sustainability

MDPI

Article

Estimating the Impact of COVID-19 on International Trade: Cases of Major Countries Using the SUR Model

Taeil Kim [1], Sunghwa Park [2,*], Hanna Kim [1] and Janghan Kwon [3]

[1] Maritime Policy Research Department, Korea Maritime Institute, Busan 49111, Republic of Korea; ktizorro@kmi.re.kr (T.K.); h.kim@kmi.re.kr (H.K.)
[2] College of Business Administration, Gyeongsang National University, Jinju 52828, Republic of Korea
[3] Ocean Economy Strategy Department, Korea Maritime Institute, Busan 49111, Republic of Korea; jkwon@kmi.re.kr
* Correspondence: sh.park@gnu.ac.kr

Abstract: This study examined the intricate effects of the COVID-19 pandemic on international trade complexity. Focusing on major international trading entities such as Hong Kong, Korea, China, Japan, and the U.S., we evaluated how confirmed COVID-19 cases and government responses influenced trade patterns, particularly in exports and imports. We employed a seemingly unrelated regression (SUR) analysis with cyclic regression coefficients to scrutinize changes in trade relationships between 2020 and 2021. Korea serves as the central country for this analysis, and the findings extend to other nations. The results revealed the varied impact of COVID-19 on trade across countries. Exports from Korea to China were correlated with COVID-19 case numbers and government actions in both countries. Additionally, imports from China, Japan, the U.S. and Vietnam—excluding Hong Kong—were significantly influenced by confirmed COVID-19 cases in Korea, reflecting the demand dynamics. Government interventions also played a substantial role in shaping trade patterns. Previous studies have primarily focused on financial markets and supply chains, whereas our study analyzed the changes in trade with Korea's five largest trading partners: China, the U.S., Japan, Vietnam, and Hong Kong. Notably, we utilized long-term data and changes in major trading partners in Asia over time.

Keywords: COVID-19; international trade; Asian countries; seemingly unrelated regression

Citation: Kim, T.; Park, S.; Kim, H.; Kwon, J. Estimating the Impact of COVID-19 on International Trade: Cases of Major Countries Using the SUR Model. *Sustainability* **2023**, *15*, 16560. https://doi.org/10.3390/su152416560

Academic Editors: Jacob Arie Jordaan and Gioacchino Pappalardo

Received: 29 September 2023
Revised: 1 December 2023
Accepted: 1 December 2023
Published: 5 December 2023

1. Introduction

On 11 March 2020, the World Health Organization (WHO) declared COVID-19 a pandemic, with critical global impacts since its outbreak [1]. As of 1 April 2022, WHO reported 486,761,597 confirmed cases (cumulative) and 6,142,735 deaths [2]. This pandemic significantly affected international trade, leading to a decline since WHO declared a national emergency due to COVID-19, causing fluctuations in gradual growth (Figure 1).

The COVID-19 pandemic has impacted both exporting and importing countries. The spread of COVID-19 prompted various levels of social distancing and lockdown orders. From an exporting country's standpoint, these measures affected industrial production, leading to a sharp decrease in the labor force and a subsequent reduction in the production of goods, thereby hampering exports. Additionally, disruptions in marine and land transportation cycles increased logistics costs and potentially caused delays in exports. In essence, exporting countries encountered challenges of reduced production and supply chain disruptions.

For importing countries, the spread of COVID-19 was anticipated to decrease demand. However, there might be an offsetting effect due to an increase in overseas direct purchases resulting from the expansion of telecommuting, among other factors.

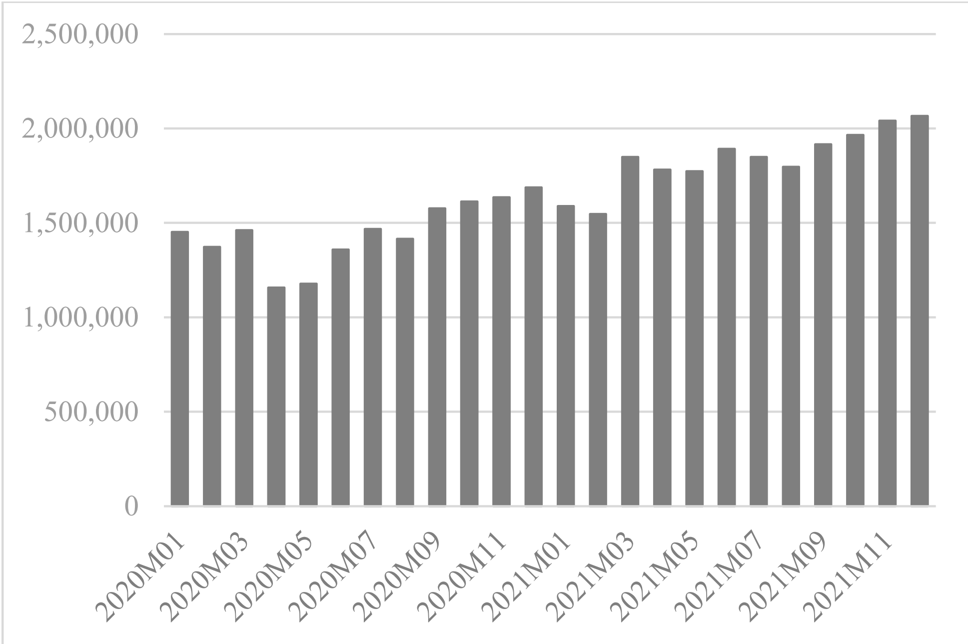

Figure 1. World exports (US Dollars, Millions, FOB).

Furthermore, these effects may vary based on the severity of COVID-19 cases among countries and governments' crisis response measures. This can act as a factor affecting international trade, shipping, and air logistics. Notably, ocean freight rates surged due to the spread of COVID-19, and operational efficiency at ports significantly declined [3]. Government measures are also expected to impact the operation of maritime transport and port authorities.

This study aimed to examine the complexity that emerged in international trade due to COVID-19. We analyzed the Special Administrative Region of Hong Kong and major international trading entities such as Korea, China, Japan, and the US. Specifically, we examined how the number of confirmed cases and government responses in each country affected international trade (exports and imports). Korea was selected as the central country, and the results could be applied to the analysis of other nations.

This study contributes to existing research in several ways. Firstly, the analysis period spans from early 2020 to the end of 2021, constituting a relatively long term compared to existing literature that primarily focused on the early stages of the COVID-19 pandemic. Secondly, the construction of panel data and an appropriate model allows for dynamic analysis. Thirdly, we analyzed the impact of the spread of COVID-19 using country comparisons and evaluated the correlation between confirmed cases among trading countries and government measures. Fourthly, we examined how the influence of variables on trade changes over time.

Analyzing how the spread of COVID-19 differs by import and export trade and by country is critical. This has implications for intergovernmental cooperation among countries to promote trade, such as cooperation in quarantine systems or collaboration in trade, transportation, and logistics systems. Cooperation becomes crucial when unloading at ports and airports is not possible. Additionally, cooperative discussions on the effort required to build a supply chain and improve the logistics system under the impact of international trade between private companies will be possible.

2. Literature Review

Numerous papers have recently been published examining the impact of COVID-19 on trade. Friedt and Zhang [4], utilizing monthly export data from Chinese provinces, reported that the primary factor contributing to the decline in Chinese imports during the pandemic was the production disruption in countries supplying intermediate goods. Barbero et al. [5] employed a gravitational trade model, analyzing monthly trade data from 68 countries between January 2019 and October 2020. They revealed that COVID-19 had a more substantial negative impact on bilateral trade in countries that were members of regional trade agreements before the pandemic. Additionally, the negative impact of COVID-19 was significant in relation to indicators of government actions, with exports between high-income countries being the most negatively affected. Büchel et al. [6] investigated the impact of COVID-19 on international trade in goods using trade data from the Swiss Federal Customs Service for the period between January and July 2020. They observed an 11% decline in Swiss trade compared to 2019 during this period, attributing it to the federal lockdown in mid-March negatively impacting both the supply and demand side of foreign trade. Demir and Javorcik [7] focused on export transactions backed by letters of credit and documentary collection, finding them to be more resilient to the COVID-19 crisis compared to transactions using open accounts or cash in advance. Vidya and Prabheesh [8] measured trade interconnection between countries before and after the COVID-19 outbreak, predicting a sharp decline in trade for most economies by December 2020. Li and Lin [9] established a global general equilibrium for 26 countries using 2018 data as a benchmark and simulated the trade effect of COVID-19. The simulation results indicated a significant impact on trade and exports for all countries. Hayakawa and Mukunoki [10] estimated the gravitational equation using various variables for COVID-19 damage. Their findings showed a significant negative impact on international trade in both exporting and importing countries. They identified heterogeneous effects across industries, with negative effects on non-essential and durable goods persisting for a long time, while positive effects were observed in the industry providing medical products. Xu et al.'s [11] study, similar to the present one, investigated the gap in shipping trade between China and three regions (ASEAN, the European Union, and the United States) from February to October 2020. They found that the government's preventive and control measures against COVID-19 negatively affected export trade while import trade increased. Various studies have also conducted impact analyses on economic aspects [12–14], global supply chain disruption, demand decline [15,16], stock market returns, and volatility [17,18] in the context of the COVID-19 pandemic.

Moreover, studies have delved into the impact of COVID-19 on maritime transport, the primary mode of international trade [19–25]. Michail and Melas [26] specifically linked the outbreak of COVID-19 to dry bulk and dirty tankers in the shipping industry, a derivative of international trade, highlighting the negative effects on the shipping market.

While previous studies have examined the impact of the COVID-19 pandemic on financial markets and supply chains, and some have analyzed trade during the pandemic, this study distinguishes itself by adopting a relatively long-term perspective (2020–2021) and incorporating changes in major trading partners in Asia over time. The focus is on analyzing shifts in trade with Korea's five largest trading partners: China, the United States, Japan, Vietnam, and Hong Kong. The study aims to unveil the impact of government preventive and control measures on trade, providing insights not only for trading companies but also for logistics and shipping companies in making strategic decisions.

3. Materials and Methods

3.1. Data

In this study, trade statistics relied on import/export data from Korea. Figure 2 shows share of Korea's major import and export countries as of the end of 2021 [27]. As shown in Figure 2, Korea's five major exporting countries are China, the U.S., Vietnam, Japan, and Hong Kong, while the major importing countries are China, the U.S., Japan, Australia, and

Saudi Arabia. Given Korea's profile as a nation predominantly importing raw materials and exporting industrial products, exports take precedence in its trade dynamics [27]. Among the importing nations, Australia primarily imports coal, and Saudi Arabia predominantly imports crude oil, resulting in a trade structure centered around a single cargo [27]. To comprehensively examine the effects of COVID-19, with a focus on various industrial products, this study centers on exporting countries.

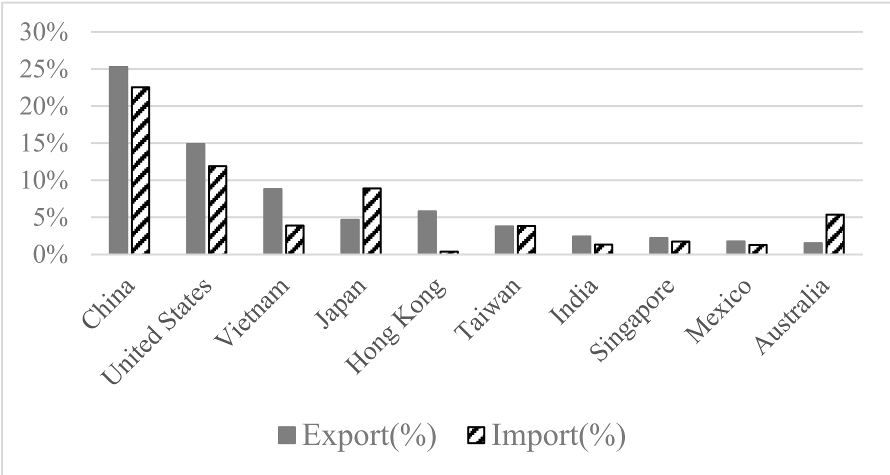

Figure 2. Share of Korea's major import/export countries as of the end of 2021 (%).

Confirmed COVID-19 cases are anticipated to negatively impact both imports and exports. However, government measures to combat COVID-19 are expected to mitigate this negative impact. The analysis period spans from January 2020 to December 2021. The dependent variables in this study are Korea's exports (ex) and imports (im) by country. Independent variables include the monthly number of confirmed cases by country (Confirmed Cases; CC), the monthly number of confirmed cases in Korea (Confirmed Cases; koCC), the government response index (GRI), and government response measures in Korea (KoGRI). Cumulative confirmed cases were chosen as an independent variable under the assumption that concerns about the cumulative number of confirmed cases would exert a greater impact on imports and exports than new cases [28].

To scrutinize how the number of confirmed cases influences imports and exports, the number of confirmed cases in each country was adopted as an independent variable, as seen in previous studies [4,11]. The GRI was selected from the COVID-19 Government Response Tracker [28] database, as it incorporates various indices, such as the containment and health index, stringency index, and economic support index, among others. The GRI provides a comprehensive evaluation of these indices, offering an estimation of the effect on imports and exports that reflects the policy efforts of each country. In essence, this index encompasses the severity of sub-concepts, economic support (income support and debt relief), and other relevant factors [28].

Descriptive statistics of the variables employed in this study are outlined in Table 1. Standard errors and means for the sample categories are presented to gauge the variability of the variables. The variables encompass Korea's import and export data by country, the number of confirmed cases, and government countermeasures (GRI) for each country.

Table 1. Descriptive statistics.

Variable	Definition	Unit	Mean	Median	Std. Dev.	Skewness	Kurtosis
Chex	Export from Korea to China	m$	12,311,601.0	12,107,564.0	1,729,142.0	−0.04013	2.279989
Chim	Import from China to Korea	m$	10,313,032.0	10,524,718.0	1,785,010.0	−0.27290	3.784056
HKex	Export from Korea to Hong Kong	m$	2,838,370.0	2,806,012.0	490,359.8	0.17234	2.062000
HKim	Import from Hong Kong to Korea	m$	157,824.3	152,512.5	50,014.2	0.83501	2.995644
Jpex	Export from Korea to Japan	m$	2,298,311.0	2,346,900.0	299,762.7	−0.28697	2.053611
Jpim	Import from Japan to Korea	m$	4,194,383.0	4,085,545.0	549,639.3	−0.25522	2.225669
USex	Export from Korea to the US	m$	7,084,074.0	7,219,431.0	1,185,691.0	−0.31699	2.128292
USim	Import from US to Korea	m$	5,446,066.0	5,506,044.0	806,986.9	−0.08515	1.589191
VNex	Export from Korea to Vietnam	m$	4,384,963.0	4,420,536.0	711,443.8	−0.51286	3.178735
VNim	Import from Vietnam to Korea	m$	1,856,012.0	1,848,374.0	213,066.0	−0.23367	2.002283
ChCC	Confirmed cases in China	Cases	28,916.0	30,705.5	6157.9	−4.18792	19.49395
ChGRI	GRI of China	Index	1640.8	1649.7	295.3	−1.86923	8.474372
HKCC	Confirmed cases in Hong Kong	Cases	220,259.3	268,907.5	150,735.6	−0.29873	1.418800
HKGRI	GRI of Hong Kong	Index	2004.2	2111.9	416.6	−2.34347	8.982595
JpCC	Confirmed cases in Japan	Cases	16,048,736.0	7,895,601.0	19,127,279.0	1.00819	2.552839
JpGRI	GRI of Japan	Index	1465.6	1575.6	406.9	−1.95516	6.776954
USCC	Confirmed cases in the US	Cases	625,000,000.0	631,000,000.0	535,000,000.0	0.22501	1.590511
USGRI	GRI of US	Index	1708.7	1870.7	526.6	−2.34328	7.541412
VNCC	Confirmed cases in Vietnam	Cases	5,656,610.0	45,800.0	12,394,271.0	2.15671	6.502968
VNGRI	GRI of Vietnam	Index	1736.5	1829.0	461.2	−2.35665	8.727254
KoCC	Confirmed cases in Korea	Cases	3,597,055.0	1,841,995.0	4,485,765.0	1.55896	4.711105
KoGRI	GRI of Korea	Index	1660.7	1766.9	409.2	−2.97964	11.92697

3.2. Methodology

This study utilized Zellner's [29] seemingly unrelated regression (SUR) model to assess the heterogeneous characteristics of various import and export countries. The application of the SUR model is an efficient estimator compared to independently estimating the formula for each public transportation method [30]. For instance, when the SUR model is applied, each model is simultaneously estimated by considering the correlation of error terms for demand models for several products or test performance for various subjects.

If G represents multiple variables of the i-th object among N samples set as dependent variables, G regression models can be developed, and the regression coefficients of each model can be calculated using the ordinary least squares (OLS) method. Alternatively, they can be estimated independently (equation-by-equation OLS). However, if the error terms of the G regression models are correlated, the SUR model estimator, based on the generalized least squares (GLS) method, is more efficient than the OLS estimator. The application of the SUR model to the G models also has the advantage of testing cross-equation parameter restrictions on the regression coefficients of the same independent variable included [29,31–33].

In essence, the SUR model extends the application of the GLS estimation method to an equation system with G-dependent variables. The equation system of the i-th entity with G-dependent variables can be expressed as Equation (1) [31,33].

$$\begin{bmatrix} y_{il} \\ \vdots \\ y_{ig} \\ \vdots \\ y_{iG} \end{bmatrix} = \begin{bmatrix} x' & 0 & 0 & 0 & 0 \\ 0 & \ddots & 0 & 0 & 0 \\ 0 & 0 & x'_{ig} & 0 & 0 \\ 0 & 0 & 0 & \ddots & 0 \\ 0 & 0 & 0 & 0 & x'_{iG} \end{bmatrix} \begin{bmatrix} \beta_1 \\ \vdots \\ \beta_g \\ \vdots \\ \beta_G \end{bmatrix} + \begin{bmatrix} \varepsilon_{il} \\ \vdots \\ \varepsilon_{ig} \\ \vdots \\ \varepsilon_{iG} \end{bmatrix}, \quad (1)$$

where y_{ig} is the value of the dependent variable of the g-th model for the i-th individual, x_{ig} is the exogenous variables vector of the g-th model for the i-th individual, and β_g is a vector of $K_g \times 1$ regression coefficients for K_g exogenous variables included in the g-th model. ϵ_{ig} is the error term for y_{ig}. In Equation (1), if the error terms included in the G equations for the i-th entity are correlated, then $\mathrm{E}[\epsilon_j \epsilon'_{j'} | X] = \sigma_{ij'}$ and $j \neq j'$ at the time $\sigma_{ij'} \neq 0$. At this time, if the $N \times 1$ error term vector for each model is defined as ϵ_j (j = 1,2, . . ., G), then

$$\mathrm{E}\left[\epsilon_j | X\right] = 0,\ \mathrm{E}\left[\epsilon_j \epsilon'_j | X\right] = \sigma_{ij} I_N,\ \mathrm{E}\left[\epsilon_j \epsilon'_{j'} | X\right] = \sigma_{ij} I_N \left(j \neq j'\right). \quad (2)$$

Therefore, the conditional covariance matrix Ω of the error term for all exogenous variables X is expressed using Equation (3).

$$\Omega = E\left[\epsilon\epsilon' | X\right] = \sum \otimes I_N, \quad (3)$$

where Σ denotes a $G \times G$ matrix with covariance $\sigma_{ij'}$ as an element, I_N denotes an $N \times N$ identity matrix, and $\otimes$ denotes the Kronecker product between the two matrices.

Applying the OLS method to the equation system with the stated correlation in the error terms ensures the consistency of the regression coefficients values. However, due to the existence of a correlation between error terms, the SUR estimator based on the GLS method is more efficient. The SUR estimator of the regression coefficient is expressed in Equation (4).

$$\hat{\beta} = \left\{X'\left(\Sigma^{-1} \otimes I_N\right)X\right\}^{-1}\left\{X'\left(\Sigma^{-1} \otimes I_N\right)y\right\} \quad (4)$$

In Equation (3), Σ, I_N, X are the same as described previously, and y means a dependent variable vector (GN $\times$ 1) with N individuals for each G model. The SUR estimator $\hat{\beta}$ is estimated sequentially after initially estimating the covariance matrix Ω using the residuals obtained through OLS estimation that does not assume a correlation between error terms.

The generalization of the matrix and system of equations models in this study is as follows:

$$\Delta logY_{ei,i,t} = \beta_0 + \beta_1 \Delta logCC_{i,t} + \beta_2 \Delta logGRI_{i,t-2} + \beta_3 \Delta logCC_{k,t} + \beta_4 \Delta logGRI_{k,t-2} + \varepsilon_{i,t} \quad (5)$$

where $Y_{ei,i,t}$ represents the import/export(ei) with country i in period t. The countries are China, the United States, Japan, Hong Kong, and Vietnam. $CC_{i,t}$ is the number of confirmed cases in country i in period t. $GRI_{i,t-2}$ is the government response measure in country i in period $t-2$. $CC_{k,t}$ is the number of confirmed cases in Korea in the t period, and $GRI_{k,t-2}$ is the government's countermeasures in the $t-2$ period. The time lag between the $t-2$ periods is due to countermeasures being implemented immediately after the occurrence of a confirmed case, while the effect on import and export becomes statistically significant after at least two months.

3.3. Unit Root Test and Multicollinearity Test

Unit root tests were conducted on all variables to assess the stability of the data before analysis. The analysis revealed a unit root in the original time series (level data).

Consequently, all variables were log-differenced to test for unit roots, resulting in stationary time series for all variables, as presented in Table 2. The table displays the results of the Augmented Dickey-Fuller (ADF) test, applying a lag of 5 to log-differential variables.

Table 2. Unit root test.

	Test Critical Values			**ADF Test Statistic**	**Prob.**
	1% Level	**5% Level**	**10% Level**		
Chex	−3.78803	−3.012363	−2.646119	−5.999263	0.0001
Chim	−3.857386	−3.040391	−2.660551	−4.555971	0.0024
HKex	−3.857386	−3.040391	−2.660551	−4.266986	0.0044
HKim	−3.78803	−3.012363	−2.646119	−5.405238	0.0003
Jpex	−3.78803	−3.012363	−2.646119	−3.885526	0.0081
Jpim	−3.78803	−3.012363	−2.646119	−7.518619	0.0000
USex	−3.857386	−3.040391	−2.660551	−5.245058	0.0006
USim	−3.769597	−3.004861	−2.642242	−4.131366	0.0045
VNex	−3.769597	−3.004861	−2.642242	−4.781995	0.0010
VNim	−3.78803	−3.012363	−2.646119	−5.2326	0.0004
ChCC	−3.78803	−3.012363	−2.646119	−13.7749	0.0000
ChGRI	−3.769597	−3.004861	−2.642242	−21.34417	0.0000
HKCC	−3.831511	−3.02997	−2.655194	−3.276495	0.0309
HKGRI	−3.78803	−3.012363	−2.646119	−5.249747	0.0004
JpCC	−3.831511	−3.02997	−2.655194	−4.106955	0.0056
JpGRI	−3.769597	−3.004861	−2.642242	−9.541732	0.0000
USCC	−3.808546	−3.020686	−2.650413	−2.944233	0.0579
USGRI	−3.769597	−3.004861	−2.642242	−2.730207	0.0850
VNCC	−3.769597	−3.004861	−2.642242	−4.326835	0.0029
VNGRI	−3.808546	−3.020686	−2.650413	−6.748324	0.0000
KoCC	−3.769597	−3.004861	−2.642242	−12.23117	0.0000
KoGRI	−3.769597	−3.004861	−2.642242	−27.34188	0.0000

Multicollinearity exists when two or more of the predictors in a regression model are moderately or highly correlated with one another. However, when it exists, it can negatively impact our analysis, thereby limiting our research conclusions. Some of the common methods used for detecting multicollinearity are as follows:

- The analysis exhibits the signs of multicollinearity—such as estimates of the coefficients vary excessively from model to model.
- The *t*-tests for each of the individual slopes are nonsignificant ($p > 0.05$), but the overall *F*-test for testing all of the slopes is significant ($p < 0.05$).
- The correlations among pairs of predictor variables are large.

However, relying solely on pairwise correlations is limiting, as linear dependence can exist among three or more variables. Many regression analysts use variance inflation factors (VIF) to detect multicollinearity [34]. The results of the multicollinearity test are presented in Table 3, where some variables exhibited multicollinearity. Rather than removing these variables, we opted to assess their statistical significance by examining the significance level of the SUR model.

Table 3. Multicollinearity test results: variance inflation factor (VIF) calculations.

Dependent Variable	Independent Variable	Centered VIF
Chex	ChCC	8.885369
	ChGRI(-2)	2.628776
	KoCC	6.162145
	KoGRI(-2)	3.713037
HKex	HKCC	3.662980
	HKGRI(-2)	7.738799
	KoCC	2.158777
	KoGRI(-2)	5.870335
Jpex	JpCC	18.29394
	JpGRI(-2)	14.06982
	KoCC	13.31710
	KoGRI(-2)	9.364787
USex	USCC	6.115973
	USGRI(-2)	4.451580
	KoCC	5.715250
	KoGRI(-2)	5.372404
VNex	VNCC	11.75435
	VNGRI(-2)	5.833888
	KoCC	12.42780
	KoGRI(-2)	5.979388
Chim	ChCC	8.885369
	ChGRI(-2)	2.628776
	KoCC	6.162145
	KoGRI(-2)	3.713037
HKim	HKCC	3.662980
	HKGRI(-2)	7.738799
	KoCC	2.158777
	KoGRI(-2)	5.870335
Jpim	JpCC	18.29394
	JpGRI(-2)	14.06982
	KoCC	13.31710
	KoGRI(-2)	9.364787
USim	USCC	6.115973
	USGRI(-2)	4.451580
	KoCC	5.715250
	KoGRI(-2)	5.372404
VNim	VNCC	11.75435
	VNGRI(-2)	5.833888
	KoCC	12.42780
	KoGRI(-2)	5.979388

4. Results

4.1. Seemingly Unrelated Regression

In general, the model of this study cannot be estimated using Ordinary Least Squares (OLS) when a relationship exists between error terms. In such cases, the model can be effectively estimated using seemingly unrelated regression (SUR), as advocated by Zellner [29], as previously mentioned. SUR yields superior results compared to OLS, providing a basis for comparison of the analysis outcomes. The individual equations input into the SUR model are as follows:

$$\Delta logChex_t = \beta_1 + \beta_2 \Delta logChCC_t + \beta_3 \Delta logChGRI_{t-2} + \beta_4 \Delta logKoCC_t + \beta_5 \Delta logKoGRI_{t-2} + \varepsilon_{1t}, \quad (6)$$

$$\Delta logChim_t = \beta_6 + \beta_7 \Delta logChCC_t + \beta_8 \Delta logChGRI_{t-2} + \beta_9 \Delta logKoCC_t + \beta_{10} \Delta logKoGRI_{t-2} + \varepsilon_{2t} \quad (7)$$

$$\Delta logHKex_t = \beta_{11} + \beta_{12} \Delta logHKCC_t + \beta_{13} \Delta logHKGRI_{t-2} + \beta_{14} \Delta logKoCC_t + \beta_{15} \Delta logKoGRI_{t-2} + \varepsilon_{3t}, \quad (8)$$

$$\Delta logHKim_t = \beta_{16} + \beta_{17} \Delta logHKCC_t + \beta_{18} \Delta logHKGRI_{t-2} + \beta_{19} \Delta logKoCC_t + \beta_{20} \Delta logKoGRI_{t-2} + \varepsilon_{4t}, \quad (9)$$

$$\Delta logJpex_t = \beta_{21} + \beta_{22} \Delta logJpCC_t + \beta_{23} \Delta logJpGRI_{t-2} + \beta_{24} \Delta logKoCC_t + \beta_{25} \Delta logKoGRI_{t-2} + \varepsilon_{5t}, \quad (10)$$

$$\Delta logJpim_t = \beta_{26} + \beta_{27} \Delta logJpCC_t + \beta_{28} \Delta logJpGRI_{t-2} + \beta_{29} \Delta logKoCC_t + \beta_{30} \Delta logKoGRI_{t-2} + \varepsilon_{6t}, \quad (11)$$

$$\Delta logUSex_t = \beta_{31} + \beta_{32} \Delta logUSCC_t + \beta_{33} \Delta logUSGRI_{t-2} + \beta_{34} \Delta logKoCC_t + \beta_{35} \Delta logKoGRI_{t-2} + \varepsilon_{7t}, \quad (12)$$

$$\Delta logUSim_t = \beta_{36} + \beta_{37} \Delta logUSCC_t + \beta_{38} log\Delta USGRI_{t-2} + \beta_{39} \Delta logKoCC_t + \beta_{40} \Delta logKoGRI_{t-2} + \varepsilon_{8t}, \quad (13)$$

$$\Delta logVNex_t = \beta_{41} + \beta_{42} \Delta logVNCC_t + \beta_{43} \Delta logVNGRI_{t-2} + \beta_{44} \Delta logKoCC_t + \beta_{45} \Delta logKoGRI_{t-2} + \varepsilon_{9t}, \quad (14)$$

$$\Delta logVNim_t = \beta_{46} + \beta_{47} \Delta logVNCC_t + \beta_{48} \Delta logVNGRI_{t-2} + \beta_{49} \Delta logKoCC_t + \beta_{50} \Delta logKoGRI_{t-2} + \varepsilon_{10t} \quad (15)$$

Here, the initial "*ex*" in the formula denotes export, and "*im*" signifies import. "*Ch*" represents China, "*HK*" represents Hong Kong, "*Jp*" represents Japan, "*US*" represents the United States, "*VN*" represents Vietnam, "*CC*" represents Confirmed Cases, and "*GRI*" represents Government Response Index. For instance, in Equation 6, the dependent variable signifies Korea's exports to China, where "*ChCC*" is the confirmed case in China, "*ChGRI*" is the government action in China, "*KoCC*" is the confirmed case in Korea, and "*KoGRI*" is the government action in Korea. ε_t represents an error term in the t period.

Estimation using the SUR model demonstrates higher efficiency compared to the OLS model, as noted by Zellner [29]. The SUR model comprises seemingly unrelated regression equations that are interrelated. It encompasses multiple regression equations, analyzing them while considering the correlation of error terms between these equations. In the realm of world trade, where intricate factors often influence one another, the information in the error term is frequently correlated. The SUR model proves to be a suitable tool for considering such complex factors. The analysis results of the SUR model are presented in Tables 4 and 5.

Table 4. Regression results (SUR) for trade (Export).

Dependent Variables		Coefficient	Std. Error	t-Statistic	Prob.	R-Squared
Chex	Constants	2,755,566	2,899,861	0.950241	0.3433	0.899476
	ChCC	1.569573	0.549094	2.858476	0.0048	
	ChGRI(-2)	−7.603143	13.53470	−0.561752	0.5750	
	KoCC	0.155260	0.041676	3.725366	0.0003	
	KoGRI(-2)	680.2137	368.9428	1.843683	0.0670	
HKex	Constants	2,813,991	338,061.5	8.323903	0.0000	0.551745
	HKCC	1.953855	0.812988	2.403302	0.0173	
	HKGRI(-2)	264.5897	349.4195	0.757226	0.4500	
	KoCC	0.028519	0.021133	1.349461	0.1790	
	KoGRI(-2)	−630.6404	330.5574	−1.907809	0.0581	
Jpex	Constants	2,276,348	140,006.4	16.25888	0.0000	0.734538
	JpCC	0.005333	0.005315	1.003352	0.3171	
	JpGRI(-2)	573.3913	236.4426	2.425076	0.0164	
	KoCC	0.021524	0.020057	1.073136	0.2847	
	KoGRI(-2)	−595.5373	195.5090	−3.046087	0.0027	
USex	Constants	7,130,185	423,811.0	16.82397	0.0000	0.818476
	USCC	0.001126	0.000205	5.484495	0.0000	
	USGRI(-2)	32.91608	6.004971	5.481471	0.0000	
	KoCC	0.028940	0.045900	0.630502	0.5292	
	KoGRI(-2)	−2561.219	456.6334	−5.608916	0.0000	
VNex	Constants	5,288,172	507,681.5	10.41632	0.0000	0.682445
	VNCC	0.036603	0.022279	1.642979	0.1022	
	VNGRI(-2)	−56.01063	12.90683	−4.339611	0.0000	
	KoCC	−0.020431	0.068446	−0.298497	0.7657	
	KoGRI(-2)	1186.450	336.9515	3.521129	0.0006	

Table 5. Regression results (SUR) for trade (Import).

Dependent Variables		Coefficient	Std. Error	t-Statistic	Prob.	R-Squared
Chim	Constants	3,367,167	4,040,174	0.833421	0.4058	0.817359
	ChCC	1.103938	0.767528	1.438303	0.1522	
	ChGRI(-2)	11.82608	17.62857	0.670847	0.5032	
	KoCC	0.220241	0.057793	3.810878	0.0002	
	KoGRI(-2)	−164.8619	497.8159	−0.331170	0.7409	
HKim	Constants	158,290.7	43,072.20	3.675007	0.0003	0.354964
	HKCC	0.179989	0.108031	1.666086	0.0975	
	HKGRI(-2)	−54.91931	44.53351	−1.233213	0.2192	
	KoCC	0.003177	0.002749	1.155635	0.2495	
	KoGRI(-2)	34.00363	42.36556	0.802624	0.4233	
Jpim	Constants	4,154,091	292,284.6	14.21248	0.0000	0.575709
	JpCC	−0.005673	0.012415	−0.456963	0.6483	
	JpGRI(-2)	838.0596	533.1658	1.571855	0.1178	
	KoCC	0.086290	0.046246	1.865886	0.0638	
	KoGRI(-2)	−808.8721	434.0727	−1.863449	0.0641	
USim	Constants	5,064,251	314,156.1	16.12018	0.0000	0.811930
	USCC	0.001123	0.000150	7.497226	0.0000	
	USGRI(-2)	−11.40261	4.764915	−2.393036	0.0178	
	KoCC	−0.120421	0.033740	−3.569066	0.0005	
	KoGRI(-2)	146.6877	353.1224	0.415402	0.6784	
VNim	Constants	2,026,098	187,044.8	10.83215	0.0000	0.525000
	VNCC	−0.004888	0.009217	−0.530304	0.5966	
	VNGRI(-2)	−7.944791	5.071507	−1.566554	0.1191	
	KoCC	0.040327	0.027988	1.440904	0.1515	
	KoGRI(-2)	85.12596	128.5287	0.662311	0.5087	

4.2. Description of Analysis Results

The results revealed that the negative coefficient (β) indicated that the variable primarily affecting exports was the government's action (GRI). Consequently, Korea's exports were predominantly influenced by the COVID-19-related measures implemented by the Korean government. Similarly, the negative coefficient (β) indicated that the variable mainly impacting imports was the counterpart government action (Partner_GRI). In essence, trade was primarily shaped by governmental measures in response to the COVID-19 pandemic. Other government measures had a predominant effect on Korea's exports, while Korea's government measures primarily influenced Korea's imports. Additionally, a small coefficient size suggests a minor impact on imports and exports. However, caution is necessary when interpreting variables with non-significant *p*-values. For instance, Korea's exports to China (Chex) have a *p*-value of 0.5750 for China's government measures (ChGRI-2), indicating no significant effect. Similarly, Korea's exports to Hong Kong (HKex) show non-significant *p*-values of 0.4500 for Hong Kong's government measures (HKGRI-2) and 0.1790 for confirmed cases in Korea (KoCC). On the contrary, Hong Kong's confirmed cases (HKCC) and Korea's government measures (KoGRI-2), with *p*-values of 0.0173 and 0.0581, respectively, are interpreted as having a more substantial impact. Additionally, R-squared, indicating the model's goodness of fit, varies but generally falls within appropriate values ranging from 0.35 to 0.89.

As shown in Table 6, a significant characteristic finding is the varied direction of coefficients and levels of statistical significance for each country, with crucial implications for cross-border trade. These results suggest the importance of tailored policies in each country's trade strategy.

Table 6. Sign of the coefficients.

Dependent Variables	Partner_CC	Partner_GRI	Korea_CC	Korea_GRI
Chex	+	−	+	+
Chim	+	+	+	−
HKex	+	+	+	−
HKim	+	−	+	+
Jpex	+	+	+	−
Jpim	+	−	+	−
USex	+	+	+	−
USim	+	−	−	+
VNex	−	−	−	−
VNim	−	−	+	+

Firstly, Korea's exports to China were heavily dependent on the number of confirmed cases in Korea and China's government measures. Exports were also influenced by other countries' government measures, underscoring the significant impact of these measures on trade with China, Korea's largest trading partner. Imports from China were affected by the number of confirmed cases in Korea, reflecting the dependence on imports of raw materials, parts, or finished products from Korea.

Secondly, imports from China, Japan, the United States, Vietnam, and Hong Kong were significantly affected by confirmed cases in Korea, likely due to the demand situation in Korea. Particularly, a positive relationship existed between confirmed cases and Korea's income, reflecting increased purchases of home appliances and overseas goods due to telecommuting.

Thirdly, Korea's exports were influenced by the government measures of other countries, such as the United States and Vietnam. However, Korea's government measures had a negative impact on exports, influenced by factors like social distancing leading to business closures and subsequent production setbacks.

Fourthly, among the five major countries (China, Hong Kong, Japan, the United States, and Vietnam), the United States, being non-Asian, was relatively strongly affected compared to others. South Korea's government measures negatively impacted exports to the United States, while imports from the United States had a positive impact. As previously noted, exports can be considered a situation where the supply chain in Korea faces disruptions, while imports are attributed to the creation of internal demand through government support, leading to increased purchasing power.

4.3. Analysis of Time-Varying Impact: Rolling Regression

Each country exhibited varying effects on imports and exports due to COVID-19. Furthermore, the impact of confirmed cases and government measures related to COVID-19 on import and export trade was expected to differ depending on the evolving time situation. While rolling regression analysis has been utilized in various studies to demonstrate the importance of time change, its application has been lacking in studies related to COVID-19. General regression analysis, assuming long-term average values, lacks the ability to determine changes in estimated coefficients due to structural changes. In contrast, rolling regression analysis allows the examination of long-term statistical changes in estimated coefficients [35,36]. A common assumption in time series analysis is that model parameters are time-invariant. However, given the dynamic nature of the economic environment, assessing whether model parameters remain constant over time is a reasonable consideration. Rolling regression, a time series modeling technique frequently employed in finance and economics [37–40], was, therefore, applied in this study, combining it with Seemingly Unrelated Regression (SUR) estimation for exports and imports to five countries over time. Figures 3 and 4 illustrate the derived coefficients, with cyclic regression spanning from July 2020 to December 2021. The circular regression coefficient is divided into exports and imports, further stratified into eight cases, each considering the number of confirmed cases and government measures by country, along with the number of confirmed cases and government measures in Korea. The analysis revealed distinct temporal movements in these coefficients across countries.

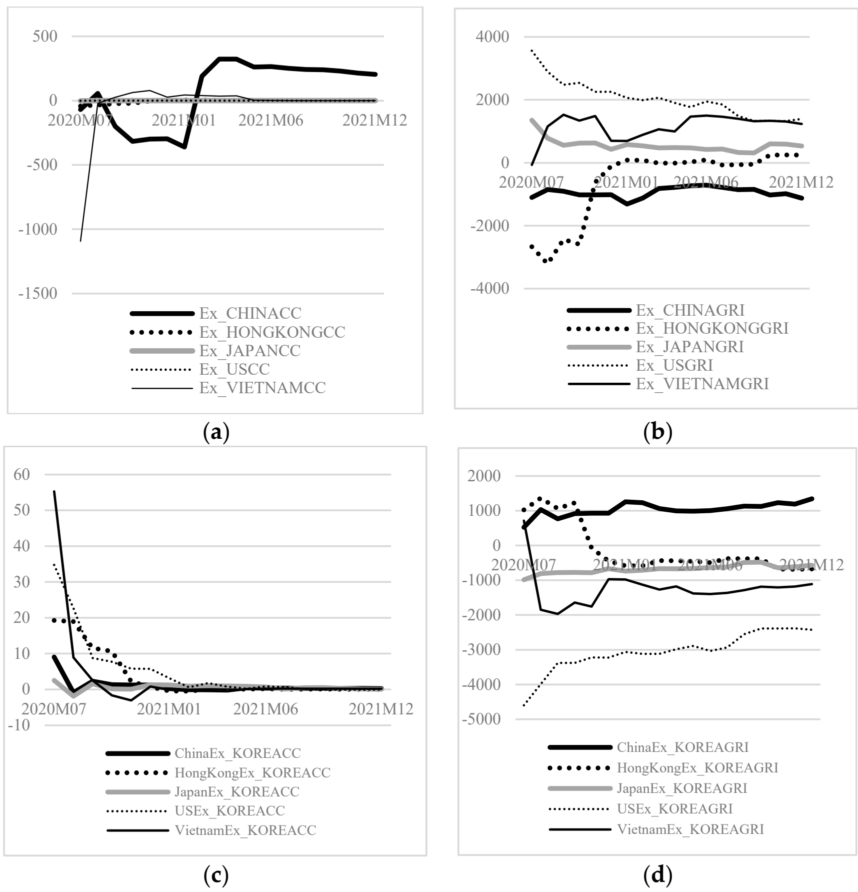

Figure 3. (**a**) Rolling regression coefficients of the corresponding nation's confirmed cases variables for exports; (**b**) Rolling regression coefficients of corresponding government action variables for exports; (**c**) Rolling regression coefficient of Korean confirmed cases variables for exports; (**d**) Rolling regression coefficient of Korean government responses index variables for exports.

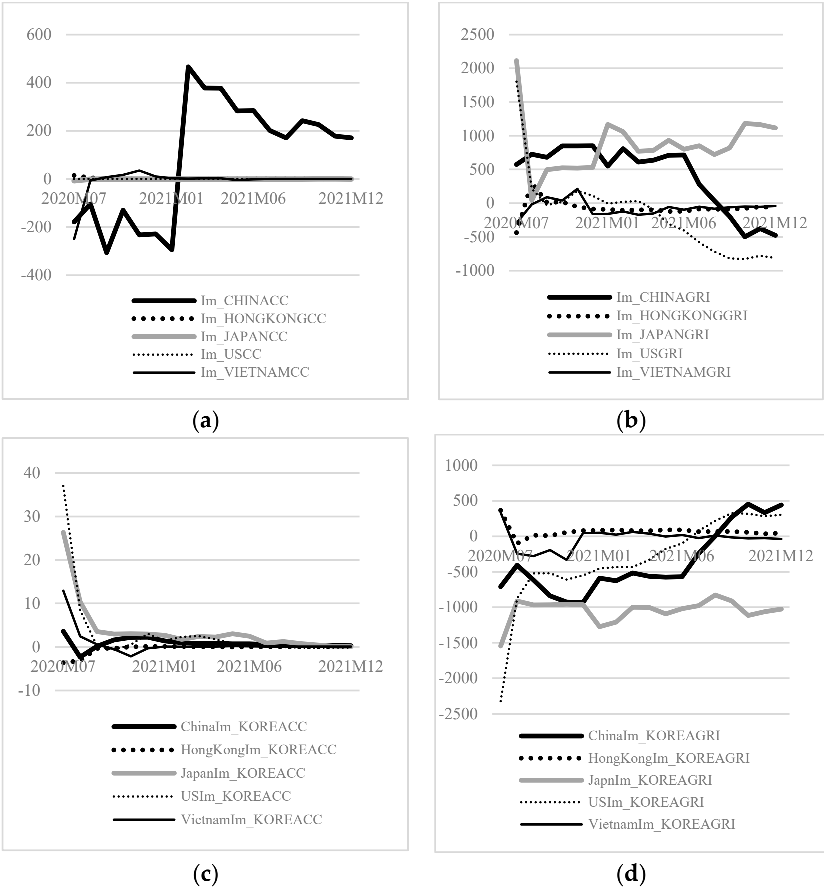

Figure 4. (**a**) Rolling regression coefficients of the corresponding nation's confirmed cases variables for imports; (**b**) Rolling regression coefficients of corresponding government action variables for imports; (**c**) Rolling regression coefficient of Korean confirmed cases variables for imports; (**d**) Rolling regression coefficient of Korean government responses index variables for imports.

The rolling regression coefficient for each country's variable concerning exports demonstrated that most countries did not experience a significant change. However, China exhibited a negative (−) and then a positive (+) coefficient after a certain period, suggesting that while the variable of confirmed cases did not significantly impact Korea's exports in most countries, China and Vietnam, experiencing an initial shock, displayed country-specific characteristics. The rolling regression coefficient for each country's government action variable on exports revealed mostly positive (+) coefficients for most countries, with Hong Kong and China showing negative (−) coefficients. Although Hong Kong's coefficient turned positive over time, most countries displayed a declining trend. The rolling regression coefficient for the Korean confirmed case variable in exports indicated mostly positive (+) coefficients, with a decreasing trend over time for most countries. Finally, the rolling regression coefficient for the Korean government action variable on exports displayed an upward trend, except for Hong Kong, signifying a gradual increase in the positive effect of the Korean government's actions on Korean exports over time.

Similar results were obtained for imports, where the influence of each variable manifested differently over time for each country. The rolling regression coefficient for each country's variable regarding imports revealed rapid fluctuations for China, while most countries displayed a certain shape without significant changes over time. The rolling regression coefficient for each country's government action variable on imports indicated a downward trend for the U.S. and China, whereas other countries exhibited an upward or fine fluctuation. This suggested that over time, Korea's imports from the United States and China were negatively affected by the respective government actions. The rolling regression coefficients of Korean confirmed cases on imports showed that most countries adopted a mode of easing the impact, with the influence of Korea's imports on Korean confirmed cases decreasing over time. The rolling regression coefficient for the Korean government action variable on imports indicated an upward trend, signifying that the negative impact of the Korean government's measures on Korea's imports from each country decreased over time.

4.4. Examples of Measures Taken by Major Countries and Their Main Impact Related to COVID-19

As depicted in online Appendix A Table A1, various government measures were implemented in response to COVID-19, affecting trade and supply chains. In Vietnam, stringent quarantine measures in 2021 led to challenges such as workplace and factory operation restrictions, time movement constraints, delays in customs clearance, disruptions in production for global companies entering Vietnam, and damage to the global supply chain, impacting trade [41]. In Japan, the government's heightened awareness of a crisis in the global supply chain due to the COVID-19 outbreak led to increased demand for countervailing duties as a countermeasure [42]. The U.S. manufacturing industry, heavily reliant on Asian imports, faced direct hits. The U.S. government emphasized building a stable supply chain through the "White House 100-Day Supply Chain Report", strengthening economic interventions to overcome COVID-19 [43]. China, being the first to recover from COVID-19, continued to expand its trade surplus; however, the analysis revealed that its stringent quarantine policy significantly impacted initial import and export trade [44].

This study conducted an in-depth analysis of the COVID-19 pandemic's impact on trade in various countries using the SUR model. From a trade policy perspective, the statistically significant negative effect of exports from Korea to China and the United States due to the government measures of other countries suggests a need for policy cooperation with these two trading partners. Additionally, cooperation with other major trading countries such as Vietnam, Japan, and Hong Kong is deemed crucial for normalizing trade.

5. Conclusions

This study investigated the impact of the COVID-19 pandemic on international trade between 2020 and 2021, utilizing the monthly trade data of five major trading countries and examining the influence of each country's confirmed COVID-19 cases and government countermeasures.

Initially, while the overall impact of COVID-19 on trade was negative across all countries, variations in trade patterns emerged over the past two years, reflecting differences in confirmed cases trends and government countermeasures. This diverges from prior studies that primarily focused on estimating demand decreases as a consequence.

Furthermore, there is a crucial need for cooperation in quarantine systems and trade policies, especially at ports and airports, border facilities where trade activities occur. Thirdly, understanding the evolving dynamics in major countries over time is essential for effective policy cooperation, as trade collaboration significantly impacts the economies of nations with substantial trade scales. For instance, the strategic initiatives announced by Vietnam and South Korea, such as the "New Southern Policy Plus" and "post-COVID-19 comprehensive healthcare cooperation", highlight the importance of strengthening cooperation in response to the pandemic. In the case of Japan and the United States, the study suggests potential areas for investment cooperation, considering the increased job demand in certain sectors and disruptions in the semiconductor supply chain. Finally, with China being a crucial market for Korean companies, collaborative negotiations between the two countries are essential to address trade and investment obstacles, especially considering mega Free Trade Agreements.

However, there remains a need for further research. First, a detailed and systematic analysis of the quarantine and trade policies that led to changes in multilateral trade is required. Additionally, a comprehensive evaluation of the effects of bilateral trade is essential. As the COVID-19 pandemic may become endemic [45], continuous assessment of its impact on trade is necessary. Management implications for various entities, including governments, shipping, ports, airports, and logistics-related companies, should be identified. Second, future research should explore the impact of each country's trade policies on exports and imports from the perspective of traditional trade theory based on macroeconomics. Finally, considering time series models such as the panel vector error correction model could provide valuable insights in future analyses.

Author Contributions: Conceptualization, T.K. and S.P.; data curation, T.K., H.K. and J.K.; formal analysis, T.K. and S.P.; funding acquisition, S.P.; investigation, T.K. and H.K.; methodology, T.K. and S.P.; project administration, H.K.; software, T.K. and S.P.; supervision, S.P.; validation, T.K.; writing—original draft, T.K. and S.P.; writing—review & editing, T.K., S.P., H.K. and J.K. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by a research grant from the Gyeongsang National University in 2023.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Statistical data are provided upon request to the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Estimating the Impact of COVID-19 on International Trade: Cases of Major Countries Using the SUR Model

Table A1. Cases of government measures and major impacts related to COVID-19.

Major Countries	Government Measures and Their Main Impacts Related to COVID-19
Vietnam	Strict quarantine measures created difficulties, such as restrictions on the operation of workplaces and factories, control of gender and time movement, and customs clearance - (Electrical/Electronics) Temporary business disruption occurred in April 2021 owing to an outbreak of community transmission in the Bac Ninh and Bac Giang industrial complexes in northern Vietnam - (Automobile parts) In 2021, the global supply of semiconductor chips and quarantine measures related to COVID-19 significantly contracted automobile assembly and production and the domestic market - (Textiles and Sewing) As a labor-intensive industry, it was severely hit by COVID-19. According to the Vietnam Textile and Apparel Association, as of August 2021, the proportion of companies that completely suspended operations reached 30–35%. Companies also had a utilization rate of less than 20%
Japan	In 2021, the Japanese government raised awareness of a crisis in the global supply chain owing to COVID-19, and demand for countervailing duties increased as a countermeasure. * Countervailing duty: A system recognized by the World Trade Organization (WTO) that imposes tariffs on an amount equivalent to the subsidy on imports subsidized by other governments if it is recognized that they cause harm to the domestic industry Online shopping use increased to a record high owing to refraining from going out and shortening sales after the declaration of emergency - The proportion of internet shopping usage per household was more than 50% during the COVID-19 pandemic The Japanese government has provided subsidy support for Japanese companies moving production bases, such as China to Japan (return) and Southeast Asia, since May 2020.
The U.S.	As Asian countries disrupted US exports owing to COVID-19, US manufacturing, which is highly dependent on Asian imports, was directly hit. * US imports from Asia are 50% semiconductors and 20% automobiles The US emphasizes building a stable supply chain for four industries: semiconductors, batteries, pharmaceuticals, and rare minerals through the "White House 100-Day Supply Chain Report" - The report mentions key allies, such as Korea (74 times), Taiwan (84 times), and Japan (85 times) The proportion of government spending in U.S. GDP was on the decline but rose in 2020, and the government's economic intervention to overcome COVID-19 was confirmed numerically (12.3%⟶12.8%) - The US steel industry was hit hard by the COVID-19 pandemic, with both demand and production plummeting in 2020 (as of the second quarter of 2020, the utilization rate is 56%).
China	Early stabilization of the COVID-19 pandemic through strict quarantine measures by the government - Owing to the government's full publicity and encouragement, China expected to achieve 85–90% vaccination coverage by the end of 2021. - The first to recover from COVID-19 and continue to expand the trade surplus The main factors were (1) recovery of overseas demand from major countries centered on the United States, (2) supply lines that recovered first from COVID-19, (3) increases in the unit price of export products, etc.

Source: KORTA [41–44].

References

1. World Health Organization (2020), Listings of WHO's Response to COVID-19. Available online: https://www.who.int/news/item/29-06-2020-covidtimeline (accessed on 4 April 2022).
2. World Health Organization (n.d.), WHO Coronavirus (COVID-19) Dashboard. Available online: https://covid19.who.int/ (accessed on 4 April 2022).
3. Cullinane, K.; Haralambides, H. Global trends in maritime and port economics: The COVID-19 pandemic and beyond. *Marit. Econ. Logist.* **2021**, *23*, 369–380. [CrossRef]
4. Friedt, F.L.; Zhang, K. The triple effect of COVID-19 on Chinese exports: First evidence of the export supply, import demand and GVC contagion effects. *Covid Econ.* **2020**, *53*, 72–109.
5. Barbero, J.; de Lucio, J.J.; Rodríguez-Crespo, E. Effects of COVID-19 on trade flows: Measuring their impact through government policy responses. *PLoS ONE* **2021**, *16*, e0258356. [CrossRef] [PubMed]
6. Büchel, K.; Legge, S.; Pochon, V.; Wegmüller, P. Swiss trade during the COVID-19 pandemic: An early appraisal. *Swiss J. Econ. Stat.* **2020**, *156*, 22. [CrossRef] [PubMed]
7. Demir, B.; Javorcik, B. Trade finance matters: Evidence from the COVID-19 crisis. *Oxf. Rev. Econ. Policy* **2020**, *36* (Suppl. S1), 397–408. [CrossRef]
8. Vidya, C.T.; Prabheesh, K.P. Implications of COVID-19 pandemic on the global trade networks. *Emerg. Mark. Financ. Trade* **2020**, *56*, 2408–2421. [CrossRef]
9. Li, C.; Lin, X. COVID-19, and trade: Simulated asymmetric loss. *J. Asian Econ.* **2021**, *75*, 101327. [CrossRef]
10. Hayakawa, K.; Mukunoki, H. The impact of COVID-19 on international trade: Evidence from the first shock. *J. Jpn. Int. Econ.* **2021**, *60*, 101135. [CrossRef]
11. Xu, L.; Shi, J.; Chen, J.; Li, L. Estimating the effect of COVID-19 epidemic on shipping trade: An empirical analysis using panel data. *Mar. Policy* **2021**, *133*, 104768. [CrossRef]
12. Daly, J.; Chuenpagdee, R. Community responses to international trade policy: A Newfoundland case study. *Ocean Coast. Manag.* **2021**, *206*, 105578. [CrossRef]
13. Padhan, R.; Prabheesh, K.P. The economics of COVID-19 epidemic: A survey. *Econ. Anal. Policy* **2021**, *70*, 220–237. [CrossRef] [PubMed]
14. Susskind, D.; Vines, D. The economics of the COVID-19 pandemic: An assessment. *Oxf. Rev. Econ. Policy* **2020**, *36* (Suppl. S1), S1–S13. [CrossRef]
15. Ivanov, D. Predicting the impacts of epidemic outbreaks on global supply chains: A simulation based analysis on the Coronavirus outbreak (COVID-19/SARS-CoV-2) case. *Transp. Res. E Logist. Transp. Rev.* **2020**, *136*, 101922. [CrossRef] [PubMed]
16. McKibbin, W.; Fernando, R. The global macroeconomic impacts of COVID-19: Seven scenarios. *Asian Econ. Pap.* **2021**, *20*, 1–30. [CrossRef]
17. Ashraf, B.N. Stock markets' reaction to COVID-19: Cases or fatalities? *Res. Int. Bus. Finance* **2020**, *54*, 101249. [CrossRef]
18. Baker, S.R.; Bloom, N.; Davis, S.J.; Kost, K.; Sammon, M.; Viratyosin, T. The unprecedented stock market reaction to COVID-19. *Rev. Asset Pricing Stud.* **2020**, *10*, 742–758. [CrossRef]
19. Fei, Y.; Chen, J.; Wan, Z.; Shu, Y.; Xu, L.; Li, H.; Bai, Y.; Zheng, T. Crude oil maritime transportation: Market fluctuation characteristics and the impact of critical events. *Energy Rep.* **2020**, *6*, 518–529. [CrossRef]
20. De Oliveira, D.D.; Rojas, E.G.; dos Santos Fernandez, M.A. Should TBT continue to be considered an issue in dredging port areas? A brief review of the global evidence. *Ocean Coast. Manag.* **2020**, *197*, 105303. [CrossRef]
21. Jindřichovská, I.; Uğurlu, E. EU and China Trends in Trade in Challenging Times. *J. Risk Financ. Manag.* **2021**, *14*, 71. [CrossRef]
22. Ugurlu, E.; Jindřichovská, I. Effect of COVID-19 on International Trade among the Visegrad Countries. *J. Risk Financ. Manag.* **2022**, *15*, 41. [CrossRef]
23. Abrhám, J.; Vošta, M. Impact of the COVID-19 Pandemic on EU Convergence. *J. Risk Financ. Manag.* **2022**, *15*, 384. [CrossRef]
24. Tudorache, A.T.; Nicolescu, L. Insights about the Effects of COVID-19 on International Trade during the Main Pandemic Years in Romania and Poland. *Sustainability* **2023**, *15*, 8726. [CrossRef]
25. Erokhin, V.; Gao, T. Impacts of COVID-19 on trade and economic aspects of food security: Evidence from 45 developing countries. *Int. J. Environ. Res. Public Health* **2020**, *17*, 5775. [CrossRef] [PubMed]
26. Michail, N.A.; Melas, K.D. Shipping markets in turmoil: An analysis of the COVID-19 outbreak and its implication. *Transp. Res. Interdiscip. Perspect.* **2020**, *7*, 100178. [CrossRef]
27. Korea International Trade Association (2022), 5 Major Trading Countries. Available online: https://stat.kita.net/stat/kts/ctr/CtrTotalImpExpList.screen (accessed on 6 April 2022).
28. Blavatnik School of Government and University of Oxford (n.d.), COVID-19 Government Response Tracker. Available online: https://covidtracker.bsg.ox.ac.uk/ (accessed on 6 April 2022).
29. Zellner, A. An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *J. Am. Stat. Assoc.* **1962**, *57*, 348–368. [CrossRef]
30. Baum, C.F. *An Introduction to Modern Econometrics Using Stata*; Stata Press: College Station, TX, USA, 2006.
31. Cameron, A.C.; Trivedi, P.K. *Microeconometrics: Methods and Applications*; Cambridge University Press: New York, NY, USA, 2005.
32. Greene, W.H. *Econometric Analysis*, 5th ed.; Prentice Hall: Saddle River, NJ, USA, 2001.

33. Shin, K.; Choi, K. Analyzing the relationship between precipitation and transit ridership through a seemingly unrelated regression model. *J. Korean Soc. Transp.* **2014**, *32*, 83–92.
34. PennState Eberly College of Science, Detecting Multicollinearity Using Variance Inflation Factors. Available online: https://online.stat.psu.edu/stat462/node/180/ (accessed on 28 October 2023).
35. Śmiech, S.; Papież, M. In search of hedges and safe havens: Revisiting the relations between gold and oil in the rolling regression framework. *Finance Res. Lett.* **2017**, *20*, 238–244. [CrossRef]
36. Zanin, L.; Marra, G. Rolling regression versus time-varying coefficient modelling: An empirical investigation of the Okun's law in some Euro area countries. *Bull. Econ. Res.* **2012**, *64*, 91–108. [CrossRef]
37. Chen, L.; Da, Z.; Priestley, R. Dividend smoothing and predictability. *Management science.* **2012**, *58*, 1834–1853. [CrossRef]
38. Dunis, C.L.; Laws, J.; Na, P. (Eds.) *Applied Quantitative Methods for Trading and Investment*; John Wiley & Sons.: Hoboken, NJ, USA, 2004.
39. Fabozzi, F.J.; Markowitz, H.M. *Equity Valuation and Portfolio Management*; John Wiley & Sons: Hoboken, NJ, USA, 2011; Volume 199.
40. Laws, J.; Thompson, J. Hedging effectiveness of stock index futures. *European J. Oper. Res.* **2005**, *163*, 177–191. [CrossRef]
41. Korea Trade-Investment Promotion Agency (2022). 2022 Vietnam Entry Strategy, KOTRA Data 21-225. Available online: https://dream.kotra.or.kr/kotranews/cms/news/actionKotraBoardDetail.do?SITE_NO=3&MENU_ID=250&CONTENTS_NO=1&bbsGbn=252&bbsSn=252&pNttSn=192943 (accessed on 30 July 2023).
42. Korea Trade-Investment Promotion Agency (2022). 2022 Japanese Entry Strategy, KOTRA Data 21-209. Available online: http://openknowledge.kotra.or.kr/handle/2014.oak/28353 (accessed on 30 July 2023).
43. Korea Trade-Investment Promotion Agency (2022). 2022 U.S. Entry Strategy, KOTRA Data 21-234. Available online: http://openknowledge.kotra.or.kr/handle/2014.oak/28380 (accessed on 30 July 2023).
44. Korea Trade-Investment Promotion Agency (2022). 2022 Chinese Entry Strategy, KOTRA Data 21-207. Available online: http://openknowledge.kotra.or.kr/handle/2014.oak/29204 (accessed on 30 July 2023).
45. Murray, C.J.L. COVID-19 will continue but the end of the pandemic is near. *Lancet* **2022**, *399*, 417–419. [CrossRef] [PubMed]