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Trade of the Virus: An Empirical Investigation using the Dynamic Panel Data Analysis

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ABSTRACT: *The present study aims to investigate the evidence of "Sicken Thy Neighbour Policy" amidst the pandemic via international trade by employing a balanced cross country and time series data panel consisting of 45 developing and developed countries over the period January 2020 to August 2020. The study employs both homogeneous and heterogenous panel data approaches. Under the conventional homogenous approaches fixed effects and random effects models are used. However, to counter the significant presence of cross-sectional dependence and non-stationarity in the data dynamic heterogenous approach of Mean Group and Common Correlated Effects Mean Group estimators is employed. Country specific effect is studied using Toda Yamamoto Granger Causality test. The empirical results reveal absence of evidence for Sicken Thy Neighbour policy among the countries under consideration. However, country specific effects do reveal causality either bidirectional or unidirectional between imports, exports and cases for the countries under consideration. Moreover, there exists no causality between trade and COVID cases in 2 countries namely, France and Cyprus.*

Keywords: *COVID, Pandemic, Trade, Imports, Exports, Panel Data. JEL Classification: F14*

I. INTRODUCTON

The COVID-19 pandemic first witnessed in China has proven to be a complete shock for the global economy. It has caused drastic moderation in the world's GDP growth because of the lockdowns worldwide leading to severe disruptions in various important sectors of the economy. It has proven to be both a financial and social crisis. The virus has created a stressful environment causing many lives to battle in their own ways. Economically Backward countries are mostly affected because of their weaker healthcare systems. The disease has come along with an uncertainty about how long this new normal will be once again normal across the globe. Two major challenges on its path are, firstly save people's lives from the deadly virus and secondly save the economy from financial uncertainty.

The pandemic was accompanied by numerous lockdowns leading to a fall in global trade, capital flows, disruptions in supply chains, rise in poverty and unemployment. With this whole scenario, there is an explicit requirement to keep trade in pace in order to ensure the supply of certain necessary products, and also to transmit a little confidence for the overall economy as trade is a pre-requisite for every economy. To keep up with the trade it requires co-operation from every country's side as import and export restrictions also called trade tensions tend to be the greatest risks for international trade in the times of COVID-19. Thus, it becomes imperative to figure out which policy measures would help setting the stage for recuperation while simultaneously tackling trade tensions (Woo et el. 2020). However, appropriate policy responses require robust prediction of the impact of the shock or event on the policy variable in question. Contemporary studies on the impact of the COVID-19 pandemic have generally centered around financial markets (Ali, Alam, and Rizvi 2020; Apergis and Apergis 2020; Fu and Shen 2020; Gil-Alana and Monge 2020; Haroon and Rizvi 2020; Liu et al., 2020; Narayan 2020; Phan and Narayan 2020). But there exists a paucity of research that studies the impact of the pandemic on international trade and as far as empirical literature (though evolving, as more data becomes available) is concerned, this shortage is extensive. Hence, this study contributes to the literature by analyzing the impact of the present pandemic on the world trade and vice-versa by employing homogenous and heterogenous panel data approaches for 45 countries from January 2020 to August 2020.

While trade fosters globalization, it can also act as a catalyst for the spread of contagious and infectious diseases through shipping functions, and associated human involvement (Gubler and Rosen, 1976; Mack, Choffnes and Relman, 2011; Rezza et. al 2008). Globalization and ease of trade have increased the prospective of infectious contacts (Fidler,1996; Frenk, Gomez Dantes and Knaul 2011) The compulsion and incentive for global trade may threaten bio-security of local and global population as was evidenced by the H1N1 virus (Kimball 2006). Global trade was also held responsible for the spread of HIV/AIDS, tuberculosis, cholera, and malaria to new regions. Given this understanding, this research further aims to study the direction of the causality between trade and the COVID-19 cases by employing Toda -Yamamoto Granger Causality Test for each country.

II. LITERATURE REVIEW

We are over ten months into the pandemic without any indications of coronavirus subsiding. In such a brief span of time our world has changed significantly—how we live, shop, educate our children, receive medical care benefits, and interact with others personally and professionally (Causland 2020). It has caused unprecedented disruptions to economic activities across the globe. It has seriously influenced and has led to disruption of global value chains, domestic production network, trade, services thereby affecting overall growth and welfare. The current pandemic is managing its way through a profoundly globalized world with interconnected financial markets and production networks. The policy measures embraced to control its spread like complete and partial lockdowns have both demand and supply-side repercussions on the world economy. The supply side effects encompass the effect on the production network due to the controls on movement of merchandise, services and personnel. This decrease in economic activities and overall output growth leads to loss of employment. The supply side shocks will additionally create demand-side effects by reducing the economy's disposable income, savings and giving rise to instability in the economy. Therefore, COVID-19 pandemic seems to have a significant impact on most of the economic variables such as growth, international trade, financial markets, unemployment, income, poverty and many more variables (Sahoo and Ashwani 2020).

Literature that investigates the macroeconomic effects of COVID-19 is growing. Bonadio et al. (2020) show the effect of COVID-19 on output growth in 64 nations. Ludvigson et al. (2020) evaluate the macroeconomic effect of COVID-19 in the United States using a VAR framework and a measure of the magnitude of the COVID-19 shock in relation to past expensive calamities. Baqaee and Farhee (2020) build a disaggregated multisectoral model to contemplate the non-linearities in supply and demand in USA to the COVID-19 shocks and illustrate enhancement and moderation of these shocks by these non-linearities. Milani (2020) utilizes a GVAR model to highlight the significance of countries' interconnectedness in the evolution of COVID-19 and its unemployment effects. Cespedes et al (2020) study the macroeconomic effects of the pandemic by using a threshold model. McKibbin and Fernando (2020) employ a hybrid DSGE/CGE model to investigate the worldwide macroeconomic impacts of the different situations on the advancements of

COVID-19. The study finds substantial influence of the outbreak on the world economy. Chiah and Zhong (2020) examine the impact of COVID-19 on trading volume in 37 international equity markets around the world using daily data from 23rd January 2020 to 15th May 2020 and establish that there exists greater tendency that the investors trade in societies with a higher level of trust and individualism. Bashir et al. (2020) evaluate the socio-economic and ecological impact of COVID-19 and find socioeconomic demographics at the center of the COVID-19 pandemic. Vidya and Prabheesh (2020) find that the COVID induced suspension of production and non-availability of raw materials has mutilated the trade network in top 15 global trading countries. They furthermore establish insignificant influence of the pandemic on China's central position in the trade network. Aday and Aday (2020) determine the impact of COVID-19 in the agriculture and food sector and recommend actions required to reduce and control the effect of the pandemic. Benz et al. (2020) throw light on the increment in trade costs due to the administrative controls on the movement of people across international boundaries. Mold and Mveyange (2020) evaluate the preliminary impact of the COVID-19 pandemic on the regional trade in East African Community, Kenya. The authors find that Kenya experienced a significant decline in trade deficit due to improvement in exports and moderation of imports in the first quarter of the year 2020. Erokhin and Gao (2020) employed ARDL model, Toda- Yamamoto Granger Causality test to examine the impact of the pandemic on food security status of the people in the developing countries. Barua (2020) using a standard trade analysis framework provide a fundamental understanding of the likely ramifications of the pandemic on trade and infer introduction of new patterns of international trade, trade relations and globalization yielding some economies as winners and some losers. Estrada (2020) assess the impact of COVID-19 on the Chinese economy by applying the economic crisis from massive contagious and infectious disease simulator (ECMCID-Simulator) model and observe a negative impact on tourism, international trade, and air transportation sectors.

Thus, this research aims first, to identify the best fit model that explains the impact of the pandemic on trade and vice-versa, and second to examine whether trade contributed to the surge in the COVID cases or is it the other way round viz, cases led to the surge in international trade. Hence this study is one of the attempts to add to the flourishing literature to analyze the impact of COVID-19 on global economies (Corbet et al. 2020; Goodell 2020; Hassan et al. 2020; Ramelli and Wagner 2020). The findings aim to enable framing policies to promote international trade at present and in the post-COVID times.

III. RESEARCH METHODOLOGY

Following substantial empirical literature employing conventional homogeneous panel data approaches like random effects and fixed effects models (Bhattacharya and Hodler, 2010; Khanna, 2017) and instrumental variables approaches (Borge, Parmer, and Tervik, 2015; Tsui 2011) the paper employs fixed effects and random effects model with firstly, cases as dependent variable and secondly, imports as dependent variable. As evidenced in the estimation of disaggregated import demand literature exports are an important factor that may impact imports, as to export we need to import (Kathuria and Kumar 2020, Tang 2003, Alias and Tang 2000) therefore, exports are used as independent variable in the above two estimation models.

There subsists a large disparity in the trade performance of pandemic affected countries and existing panel data approaches do not address cross sectional dependence arising from unobserved common shocks like technological upgradation frequent oil price changes which may impact all cross-sectional members as these changes spur such similar shocks across the nations that potentially influence the economies but not in the same manner across countries (Sharma and Pal 2020).

To decide on the suitable panel unit root test and as an important prerequisite for estimating the relationship between COVID cases and trade using the heterogenous panel data approaches, the paper tests for cross sectional dependence (CD). In the presence of CD, the second-generation unit root test as suggested by Pesaran (2007) are applied as they assume cross-section dependence. However, in the absence of CD, first generation unit root tests are employed. Accordingly, the paper tests for cross sectional dependence using Pesaran's CD test (2004), Friedman's test (1937) and Frees test (1995; 2004). The paper employs second generation panel unit root test namely cross sectional augmeneted Im, Pesaran and Smith,2003 (CIPS) test proposed by Pesaran (2007) as it addresses for cross sectional dependence among the countries in the panel in a dynamic setting.

Furthermore, the study employs heterogeneous panel techniques viz, Pesaran and Smith (1995) mean group estimator, the Pesaran (2006) common correlated effects mean group estimators. These techniques address the dynamics, heterogeneity as well as cross-sectional dependence, three crucial features in a panel.
For $i = 1, \dots, N$ and $t = 1, \dots, T$ let

$y_{it} = \beta_i x_{it} + u_{it}$ (1)

where $u_{it} = \alpha_{1i} + \lambda_i f_t + \varepsilon_{it}$ (2)

$x_{it} = \alpha_{2i} + \lambda_i f_t + \gamma_i g_t + e_{it}$ (3)

where $x_{it}$and y_{it} denotes observables, β_i is the country-specific slope on the observable regressor, and u_{it} contains the unobservables and the error terms ε_{it}. The unobservable in (2) are comprised of group fixed effects α_{1i}, which captures time-invariant heterogeneity across groups, as well as an unobserved common factor f_t with heterogeneous factor loadings λ_i which can capture time-variant heterogeneity and cross-section dependence. Regressors are driven by some of the same common factors as the observables. ε_{it} and e_{it} are assumed white noise. The Pesaran and Smith (1995) MG estimator does not counter cross-sectional dependence and assumes away $\lambda_i f_t$ or addresses these unobservables with a linear trend. Thus (1) above is estimated for each panel member i, including an intercept to capture fixed effects and (optionally) a linear trend to capture time-variant unobservables. The estimated coefficients $\hat{\beta}_i$ are subsequently averaged across panel members.
The Pesaran (2006) CCEMG estimator takes into account the empirical arrangement as laid out in (1), (2), and (3). The empirical arrangement prompts cross-section dependence, time-variant unobservables with heterogeneous effect across panel members, and problems of identification (β_i is unidentified if the regressor contains f_t). The CCEMG estimator takes care of this issue with a simple but powerful augmentation of the group-specific regression equation such that barring the regressors x_{it} and an intercept, this equation now also includes the cross-section averages of the dependent and independent variables, y_t and x_t, as additional regressors. The combination of y_t and x_t can account for the unobserved common factor f_t. Since the relationship is estimated for each panel member separately, the heterogeneous impact (λ_i) is also given by construction. The focus of the estimator is to obtain consistent estimates of the parameters related to the observable variables. The CCEMG approach is robust to the presence of a limited number of "strong" factors like global shocks such as global financial crisis and an infinite number of "weak" factors like local spillover effects (Chudik, Pesaran and Tosetti, 2011; Pesaran and Tosetti, 2011). Moreover, the estimator is also robust to nonstationary common factors (Kapetanios, Pesaran, and Yamagata, 2011; Eberhardt 2012). Additionally, to know the country specific contribution of trade to the increment in the number of cases and vice-versa, Toda-Yamamoto Granger Causality test is employed. Though the Panel Granger Causality could have been employed, but due to the non-availability of data the prerequisites required for the application of the technique could not be fulfilled. However, in the future when more data becomes available robustness of the results of the present study could be tested by employing the same technique.
Data
The study employs a balanced cross country and time series data panel consisting of 45 countries over the period January 2020 to August 2020 for which complete monthly data series on imports and exports was available. The country sample includes, Austria, Bulgaria, Switzerland, Cyprus, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, UK, Greece, Croatia, Hungary, Ireland, Italy, Lithuania, Latvia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovenia, Sweden, Brazil, Canada,

Georgia, Australia, Bahrain, Bolivia, Salvador, Korea, Madagascar, Mozambique, Paraguay, Japan, Maldives, South Africa, Thailand, Turkey and USA. The data on exports and imports is sourced from the International Trade Statistics 2001-2020 whereas the data on confirmed COVID cases is sourced from World Health Organization.

IV. EMPERICAL RESULT

In the primary step of the analysis before estimating the fixed effects and random effects models the nature of the variables is studied as reported in Table 1 under descriptive statistics. It is found that the during the pandemic average imports (US $18700000) exceed the average exports ($17500000). However, for the cases the average value is 108943.8. It is also evident that for the exports and imports the variation between the countries is more than the variation within the countries which is a pretty much expected result as the panel involves a mix of both developing and developed economies. However, for the cases within variation exceeds the between variation as certain economies experienced the pandemic at a much greater extent than the rest. It indicates variation in the severity of the disease in diverse nations.

Fixed effects (FE) models intend to examine the causes of change within a country or entity. A time invariant characteristic as that is constant for each country cannot cause such a change. Another notable assumption of the FE model is that those time-invariant characteristics are unique to the individual and ought not be correlated with other individual characteristics. However, unlike the FE model in the random effects (RE) model variation across entities is assumed to be random and uncorrelated with the predictor or independent variables included in the model. Therefore, it captures the impact of the differences across entities on the variation of the dependent variable. In the RE model, we can incorporate time-invariant variables (Chatterjee 2020).

Table 2 gives us the result of the FE model where we intend to check the impact of the pandemic on trade specifically, imports. As discussed above, it is evidenced in the estimation of disaggregated import demand literature that exports are an important factor that may impact imports, as to export we need to import (Kathuria and Kumar 2020, Tang 2003, Alias and Tang 2000). Therefore, exports are used as an independent variable in the estimation models that study the impact of cases on trade. From the results, we find that the cases have a significant positive impact on imports. During the pandemic exports also have a significantly positive impact on imports. Random effects model gives the similar results. However, the Hausman test reveals the fixed effects model to be the preferred model.

Over the past decade Cross-sectional dependence in the panel data analysis has received a lot of attention. Cross-section correlation that may emerge from local spillover effects between countries or regions or from unobserved common shocks become part of the error term (Eberhardt and Teal 2011 and Dos Santos et al. 2017). As brought up by Breitung and Pesaran (2008), inability to represent this interdependence in cross-country analysis could result in inconsistent estimates. As the emphasis in this study is on the effect of COVID cases on trade and vice versa and trade integration implies expanding interdependencies between nations, it would be unreasonable to assume error cross-sectional independence. Accordingly, we test the data for cross-sectional independence using the tests proposed by Pesaran (2004), Freidman (1937) and Frees (1995,2004) tests for cross sectional independence suggest that our model suffers from cross sectional dependence. The results are presented in Table 4 and 5. The null hypothesis of no cross-section dependence can be clearly rejected, demonstrating that COVID cases and trade (imports, exports) are highly dependent across countries. This finding underlines the significance of considering cross-section dependence while examining the trade-COVID cases nexus.

Next, to analyze the long-run relationship between variables under consideration using the Westerlund (2007) error-correction-based test. It is essential that all variables in consideration show a random walk behaviour and are integrated of order one, I(1). Therefore, to test the order of integration the study employs recently developed 'second-generation' panel unit root test namely, cross-sectional augmented IPS (Im, Pesaran, and Shin 2003) (CIPS) test proposed by Pesaran (2007) that accounts for potential cross-section dependence arising from multiple unobserved factors. But in the results of CIPS reported in Table 6 it was found that cases are non-stationary and are integrated of order 3 i.e. I (3) whereas exports and imports are found to be stationary at level i.e. I (0). Therefore, long run relationship between the variables using the Westerlund test of cointegration could not be analyzed.

Thus, the presence of cross-sectional dependence and non-stationarity indicates that the results of Tables 2 do not accommodate the dynamic effects of the relationship and therefore might lead to wrong and inconsistent inferences. Therefore, the study employs the recently developed panel data techniques that account dynamic effects of the relationship namely, the mean group estimator developed by Pesaran and Smith (1995). But since the MG estimator does not account for cross-sectional dependence among the panel members therefore the study further employs CCEMG estimator that since the yields a robust estimate in case of presence of cross-sectional dependence, effectively takes care of endogeneity problem and are developed specifically for non-stationary panel time series (Eberhardt and Bond 2009). The estimation results are displayed in Table 7. While the MG estimator provides for significant positive impact of exports on imports during the pandemic, the CCEMG estimator reports insignificant impact of the pandemic on trade.

While trade is the foundation of today's globalization, it is additionally considered accountable for the spread of contagious and infectious diseases through shipping functions, shipped goods, and associated human involvement (e.g., live animals, meat, material goods) (Gubler and Rosen, 1976; Mack, Choffnes and Relman, 2011; Rezza, 2008). Therefore, the entire analysis is replicated with cases as the dependent variable and imports and exports as the independent variable with an intent to find out if trade contributed to the increment in the COVID-19 cases (Tables 8-10). However, according to the CCEMG estimator the findings revealed that the trade did not have a significant impact on the increment in COVID cases.

As using the above dynamic panel data approaches, on an average no consistent inference on the relationship between trade and the COVID cases could be found. Therefore, to find out the country specific relationship between the trade and COVID the study employs Toda Yamamoto Granger Causality test. The results are reported in Table 11. It was found that in some of the countries there exists bidirectional causality between trade and COVID cases and in some unidirectional causality. However, in Cyprus and France there is no causality between cases and exports as well as cases and imports.

V. CONCLUSION

The present study aims to investigate the evidence of "Sicken Thy Neighbour Policy" amidst the pandemic via international trade by employing a balanced cross country and time series data panel consisting of 45 developing and developed countries over the period January 2020 to August 2020. The study uses both homogeneous and heterogenous panel data approaches to find out whether trade is a contributory factor to the rising COVID cases or is it the COVID cases that have helped countries improve their trade balance by giving an impetus to exports as well as imports. Conventional panel data approaches of fixed effects and random effects models are employed. However, in the presence of dynamic heterogeneity, cross sectional dependence and non-stationarity of the data these conventional approaches might yield inconsistent results. Therefore, heterogenous panel data approaches robust to cross sectional dependence and non-stationarity of the data are employed viz, Pesaran and Smith (1995) mean group estimator, the Pesaran (2006) common correlated effects mean group estimator. In the results it is found that both the conventional and second-generation approaches do not provide conclusive evidence of "Sicken Thy Neighbour Policy". However, to examine the country specific nexus between trade and COVID cases the study employs Toda Yamamoto Granger Causality Test which reveals bidirectional causality between exports and cases and between imports and cases for some countries while unidirectional causality between exports and cases and between imports and cases in others. However, the results reveal absence of causality between exports, imports and cases for 2 countries namely France and Cyprus.

Table 1 Descriptive Statistics

Variable	Variation	Mean	Standard Deviation	Minimum	Maximum
Imports	Overall	1.87e+07	3.21e+07	99520	2.10e+08
	Between		3.22e+07	160116.8	1.91e+08
	Within		3458391	-2901221	3.77e+07
Exports	Overall	1.75e+07	2.50e+07	8194	1.35e+08
	Between		2.49e+07	12338.88	1.15e+08
	Within		3943924	-7845118	3.73e+07
Cases	Overall	108943.8	504877.2	0	5997163
	Between		334312	561.875	2007214
	Within		381203	-1898264	4098893

Table 2 Effect of COVID on Trade

Variable	Coefficient	Std. Error	t	P-value
Fixed Effects Estimator				
Exports	0.6761897	0.031299	21.65	0.000*
Cases	2.793464	0.3231047	8.65	0.000*
Constant	6583635	566877.2	11.60	0.000*

Sigma_e	2303456.4			
F(44, 313)	139.60		0.000*	
Random Effects Estimator				
Exports	0.8365836	0.0298715	28.01	0.000*
Cases	3.327818	0.3679386	9.04	0.000*
Constant	3716164	1436162	2.59	0.010*
Sigma_e	2303456.4			
Wald chi sq.	822.27		0.000*	

Note: *, **, and *** show the significance at 1%, 5%, and 10% levels, respectively.

Table 3 Hausman Test

Variable	Fixed	Random
Exports	0.6761897	0.8365836
Cases	2.793464	3.327818
Chi2(2)	305.63 (0.000)*	

Note: *, **, and *** show the significance at 1%, 5%, and 10% levels, respectively.

Table 4 Tests for Cross Sectional Independence

Test	Statistic	P-value
Pesaran	18.639	0.000*
Friedman	64.970	0.0215**

Note: *, **, and *** show the significance at 1%, 5%, and 10% levels, respectively.

Table 5 Frees test for Cross sectional Independence

Test	Statistic	Critical values	
		α=0.10	0.3169
Frees	3.319*	α=0.05	0.4325
		α=0.01	0.6605

Note: *, **, and *** show the significance at 1%, 5%, and 10% levels, respectively.

Table 6 CIPS Unit Root Test

Variable	Statistic		Critical value		
			10%	5%	1%
Imports	No constant,	-2.028*	-1.46	-1.57	-1.77

	No trend				
	Constant	-1.797	-2.05	-2.16	-2.36
	Constant &Trend	-3.456*	-2.63	-2.75	-3
Exports	No constant, No trend	-2.175*	-1.46	-1.58	-1.78
	Constant	-1.966	-2.05	-2.16	-2.36
	Constant &Trend	-2.642*	-2.63	-2.75	-3
Cases	No constant, No trend	-0.732	-1.46	-1.57	-1.77
	Constant	-0.789	-2.05	-2.16	-2.36
	Constant &Trend	-1.283	-2.63	-2.75	-3
D.Cases	No constant, No trend	-0.916	-1.46	-1.57	-1.77
	Constant	-1.131	-2.05	-2.16	-2.36
	Constant &Trend	-1.353	-2.63	-2.75	-3
D.D.Cases	No constant, No trend	-1.2020	-1.46	-1.58	-1.78
	Constant	-0.928	-2.05	-2.16	-2.36
	Constant &Trend	1.7*	-2.63	-2.75	-3
D.D.D.Cases	No constant, No trend	-0.998	-1.46	-1.57	-1.77
	Constant	2.61*	-2.05	-2.16	-2.36
	Constant &Trend	1.7*	-2.63	-2.75	-3

Note: *, **, and *** show the significance at 1%, 5%, and 10% levels, respectively.

Table 7 Effect of COVID on Trade

Variable	Coefficient	Std. Error	Z	P-value
MG Estimator				
Exports	0.8476273	0.1172567	7.23	0.000*
Cases	-7.806136	22.78276	-0.34	0.732
Constant	5434216	2975549	1.83	0.068
Sigma	1.3e+06			
Wald chi sq.	54.97			0.000*
CCEMG Estimator				
Exports	-0.1494093	0.3093655	-0.48	0.629
Cases	2403.605	2390.956	1.01	0.315
L_imports	-0.8088756	2.01037	-0.40	0.687
L_cases	31.08468	44.30146	0.70	0.483
L_exports	1.369468	1.99437	0.69	0.492
Constant	5915679	7393811	0.80	0.424
Sigma	2.9e+05			
Wald chi sq.	1.07			0.5856

Note: *, **, and *** show the significance at 1%, 5%, and 10% levels, respectively.

Table 8 Effect of Trade on COVID

Variable	Coefficient	Std. Error	t	P-value
Fixed Effects Estimator				
Exports	-0.591858	0.006993	-8.46	0.000*
Imports	0.0690092	0.0079819	8.65	0.000*
Constant	-147060.6	106256.5	-1.38	0.167
Sigma_e	362044.45			
F(44, 313)	3.16			0.000*
Random Effects Estimator				
Exports	-0.129794	0.0032363	-6.79	0.000*

Imports	0.0241786	0.0025385	9.52	0.000*
Constant	41012.39	36952.78	1.11	0.267
Sigma_e	362044.45			
Wald chi sq.	122.44			0.000*

Note: *, **, and *** show the significance at 1%, 5%, and 10% levels, respectively.

Table 9 Hausman Test

Variable	Fixed	Random
Exports	-0.591858	-0.219794
Imports	0.0690092	0.0241786
Chi2(2)	41.90 (0.000)*	

Note: *, **, and *** show the significance at 1%, 5%, and 10% levels, respectively.

Table 10 Effect of Trade on COVID

Variable	Coefficient	Std. Error	Z	P-value
MG Estimator				
Exports	-0.0011507	0.0103094	-0.11	0.911
Imports	0.0115719	0.0072455	1.60	0.110
Constant	-147232.8	184852.6	-0.80	0.426
Sigma	9.3e+04			
Wald chi sq.	3.44			0.1795
CCEMG Estimator				
Exports	-0.0051115	.0039426	-1.30	0.195
Imports	-0.0049373	0.0059471	-0.83	0.406
L_imports	-0.0157499	0.0143216	-1.10	0.271
L_cases	0.918665	0.608794	1.51	0.131
L_exports	0.015585	0.0111538	1.40	0.162
Constant	11916.21	41295.24	0.29	0.773
Sigma	8.1e+03			

Wald chi sq.	4.52	0.1042

Note: *, **, and *** show the significance at 1%, 5%, and 10% levels, respectively.

Table 11 Toda Yamamoto Granger Causality Test

Country	Exports to Cases	Cases to Exports	Causality	Imports to Cases	Cases to Imports	Causality
Austria (D)	58.56424 (0.000)*	14.68663 (0.0006)*	Bidirectional	34.22086 (0.000)*	213.6608 (0.000)*	Bidirectional
Bulgaria (D)	6.691779 (0.0352)**	2.878692 (0.2371)	Unidirectional	0.012043 (0.994)	8.320767 (0.0156)**	Unidirectional
Switzerland (D)	60.7466 (0.000)*	32.8204 (0.000)*	Bidirectional	78.16903 (0.000)*	0.834288 (0.6589)	Unidirectional
Cyprus (D)	0.43631 (0.804)	0.62932 (0.73)	No causality	1.860674 (0.3944)	0.399802 (0.8188)	No causality
Czech Republic (D)	5.029416 (0.0809)***	139.783 (0.000)*	Bidirectional	17.88903 (0.0001)*	15.49306 (0.0004)*	Bidirectional
Germany (D)	5.505879 (0.0637)***	6.496841 (0.0388)**	Bidirectional	7.883554 (0.0194)**	27.0372 (0.000)*	Bidirectional
Denmark (D)	2.982739 (0.2251)	9.092542 (0.0106)**	Unidirectional	1.515879 (0.4686)	69.30318 (0.000)*	Unidirectional
Spain (D)	3.655408 (0.1608)	6.124615 (0.0468)**	Unidirectional	8.41859 (0.0149)**	39.61195 (0.000)*	Bidirectional
Estonia (D)	1.768388 (0.413)	40.27283 (0.000)*	Unidirectional	10.98274 (0.0041)*	5.850539 (0.0537)***	Bidirectional
Finland (D)	6.904226 (0.0317)**	408.932 (0.000)*	Bidirectional	3252.007 (0.000)*	5765.051 (0.000)*	Bidirectional
France (D)	4.529225 (0.1039)	2.299343 (0.3167)	No causality	2.799241 (0.2467)	1.525963 (0.4663)	No causality

UK (D)	2.833188 (0.2425)	5.355539 (0.0687)***	Unidirectional	2.330604 (0.3118)	11.54305 (0.0031)*	Unidirectional
Greece (D)	11.54977 (0.0031)*	4.400611 (0.1108)	Unidirectional	9.632155 (0.0081)*	3.793248 (0.1501)	Unidirectional
Croatia (D)	355.2325 (0.000)*	26.84081 (0.000)*	Bidirectional	868.7137 (0.000)*	0.155013 (0.9254)	Unidirectional
Hungary (D)	2.728765 (0.2555)	6.259351 (0.0437)**	Unidirectional	23.99266 (0.000)*	163.3088 (0.000)*	Bidirectional
Ireland (D)	151.2378 (0.000)*	297.4996 (0.000)*	Bidirectional	0.836439 (0.6582)	0.000879 (0.9996)	No causality
Italy (D)	1034.946 (0.000)*	1.961694 (0.375)	Unidirectional	7.914478 (0.0191)**	3.377596 (0.1847)	Unidirectional
Lithuania (D)	10.607 (0.005)*	252.9025 (0.000)*	Bidirectional	10.23653 (0.006)*	82.02579 (0.000)*	Bidirectional
Latvia (D)	110.2007 (0.000)*	91.54461 (0.000)*	Bidirectional	33.20826 (0.000)*	132.7253 (0.000)*	Bidirectional
Malta (D)	15.49332 (0.0004)*	15.12476 (0.0005)*	Bidirectional	177.0362 (0.000)*	46.66793 (0.000)*	Bidirectional
Netherlands (D)	2.253083 (0.3242)	5.437195 (0.066)***	Unidirectional	1.407146 (0.4948)	9.215231 (0.01)*	Unidirectional
Norway (D)	9.426069 (0.009)*	11.19867 (0.0037)*	Bidirectional	3.985302 (0.1363)	58.62621 (0.000)*	Unidirectional
Poland (D)	0.715344 (0.6993)	0.745166 (0.689)	No causality	6.111498 (0.0471)**	17.71405 (0.0001)*	Bidirectional
Portugal (D)	2.323963 (0.3129)	0.216792 (0.8973)	No causality	1.803089 (0.4059)	0.469675 (0.7907)	No causality

Romania (D)	3.699948 (0.1572)	0.103059 (0.9498)	No causality	2.68977 (0.2606)	0.319644 (0.8523)	No causality
Russia (D)	1.485027 (0.4759)	0.334704 (0.8459)	No causality	11.81809 (0.0027)*	58.23432 (0.000)*	Bidirectional
Slovenia (D)	142.399 (0.000)*	10.81892 (0.0045)*	Bidirectional	1029.994 (0.000)*	83.8415 (0.000)*	Bidirectional
Sweden (D)	3.5591 (0.1687)	0.754013 (0.6859)	No causality	1.8074 (0.4051)	0.961736 (0.6182)	No causality
Canada (D)	3.485136 (0.1751)	5.373614 (0.0681)***	Unidirection al	164.7311 (0.000)*	132.3027 (0.000)*	Bidirectional
Australia (D)	0.128169 (0.9379)	0.880936 (0.6437)	No causality	241.5011 (0.000)*	5.763745 (0.056)**	Bidirectional
Japan (D)	51.02016 (0.000)*	0.82852 (0.6608)	Unidirection al	24.0584 (0.000)*	44.55133 (0.000)*	Bidirectional
USA (D)	0.061246 (0.9698)	0.294141 (0.8632)	No causality	0.456214 (0.796)	767.9892 (0.000)*	Unidirectional
Georgia (d)	10.39593 (0.0055)*	10.40977 (0.0055)*	Bidirectional	1.550231 (0.4607)	0.762771 (0.6829)	No causality
Bahrain (d)	1.734478 (0.4201)	1.812562 (0.404)	No causality	35.68694 (0.000)*	0.558027 (0.7565)	Unidirectional
Bolivia (d)	9.173998 (0.0102)**	0.080449 (0.9606)	Unidirection al	19.02397 (0.0001)*	0.722409 (0.6968)	Unidirectional
Salvador (d)	1165.925 (0.000)*	0.6931 (0.7071)	Unidirection al	44.1478 (0.000)*	0.006645 (0.9967)	Unidirectional
Korea (d)	6.940462 (0.0311)**	55.84315 (0.000)*	Bidirectional	3.408675 (0.1819)	38.74771 (0.000)*	Unidirectional

Madagascar (d)	16.62834 (0.0002)*	1.271445 (0.5296)	Unidirectional	1.110731 (0.5739)	2.498307 (0.2867)	No causality
Mozambique (d)	112.016 (0.000)*	1.146738 (0.5636)	Unidirectional	230.9485 (0.000)*	0.084628 (0.9586)	Unidirectional
Paraguay (d)	0.044606 (0.9779)	0.650255 (0.7224)	No causality	38.89216 (0.000)*	0.17177 (0.9177)	Unidirectional
Maldives (d)	1.074009 (0.5845)	1.790192 (0.4086)	No causality	195.9057 (0.000)*	0.602826 (0.7398)	Unidirectional
South Africa (d)	9.809963 (0.0074)*	0.502456 (0.7778)	Unidirectional	1.496451 (0.4732)	10.60528 (0.005)*	Unidirectional
Thailand (d)	4.558252 (0.1024)	22.73412 (0.000)*	Unidirectional	13.5049 (0.0012)*	48.91606 (0.000)*	Bidirectional
Turkey (d)	0.203346 (0.9033)	0.267235 (0.8749)	No causality	1.725985 (0.4219)	4.817004 (0.0899)***	Unidirectional

Note: *, **, and *** show the significance at 1%, 5%, and 10% levels, respectively; (D) denotes a Developed Economy and (d) denotes a Developing Economy.

VI. COMPLIANCE WITH ETHICAL STANDARDS

- Conflict of Interest: The authors declare that they have no conflict of interest.
- Ethical Approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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