19 outbreak officially at the end of January 2020. Therefore, a dummy variable was created by assigning ''0' for months before February 2020 and '1' for the rest of the data series. Since ADF with breaks confirmed both series were stationary with beaks analysis was continued with time series regression with Ordi-

nary Least Square (OLS) technique. Stationary time series can be applied for time series linear regression under the all assumptions of linear regression model. In addition to that the structural break was included to the model as a dummy variable. The multiple linear regression model as a combination of static model approach, finite distributed lag model and autoregressive model.

The adequacy of the model was tested under all assumption of the regression model assumptions and the overall model adequacy was checked by the ANOVA test in time Series Regression-F statistic, Auto Correlation in time Series Regression was checked by Durbin-Watson statistic, stability in Time Series Regression was checked by CUSUM Test and CUSUM Square Test, Heteroskadesticity in Time Series Regression was checked by Breusch-Pagan-Godfrey, Serial Correlation in time Series Regression was checked by Breusch–Godfrey Serial Correlation LM Test, Mullticollinearity in Time Series Regression was checked by Variance Inflation Factor (VIF), Residual was checked by plot-Q-Q plot, Jarque-Bera Test. Competitive models were run and based on the stability test-CUSUM square recursive estimation graph and the forecasting efficiency; Mean Absolute Percentage Error (MAPE) value of the best-fitted time series regression model was selected to investigate the impact and its magnitude of Covid-19 on finfish exports from Sri Lanka to the EU and the USA.

RESULTS AND DISCUSSION

Descriptive Statistics

The total quantity exported under each category from 2017 to end of 2019, fish fillets or other meat including fresh, chilled, or frozen (HS 0304) accounted 75.47% of total food fish exported to European markets, followed by fresh fish (HS 0302) (Table 01). The export product composition to United States was completely different where fresh fish accounted over 75%, followed by fish fillets or other meat as fresh, chilled, or frozen products (HS 0304). The amount of frozen fish exported to both markets were negligible.

The importation of finfish to EU from Sri Lanka was over three times higher than that of the USA during the study period with the mean of 636.56 and 165.72 respectively while higher dispersion shown by the EU data series. The summary of the EU and the USA finfish trade flow was given in the table 02.

Table 01: **Product composition of exported food fish from Sri Lanka to the EU and USA markets**

Product Type	HS Code	USA	EU
Fish fresh or chilled	HS 0302	74.86%	24.20%
Fish frozen	HS 0303	0.26%	0.33%
Fish fillets and other fish meats, fresh, chilled or frozen	HS 0304	24.88%	75.47%

Table 02: Descriptive statistics – Average values form January 2017-December 2021

	EU		USA	
	2017 -2019	**2020 onward**	**2017 -2019**	**2020 onward**
Mean	554.72	740.03	234.28	68.96
Standard deviation	138.20	134.50	92.87	71.00
Minimum	296.35	495.27	73.29	8.13
Maximum	788.64	1115.60	458.21	298.39

According to the Time series plots for the EU and the USA revealed that, the overall trend of Sri Lankan finfish exports to United States showed a noticeable downward with a sudden drastic drop occurring in the second quarter of 2020. In contrast EU market shown a slight downfall during that period and there after increased gradually and recorded highest import during the first and second quarters of 2021 (Figure 01).

Figures 02 and 03 depicts a straightforward comparison of trade flows in 2019 (pre-Covid) and during the Covid-19 period. In terms of EU exports, there was a clear decline during the first three months of 2020 and after April 2020, the EU trade flow increased noticeably. In 2021 reported the highest traded quantities than in 2019 and 2020. Overall, the finfish export to the EU from Sri Lanka has increased by 7% in 2020. Further, the increase in 2021 was recorded as 19% compared to 2019. This is mainly because European citizens continued to consume more fish and seafood products at home during the pandemic. Household spending on fish and seafood in the EU-27 increased by 7% from 2020, maintaining the higher trend seen between 2019 and 2020. The rise in domestic consumption is most likely due to the long-term impacts of the COVID-19 epidemic (The EU Fish Market, 2022).

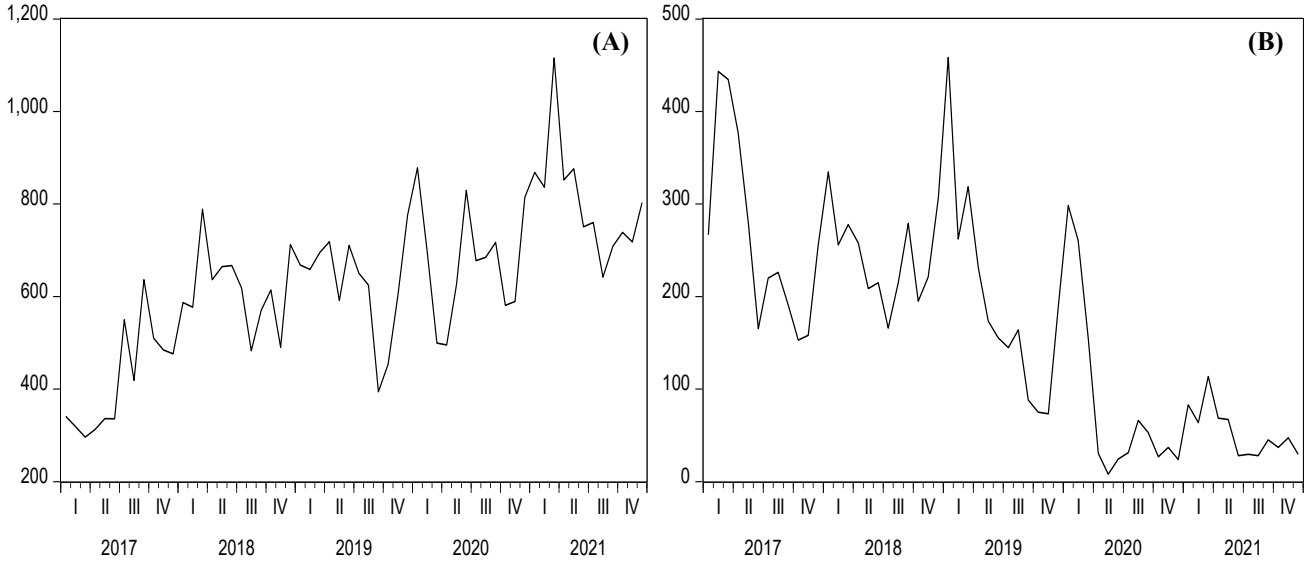

Figure 01: (A) Food fish exports of Sri Lanka to the EU from 2017-2021. (B) Food fish exports of Sri Lanka to the USA from 2019-2021

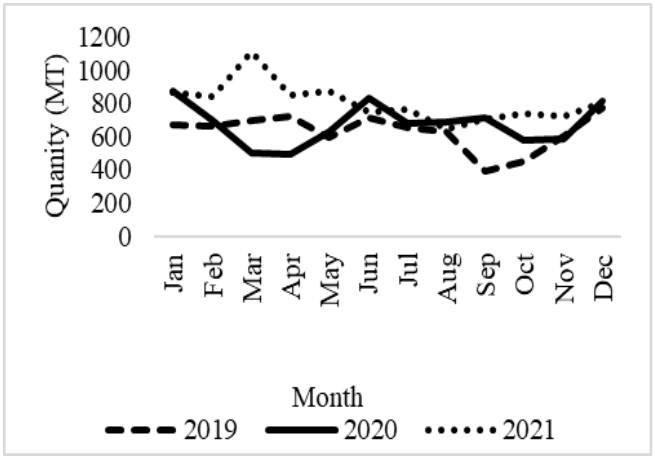

Figure 02: **Comparison between pre-Covid and during Covid trade flow to the EU**

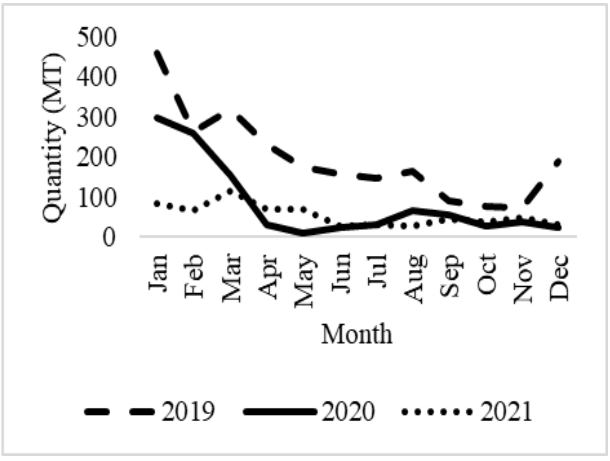

Figure 03: **Comparison between pre-Covid and during Covid trade flow to the USA**

The scenario for the United States is vastly different from that of the European Union. Finfish exports to the US from Sri Lanka decreased year-over-year in both 2020 and 2021, with a significant drop recorded in April 2020. Further, it was discovered that trade volumes did not increase even in 2021. Overall finfish exports to the United States fell by 56.6% and 72.5% in 2020 and 2021 compared to 2019. Existing literature also revealed that substantial declines imports (−37%) and exports (−43%) relative to the previous year. Social distancing policies could reduce seafood demand, given that 65% of United States spending ($69.6 billion in 2017) on seafood is in restaurants (Love *et al*. 2021; Asche *et al.* 2020). Comparing year-over-year import and export value, prior to January 2020, seafood imports had stayed within 5% of the previous year's value, but then increased by 7%–11% year over year in January and February 2020. This increase may be explained by shipments originally heading to China being redirected to the US market (Gephart *et al*. 2020). Live, fresh and chilled imports then fell to 37% below the 2019 value, while frozen products were only 3.5% below 2019 levels.

Secondary Analysis

Finfish Exports to the European Union

The ADF test for time series data stationary was done to test the stationary level of the data series with breaks and was statistically significant for the EU trade series confirming the stationary at level (ADF test statistics= -4.97, p= 0.0001) whereas CUSUM square test was insignificant.

The Bai-perron multiple breakpoint analysis test was done to test the statistically significant structural change in a time series data set. Test results revealed that there were two significant structural changes in this time series. This test has divided the data series into three regions and the second region and third region were not statistically significant (2 vs. 3). Therefore the study neglected the second and third region as well. Therefore, it was confirmed that there is only one structural break in the EU trade series and this test further suggested a break in December 2020 (Table 3).

As there was a confirmed structural break in this time series ADF test with breaks was analyzed to test the stationary level of the data series with breaks. Table 04 depicts the results for ADF test with breaks and it confirmed that the EU time series was stationary with breaks.

The time series regressions were then applied in many ways; with constant, Covid-19 dummy, EU trade series with different time lags, and interactions of Covid 19 and different time lags of EU trade series. The best model was selected based on the CUSUM square test results and the lowest MAPE value.

Below is the best model selected to describe the interested situation.

$$\text{Export}_{EU} = C + \beta_1 \text{Export}_{EU_{t-1}} + \beta_2 \text{Covid}_{Dummy}$$

……..Eqn 01

The table 05 illustrates the results of time series regression for above linear model. The Covid 19 dummy has given a small negative

Table 03: Multiple breakpoint test of EU food fish imports from Sri Lanka

Break Test	**F-statistic**	**Scaled** F-statistic	**Critical** Value**
0 vs. 1 *	30.59	30.59	8.58
1 vs. 2 *	16.49	16.49	10.13
2 vs. 3	0.92	0.92	11.14
Break dates:			
	Sequential	Repartition	
1	2020M12	2018M1	
2	2018M1	2020M12	

** Significant at the 0.05 level.*

Table 04: ADF test with breaks

Trend Specification	t- statistics		Probability	
	EU	USA	EU	USA
Trend and Intercept	-3.16	-5.16	0.0430	0.0200
Intercept only	-2.46	-4.46	0.0487	0.0473

Table 05: Time series regression results for EU

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	566.97	47.18	3.96	0.00
Export_EU$_{(t-1)}$	0.61	0.096	6.39	0.00
COVID_Dummy	-1.32	66.07	-0.02	0.98
R-squared			0.25	
Adjusted R-squared			0.18	
F-statistic			3.70	
Prob(F-statistic)			0.01	

value (- 1.32) which was not statistically significant at 95% confidence level. It implies that Covid-19 has not made a statistically significant impact on food fish exports of Sri Lanka to the EU market.

Food fish export to the USA

The ADF test for time series data stationary was insignificant for the USA trade series confirming the series is not stationary at level (ADF test statistics= -3.47, p= 0.0507). As it confirmed the non-stationary at the initial stage ADF test with breaks was employed. That test results confirmed this series was stationary with breaks (Table 04).

The Bai-perron multiple breakpoint analysis results were shown in Table 06. This results has shown there were two significant structural changes in this time series. This test has divided the data series in to three regions and as the second region and third region were not statistically significant (2 vs. 3) we could neglect the second region as well. This test confirmed the presence of a significant structural break in April 2020.

Table 06: Multiple break point test for the USA series

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	84.58	84.58	8.58
1 vs. 2 *	18.31	18.31	10.13
2 vs. 3	2.026	2.026	11.14
Break dates:			
	Sequential	Repartition	
1	2020M04	2019M05	
2	2019M05	2020M04	

** Significant at the 0.05 level.*

The time series regressions were then applied in many ways as done for the European Union trade flow; with constant, Covid-19 dummy, USA trade series with different time lags, and interactions of Covid 19 and different time lags of USA trade series. The best model was selected based on the CUSUM square test results and the lowest MAPE value and shown by equation 02.

$$\text{Export}_{\text{USA}} = C + \beta_1 \text{Export}_{\text{USA}_{t-1}} + \beta_2 \text{Covid}_{\text{Dummy}}$$

……Eqn 02

The results of time series regression for above linear model is given in table 07. The Covid-19 dummy in USA case has given a quite large value with a negative sign (-71.94) and it was statistically significant with a probability value less than 0.05. It is evident that the finfish exports of Sri Lanka to the USA has had a negative impact due to Covid 19 pandemic and it was a reduction in 71.93 Mt per month on average during the Covid-19 period than the pre-Covid period.

To determine potential demand changes, the EU and USA yearly food fish imports were examined in three categories. Figure. 5A shows that fresh fish imports (HS 0302) to the United States have dropped dramatically in 2020 whereas the EU has not shown a significant drop in demand during this period (Figure 05). However, the United States has increased its fresh fish imports in 2021 compared to 2019. Figure. 5B depicts the import behavior of HS 0303, frozen fish. According to this graph, demand for frozen fish has behaved differently in the EU and the United States. In any case, both countries have increased their frozen fish imports in 2020.However, USA has drastically increased their frozen fish imports in the year 2021 also whereas the EU has dropped the frozen fish importation drastically in 2021. The United States has significantly increased its frozen fish imports in 2021. In terms of fish fillets and meats (HS 0304), the EU markets significantly reduced their imports by 2020, and this trend is expected to continue into 2021 (Figure. 5C). The scenario in the United States was slightly different, with no significant drop in demand in 2020 but a gradual increase in 2021.

Overall, the USA seafood demand has shown a different picture than that of the EU. Whit et al, 2020 stated that the seafood importation to the USA has marked a 37% drop during this uncertain period especially during the early Covid period. They also have estimated that lock downs and social distancing rules has influenced to put down the people visiting to the USA seafood markets by 30% on average. Demand shift of USA food fish consumption is highly evident as during the Covid-19 period consumers all over the world tend to buy food items with extended shelf life ; preferably frozen forms as there were extended period of lock downs (Anderson et al, 2022). In Sri Lankan food fish export basket to the USA the lowest is the frozen fish category (HS 0303) while the largest is fresh fish (HS 0302) which was the mostly dropped food fish item by the USA. This might had a greater influence for the detected negative im-

Table 07: Time series regression results for USA

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	91.59	24.59	3.72	0.00
Export_USA$_{(t-1)}$	0.61	0.10	6.39	0.00
COVID_Dummy	-71.94	22.61	-3.18	0.00
R-squared			0.74	
Adjusted R-squared			0.74	
F-statistic			87.48	
Prob(F-statistic)			0.00	

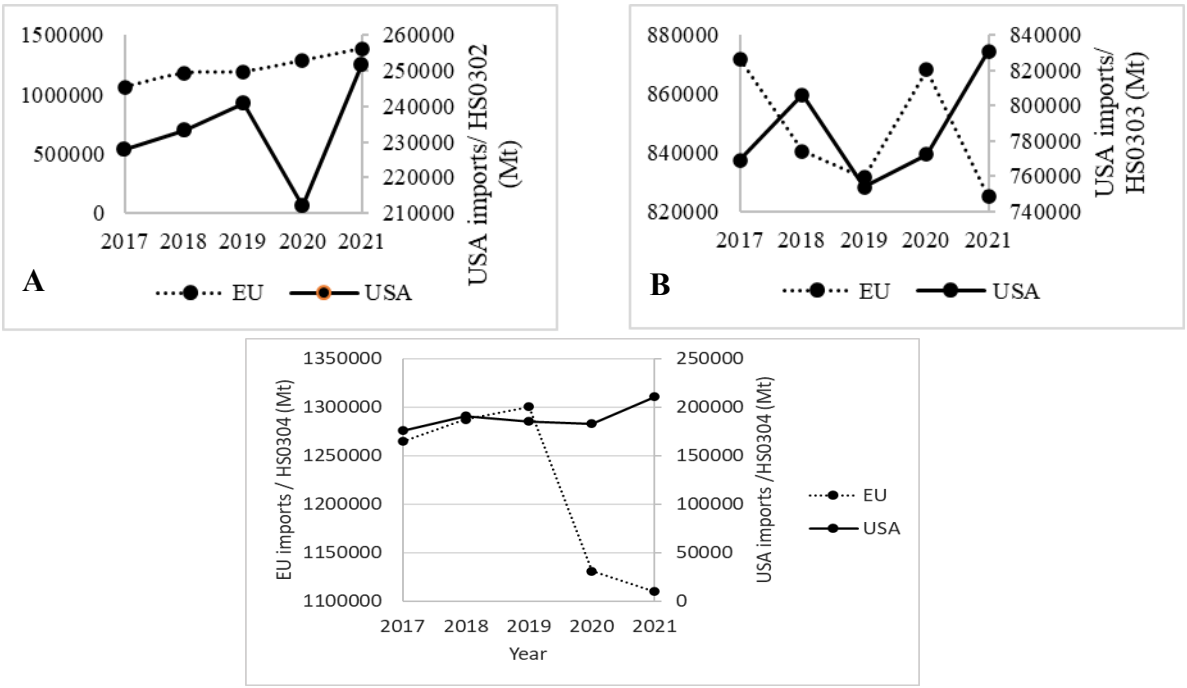

Figure 5: (A) HS 0302 importation to the EU and USA- 2017/2021 , (B) HS 0304 importation to the EU and USA- 2017/2021, (C) HS 0303 importation to the EU and USA- 2017/2021

pact of Covid 19 on the USA food fish trade flow from Sri Lanka.

The response from the EU was totally different. Even European Commission states that the Covid-19 crisis did not seem to have affected significantly the demand side for seafood from the EU (European Commission 2021). Unlike US, even though EU has dropped the importation of the HS 0304 product category during the Covid-19 period it has not put any significant impact on the exported volume from Sri Lanka to the EU.

Surprisingly, unlike the USA's response to the demand shift, the EU's decision to stop importing products from the HS 0304 product category during the Covid-19 period had no significant effect on the total finfish import from Sri Lanka to the EU.

CONCLUSIONS

The COVID-19 pandemic and resulting economic crisis represent a global-scale disturbance that is being felt across all sectors including fisheries. Hence it is critical to assess the impact of the Covid-19 outbreak on Sri Lanka's finfish exports with special reference to its key trading partners. Results discover that, in terms of category-wise export, fish fillets or other meat in the form of fresh, chilled, or frozen are the dominant export items to EU market while fresh fish is dominant for US market. According to the time series plots, overall trend of Sri Lankan food fish imports to United State has showed a 56.5% and 72.5% downfall during 2020 and 2021 than that of European market. Comparison between pre and Covid-19 pandemic period, EU trade flows disclosed that even the trade quantities have dropped during the first quota of 2020, thereafter it was notably increased while 2021 recorded the highest trade quantities of fin fish than previous two years. In contrast, US trade flows dropped significantly during pandemic period compared to pre-Covid-19 period. This mainly because the US having highly volatile sea food sector, which is susceptible to shocks and is positioned as a top global fish importer and the exporter in sea food industry**.** Further study discovered a structural change in US finfish trade flow in April 2020 and it indicates that the Covid-19 dummy was statistically significant in the time series regression, with a coefficient value of -71.93 which implies that Covid-19 has a negative impact on finfish trade to the USA. Moreover, yearly food fish imports were examined under three

categories in order to assess the demand changes during pandemic. Unlike in EU market, fresh fish (HS 0302) import for US market shown a significant dropped during 2020 and increased during 2021. Frozen fish (HS 0303) imports increased in both countries during 2020 hence drastically increased in US while significantly dropped in EU market while Fish fillets imports dropped only in EU market. Overall, the Covid-19 has a negative impact on finfish trade to the USA. However, no statistically significant impact from Covid-19 was found in the case of finfish trade to the EU.

The study underscores the significance of market diversification as a strategy to mitigate the impact of a pandemic. As evidenced by the study's findings, the behavior of import quantities varies across different markets. The presence of a diverse array of buyers is crucial because diversified markets enable countries to navigate through crises by switching to alternative buyers when established trading relationships are disrupted. Furthermore, product diversification emerges as another vital aspect in addressing pandemic-related challenges. Existing literature indicates that during the Covid-19 period, there was an increase in homemade fish consumption compared to dining at restaurants, highlighting changing consumer preferences. To adapt to this shift, it becomes imperative to adjust product quality and packaging to cater to consumers' ease of use in their homes. Additionally, strengthening the various actors within the seafood value chain is essential to effectively mitigate the impact of a pandemic. This can be achieved through measures such as vaccination programs, providing safety equipment, enhancing sanitary facilities, and improving quality certification processes. These efforts collectively contribute to greater resilience in the face of future unforeseen crises.

RECOMMENDATIONS AND FUTURE RESEARCH DIRECTIONS

Study recommended to investigate the country-specific product sensitivity at the individual product level in future research rather considering regional market as a whole. Study also suggest to incorporate aspects such as potential post-outbreak situation and the economic crisis followed by Covid-19 pandemic and geopolitical aspect in to consideration.

AUTHOR CONTRIBUTION

D.W. L.U De Silva, W.A.A.M Bandara and K.P.G.L Sadaruwan developed the concept and designed the study. E. V. D. Dilhani and D.W. L.U De Silva performed the statistical procedures and analyzed the data. D.W. L.U De Silva and W.A.A.M Bandara wrote the manuscript with inputs from all authors. K.P.G.L Sadaruwan and D.W. L.U De Silva critically revised the manuscript.

REFERENCES

Ajewole K P, Adejuwon S O, and Jemilohun V G 2020 Test for stationary on inflation rates in Nigeria using augmented dickey fuller test and Phillips-persons test. *J. Math*, *16*: 11-14.

Amaralal K H M L, Edirimanna E M A P, Lakmini W A S W, Chamodi K K D, Kuragodage A U, Sanuja R G, and Deepananda K A 2023 Impacts of COVID-19 pandemic on the fisheries sector of Sri Lanka. *Marine Policy*, *147*, 105339. https://doi.org/10.1016/j.marpol.2022.105339

Anderson, James L, Asche F, Garlock T, Hegde S, Ropicki A and Straume H 2022 "Impacts of COVID-19 on U.S. Seafood Availability" Journal of Agricultural& Food Industrial Organization, 21(1): 1-9. https://doi.org/10.1515/jafio-2022-0017

Asian Development Bank 2021 Asian Development Outlook (ADO) 2021. https://www.adb.org/news/sri-lanka-gdp-growth-projected-rebound-amid-pandemic-and-vaccination

Cottrell R S, Nash K L, Halpern B S, Remenyi T A, Corney S P and Fleming A 2019 Food production shocks across land and sea. *Nature Sustainability,* 2:130–137. https://doi: 10.1038/s41893-018-0210-1

Export Development Board 2022 Seafood Industry in Sri Lanka – EDB. https://www.srilankabusiness.com/fisheries/seafood/

Food and Agriculture Organization of the

United Nations [FAO] 2021 *The Impact of COVID-19 on Fisheries and Aquaculture Food Systems, Possible Responses-information paper, November 2020.* Rome: Food and Agriculture Organization of the United Nations.

Gephart J A, Golden C D, Asche F, Belton B, Brugere C, Froehlich H E, Fry J P, Halpern B S, Hicks C C, Jones R C and Klinger D H 2020 Scenarios for global aquaculture and its role in human nutrition. *Reviews in Fisheries Science & Aquaculture*, *29*(1): 122-138.

Gosh K, Chowdhury S, Acharjee D C, Mamun A A and Ghosh R 2022 Assessing the Economic Impacts of COVID-19 on the Aquaculture and Fisheries Sectors in Relation to Food Security: A Critical Review. *Sustainability*, *14*(14): 8766.

Hale T, Angrist N, Kira B, Petherick A, Phillips T and Webster S 2020 Variation in government responses to COVID-19 (*working paper)*.

Hobbs J E 2020 Food supply chains during the COVID-19 pandemic. *Canadian Journal of Agricultural Economics/ Revue canadienne d'agroeconomie*, *68* (2):171-176. https://doi.org/10.1111/ cjag.12237.
https://doi: 10.4060/cb2537en.

Lakshika R, Deyshappriya N P R and Athula J A 2021 Impact of Corona Virus Disease 2019 on Aquaculture and Inland Fisheries Sector with Special Reference to Trincomalee District in Sri Lanka. *International Research Conference of UWU-2021*,1: 52.

Leal M C, Vaz M C M, Puga J, Rocha RJ M, Brown C, Rosa R and Calado R 2016 Marine ornamental fish imports in the European Union: an economic perspective. *Fish and Fisheries*, *17*(2):459-468. https://doi.org/10.1111/faf.12120

Lee C C and Chang C P 2008 New evidence on the convergence of per capita carbon dioxide emissions from panel seemingly unrelated regressions augmented Dickey–Fuller tests. *Energy*, *33*(9): 1468-1475.

Love D C, Allison E H, Asche F, Belton B, Cottrell R S, Froehlich H E, Gephart J A, Hicks C C, Little D C, Nussbaumer E M and da Silva P P2021 Emerging COVID-19 impacts, responses, and lessons for building resilience in the seafood system. *Global Food Security*, *28*:100494.

Madhavika N, Jayasinghe N, Ehalapitiya S, Wickramage T, Fernando D and Jayasinghe V, 2022 Operationalizing resilience through collaboration: the case of Sri Lankan tea supply chain during Covid-19. Quality & Quantity, pp.1-38.

Ministry of Fisheries and Aquatic Resource Development 2021 http:// www.statistics.gov.lk/Agriculture/ StaticalInformation/rub21

Muthuramu P and Maheswari T U 2019 Tests for structural breaks in time series analysis: A review of recent development. *Shanlax International Journal of Economics*, *7*(4):66-79.

Nanayakkara N P, Sandaruwan K P L, Kumara W A AU and Rathnasuriya M I G 2021 Impacts of Covid-19 pandemic on ornamental fish supply chain in Sri Lanka. *Asian Fisheries Science*, pp.243-252.

Orlowski A 2020 Small-scale fishermen suffering significantly from COVID-19 pandemic.
SeafoodSource, April 27, 2020. Viewed 12 May 2023, https:// www.seafoodsource.com/news/supply-trade/small-scalefishermen-suffering-significantly-from-covid-19-pandemic.

Ragumaran M, Mohan Raj V, Susan George S R and Mathu M C 2021 Impact of Covid 19 pandemic on seafood exports from India. *Intern. J. Zool. Invest*, *7*(2): 808-813. https://doi.org/10.33745/ ijzi.2021.v07i02.067

Roshana M, Kaldeen M and Banu A R 2020 Impact of COVID-19 outbreak on Sri Lankan Economy. Journal of Critical Reviews, 7(14): 2124-2133.

Stoll J S, Harrison H L, Sousa E D, Callaway D, Collier M , Harrel K 2020 Alternative seafood networks during COVID-19: implications for resilience and sustainability. Frontiers in Sustainable Food Systems, 5: 97 *EcoEvoRxiv* doi: 10.32942/osf.io/kuzwq

The EU Fish Market, Discover the highlights 2022 Oceans and Fisheries. https://oceans-and-fisheries.ec.europa.eu/news/eu-fish-market-2022-discover-highlights-2022-12-06_en#:~:text=Salmon%3A%20Strong%20increase%20in%20the,imports%20of%20the%20whole%20tuna.

Valdimarsson G 2007 Challenges for the global seafood industry. In *Sixth World Congress on Seafood Safety, Quality and Trade: 14-16 September 2005, Sydney, Australia*. *Food & Agriculture Org, 7:17*

White E R, Froehlich H E, Gephart J A, Cottrell R S, Branch T A, Agrawal Bejarano R and Baum J K 2021 Early effects of COVID-19 on US fisheries and seafood consumption. *Fish and Fisheries*, *22*(1): 232-239. https://doi.org/10.1111/faf.12525

Wijayasiri J 2019 COVID-19 and Impact on Export Sector in Sri Lanka. *International Trade and Cooperation. VISITING SCHOLARS'OPINION PAPER*, p.55.

Zhang Y, Tang Y, Zhang Y, Sun Y and Yang H 2021 Impacts of the COVID-19 pandemic on fish trade and the coping strategies: An initial assessment from China's perspective. Marine Policy, 133:104748. https://doi.org/10.1016/j.marpol.2021.104748.