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Revisiting the Impacts of COVID-19 Government Policies and Trade Measures on Trade Flows: A Focus on RCEP Nations

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Abstract: *This study investigates the impacts of COVID-19 government policies and trade measures on trade flows and trade resilience in Regional Comprehensive Economic Partnership (RCEP) nations from the first quarter of 2017 to the fourth quarter of 2022. Using panel data analysis and penalised Poisson Pseudo-Maximum Likelihood regression, the results show that COVID-19 containment and health policies implemented by RCEP and partner countries as well as income support and debt relief measures taken by RCEP nations have favourable impacts on trade flows and trade resilience for RCEP countries. However, COVID-19 stringency measures implemented by RCEP and partner countries, as well as partners' income support and debt relief measures, had detrimental impacts on the trade flows and trade resilience of RCEP countries. RCEP trade flows were also influenced by liberalised and restricted trade measures. The implications of these findings for improving trade performance amongst RCEP nations post-COVID-19 are highlighted.*

Keywords: Trade flows; trade resilience; COVID-19 government policies; temporary COVID-19 trade measures

1. Introduction

The signing of the Regional Comprehensive Economic Partnership (RCEP) agreement[1] in 2020 – in the midst of the COVID-19 pandemic – highlighted the importance of regional economic integration for the global trade network and upcoming economic recovery (Kiyota, 2022). Although RCEP signatories have encompassed over one-fourth of global trade over the last decade, it has been challenging for them to maintain their trade performance after the COVID-19 pandemic. COVID-19 government policies and trade measures either caused trade disruptions that lowered trade resilience[2] and hindered sustainable trade, or supported trade flows, leading to trade competitiveness.[3]

A few studies have investigated the impacts of COVID-19 policies and trade measures on international trade. The first strand is the literature on the impact of COVID-19 policies –stringency, containment, health, and economic support measures – on international trade. Arita et al. (2022) and De Lucio et al. (2022) revealed that COVID-19 stringency measures negatively affected international trade, and Mena, Karatzas, and Hansen (2022) found a negative relationship between COVID-19 government responses and trade resilience. The second strand of the literature is on the impact of COVID-19 temporary liberalising and restrictive measures on international trade. Evenett et al. (2021) indicated that COVID-19 restrictive export measures significantly impacted the number of import liberalisation measures, enabling a change in trade resilience.

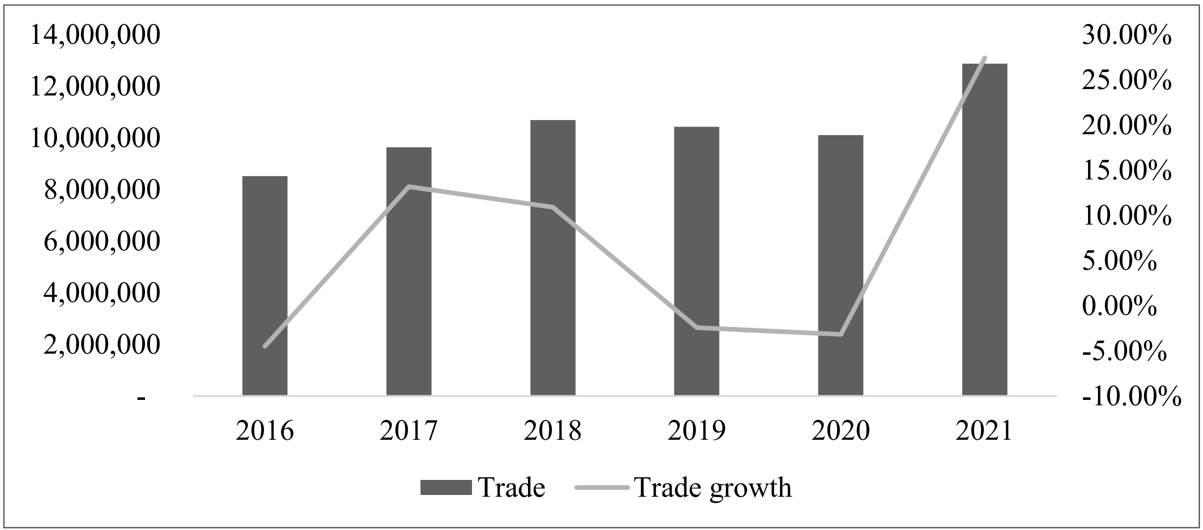
RCEP members' trade growth in 2020 fell by 3.17%; in 2021, it recovered by 27.42%, although COVID-19 government policies and trade measures had been imposed (UNCTAD, 2022) (Figure 1).

[1] The RCEP is a free trade agreement amongst the 10 Association of Southeast Asian Nations (ASEAN) Member States and five of their free trade agreement partners: Australia, China, Japan, Republic of Korea, and New Zealand. The RCEP agreement aims to reduce trade barriers, improve trade facilitation, and create a more favourable business climate for all member countries. It encompasses trade in goods and services, investment, intellectual property, competition, and government procurement.

[2] Trade resilience is a country's ability to resist and to recover from disruptions in international trade (Mena, Karatzas, and Hansen, 2022).

[3] Trade competitiveness is a country's ability to sell goods on global markets under free and fair conditions (Farole, Reis, and Wagle, 2010).

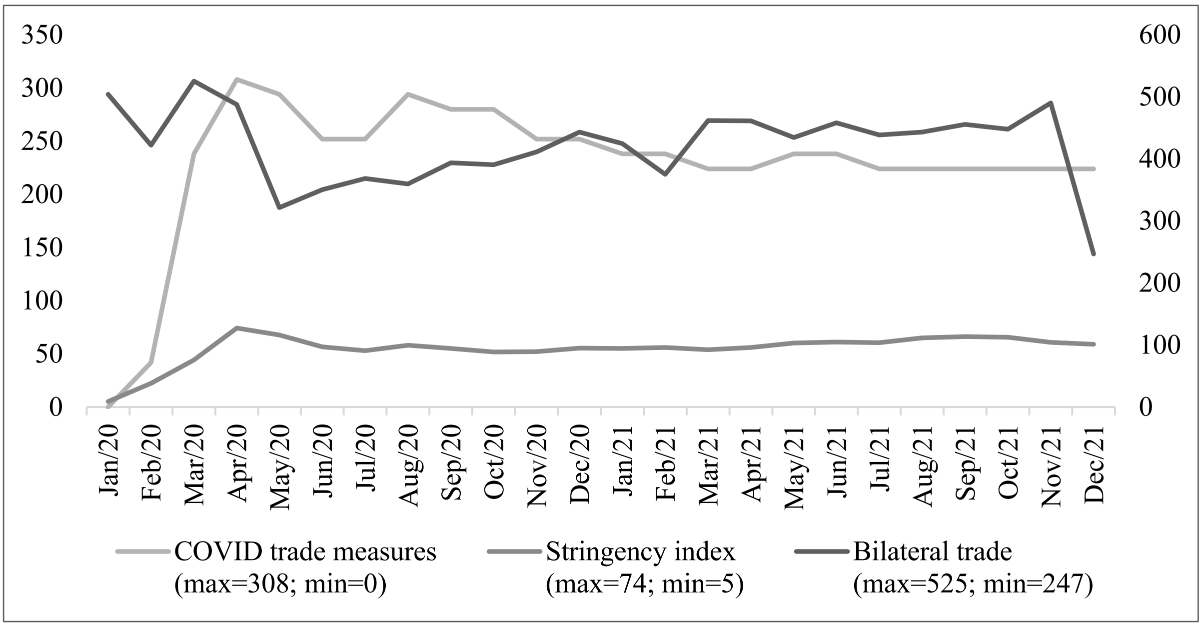
Figure 1: Bilateral Trade Flows in RCEP Nations



RCEP = Regional Comprehensive Economic Partnership.
Source: UNCTAD, https://unctadstat.unctad.org/EN/Index.html (accessed 15 November 2022), and author's calculations.

Moreover, the relationship amongst bilateral trade flows of RCEP members, their COVID-19 stringency indices, and COVID-19 trade measures was remarkable. The monthly trade flows tended to change in the same direction as COVID-19 trade measures rather than COVID-19 stringency measures (Figure 2).

Figure 2: RCEP Trade Flows, COVID-19 Stringency Index, and COVID-19 Trade Measures



RCEP = Regional Comprehensive Economic Partnership.
Source: Hale et al. (2021); ITC, Tracking of COVID-19 Temporary Trade Measures, https://m.macmap.org/covid19; and author's calculations.

The aforementioned facts and studies provide empirical evidence of the impacts of COVID-19 government policies and trade measures on international trade flows. However, the debate is not over. Specifically, COVID-19 government policies and trade measures may have impacted trade flows in partner or destination countries. Moreover, partners' government policies and trade measures may have affected changes in a home country's trade.

This study thus analyses how COVID-19 government policies and trade measures affected RCEP signatories' trade flows, trade balances, trade resilience, and trade competitiveness. This is the first study to examine how COVID-19 government policies (e.g. lockdowns, containment and health measures, income support, and debt relief) and temporary COVID-19 trade measures affected various trade flows. The results can provide a more reliable picture of a home country's level of trade performance, trade resilience, and trade competitiveness. It examines the impacts of COVID-19 government policies and trade measures on trade flows in RCEP nations, highlighting how important regional economic integration is in overcoming threats together – as a group of nations with common interests – as well as how well RCEP members can achieve their primary goal of a free trade agreement. For comparison, the effects on trade in the processed food and agro-based goods sectors are explored.

This study adopts a penalised Poisson Pseudo-Maximum Likelihood (PPML) regression with an adaptive lasso for consistent variable selection to analyse the impacts of COVID-19 government policies and trade measures on trade flows in RCEP economies. Even though it is a powerful technique for ensuring data quality and has high prediction accuracy, this data-driven approach based on machine-learning algorithms has only appeared in some literature.

The paper is structured as follows. Section 2 provides a brief literature review. Methodology and data are described in Section 3. In Section 4, the empirical results are presented and discussed. Finally, Section 5 concludes the study and highlights its policy implications.

2. Literature Review

2.1. COVID-19 Government Policies on Trade

COVID-19 government policies are one of the primary indicators that reflected the degree of a country's resilience and capacity to deal with the COVID-19 pandemic. The public and private sectors had to understand the severity of COVID-19's impact on business, particularly on the foreign trade and investment sectors. The Oxford COVID-19 Government Response Tracker (OxCGRT) created four COVID-19 policy indices to demonstrate governments' strategies to tackle the COVID-19 pandemic (Hale et al., 2021):

(i) **Stringency index.** This measures the severity of lockdown policies that primarily restricted people's behaviours. The stricter the lockdown policies, the lower the COVID-19 rate, which may support economic recovery and disruption simultaneously.

(ii) **Containment and health index.** This measures the combination of lockdown restrictions and closures with additional measures (e.g. testing and tracing policies and investments in health care and vaccines). The greater the number of containment and health policies, the better the population's health and well-being, which may benefit a nation's economy.

(iii) **Overall government response index.** This measures the government's response throughout the pandemic.

(iv) **Economic support index.** This measures income support and debt relief measures. The larger the government response and economic support, the greater the economic recovery from the pandemic.

Some empirical studies also investigated the impacts of COVID-19 government policies on international trade, reaching various conclusions. Arita et al. (2022) analysed the various impacts of the pandemic – COVID-19 incidence rates, stringency of policy responses, and human mobility reduction – on global agro and non-agro trade using 2020 monthly data, revealing that COVID-19 stringency policies and human mobility reduction negatively impacted such trade. De Lucio et al. (2022) refined the theoretical model to estimate the effects of COVID-19 containment measures on Spanish exports and imports, showing that strict measures negatively affected Spanish exports but did not affect the value of imports. Barbero, de Lucio, and Rodríguez-Crespo (2021) found similar evidence, suggesting that policy responses to a COVID-19 proxy for the stringency index, economic support index, containment and health index, and government response index negatively impacted trade flows in selected countries.

Khorana, Martínez-Zarzoso, and Ali (2021) also showed that COVID-19 stringency measures negatively affected trade in goods in the Commonwealth of Nations. Obayelu, Edewor, and Ogbe (2021) examined COVID-19 containment policies in 18 African countries, demonstrating that higher transaction costs from border closures caused decreases in exports. Moreover, Mena, Karatzas, and Hansen (2022) used a fuzzy-set qualitative comparative analysis on the effects of COVID-19 government responses on trade resilience. Results showed that a strong government response hindered international trade resilience. However, Nitsch (2022) found contradictory results, noting that seaborne exports from and imports to New Zealand increased relative to shipments by air during pandemic lockdowns. In sum, the findings indicated that COVID-19 government policies had both positive and negative impacts on trade, which are inconclusive. This literature review thus leads to the first hypothesis:

Hypothesis 1. COVID-19 stringent measures in trading countries negatively impacted bilateral trade, whereas containment and health measures, government responses, and economic support positively affected bilateral trade.

2.2. Temporary COVID-19 Trade Measures

Trade policies, such as liberalising and restrictive trade measures, are potent instruments for promoting and hindering international trade amongst nations. Liberalising trade policies help reduce trade costs and foster bilateral trade, whereas restrictive trade policies burden traders and impede bilateral trade. During the COVID-19 pandemic, countries enacted temporary trade restrictions to prevent the global spread of COVID-19, which included liberalising and restrictive export and import measures for COVID-19 vaccines, medicines, medical supplies, food products, and all other products.[4]

The literature on the role of COVID-19 trade measures in international trade is relatively scant. A strand rests on the fact that, amongst restrictive trade measures, trade flows are somewhat volatile and can result in higher instability. In this respect, Evenett et al. (2021), which studied the linkage between COVID-19 export and import measures, found that restrictive export measures (e.g. export bans, export licensing requirements, and export quotas) on medical products positively affected the number of import liberalisation

[4] ITC, Tracking of COVID-19 Temporary Trade Measures, https://m.macmap.org/covid19

measures. Their results highlighted the role of trade measures in trade resilience, trade dependency, global value chain participation, and political forces.

Hoekman et al. (2021) examined the effects of public procurement regulations (e.g. steps and time required to complete procurement processes, deep procurement agreements, and membership to the World Trade Organization [WTO] agreement on government procurement) on liberalising and restrictive trade measures on medical products during the pandemic. They found that the attributes of national public procurement regimes positively impacted COVID-19 trade measures, targeting trade in medical products. Koppenberg et al. (2020) also demonstrated that a temporary export ban during the COVID-19 pandemic caused trade vulnerability in importing countries. Thus, the evidence demonstrates that COVID-19 trade policies had both positive and negative effects on trade, leading to the second hypothesis.

Hypothesis 2. Liberalising trade measures had a positive impact on bilateral trade, whereas restrictive trade measures had a negative impact on bilateral trade.

2.3. Gravity Model Determinants of Bilateral Trade

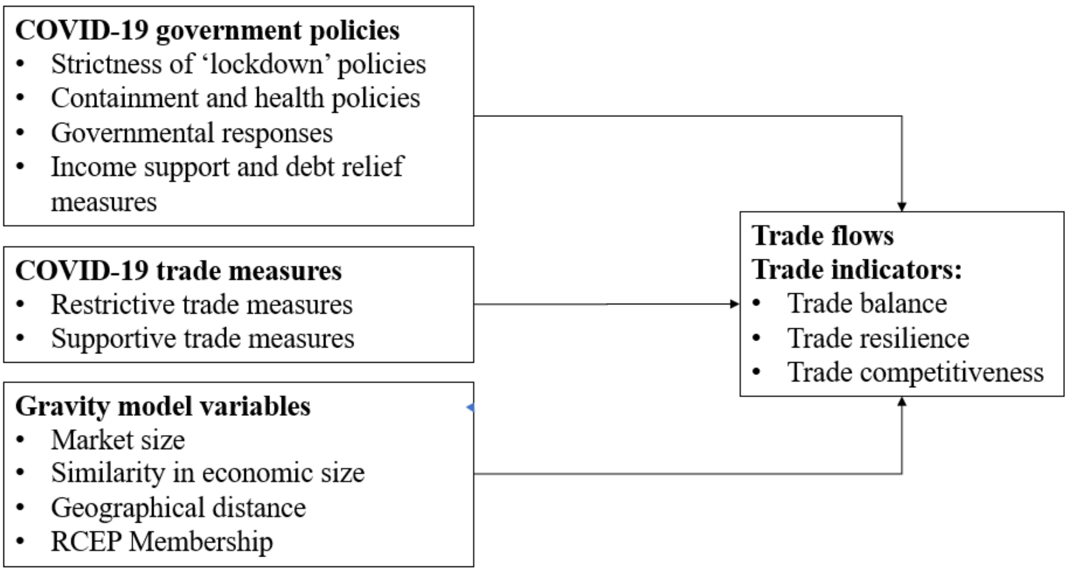
The gravity model is one of the most used empirical models for bilateral trade analysis. Traditionally, gravity model determinants (e.g. economic size, market size similarity, and remoteness) have been assumed to affect bilateral trade positively (Anderson, 1979, 2011; Anderson and Van Wincoop, 2003). Recent empirical studies have addressed the extent to which gravity trade variables impact bilateral trade. For instance, Masood et al. (2022) employed a gravity model approach to investigate the trade potential of Pakistan with South Asian countries. They found, as expected, that gross domestic product (GDP) and regional trade agreements had significant positive impacts on bilateral trade flows, whereas distance and tariffs had significant negative effects on trade. Their findings aligned with those of Tang et al. (2023), who discovered that GDP per capita, trade freedom, distance, and WTO membership statistically impacted China–Association of Southeast Asian Nations (ASEAN) bilateral trade. Likewise, Emikönel (2021) revealed that trading countries' GDP and population growth significantly positively affected Chinese trade flows with the ASEAN and Asia Pacific Economic Cooperation (APEC) Member States.

In contrast, distance has a significant negative impact on bilateral trade. Interestingly, economic agreement membership (i.e. ASEAN and APEC) between trading countries has a positive and significant relationship to bilateral trade. These findings are like those of Jagdambe and Kannan (2020), who indicated that the ASEAN–India free trade agreement positively impacted agro trade between India and ASEAN. Fan et al. (2022) adopted the gravity model to examine the influence of trade facilitation on agro exports from China to ASEAN Member States. Their results showed that gravity model determinants (e.g. GDP and distance) are in line with the theoretical foundation. Moreover, three proxy indicators of trade facilitation – economic freedom, trade across borders, and infrastructure quality – impacted agro trade flows positively and significantly. This literature review thus leads to the third hypothesis.

Hypothesis 3. Gravity trade determinants (i.e. economic size, market size similarity, and proximity) and trade agreement membership have tended to increase bilateral trade flows.

Overall, the empirical evidence on the COVID-19 policy response–trade nexus is mixed. Empirical studies on the effect of COVID-19 government policies on trade indicators (e.g. trade resilience, trade competitiveness, and trade balance) have been underwhelming. Moreover, there is hardly any evidence concerning RCEP nations or if proactive and/or reactive COVID-19 government policies have been essential drivers of economic recovery. As a result, this study aims to contribute to the existing literature by investigating the impacts of COVID-19 government policies and trade measures on trade flows and trade indicators for RCEP economies (Figure 3).

Figure 3: Conceptual Framework of Study



RCEP = Regional Comprehensive Economic Partnership.
Source: Author.

3. Research Methodology

3.1. Model and Methodology

Empirical studies and the gravity model of bilateral trade are the basis for the specification model. The model and selected variables are as follows:

$$trd_{ijt} = \propto + \beta_1 cgp_{it} + \beta_2 cgp_{jt} + \beta_3 cexp_{it} + \beta_4 cimp_{it} + \beta_5 gvt_{ijt} + \epsilon_{ijt} \quad (1)$$

where trd_{ijt} is the value of export flow, import flow, and trade flow between RCEP country i and partner country j in period t. It also is a proxy for the trade balance, trade resilience, and trade competitiveness between pairs of countries. cgp_{it} and cgp_{jt} are the variable set of COVID-19 government policies (e.g. stringency, containment and health, government response, and economic support measures) of countries i and j, respectively (Hale et al., 2021). These variables reflect the country's institutional effectiveness in dealing with COVID-19 and the level of health and safety confidence for all.

Specifically, identifying the quarters of structural breaks in these COVID-19 government indices is allowed. $cexp_{it}$ and $cimp_{it}$ are the variable set of COVID-19 trade measures (e.g. restrictive import and export measures and liberalising import and export measures) of country i. gvt_{ijt} are the gravity model variables between countries i and j in year t, consisting of the GDP of exporting and importing countries, similarity in market size between trading countries, geographical distance, and enforcement of the RCEP agreement. ϵ_{ijt} is an error term for $i = 1, \ldots, 15$ countries, $j = 1, \ldots, 95$ countries, $t = 1, \ldots, 24$, and βs are the estimated parameters.

Following Breinlich et al. (2021), this study employs a data-driven machine-learning approach, a PPML with the adaptive least absolute shrinkage and selection operator method, to investigate the panel data model and to avoid data quality problems (e.g. multicollinearity, cross-sectional dependence, autocorrelation, and heteroskedasticity). It starts with the model estimation using a PPML estimator with fixed effects and consistent and unbiased estimates proposed by Silva and Tenreyro (2006; 2011). Significantly, it mitigates (i) Jensen's inequality ($E[\ln Y] \neq \ln E(Y)$) where E is the conditional mean; (ii) the trouble of zeros in the observed data ($\sum_{i=1}^{n}[Y_i - exp(X_i\tilde{\beta})]X_i = 0$) where $exp(X_i\beta)$ is the conditional expectation of Y_i given X; and (iii) the heteroskedasticity problem by providing the assumption of conditional mean $E[Y_i|X] = exp(X_i\beta) \propto V[Y_i|X]$ where $V[Y_i|X]$ is the conditional variance of Y_i given X (Silva and Tenreyro, 2006).

The specification model with the PPML is:

$$trd_{ijt} = exp[\mu_{it} + \alpha_t + \beta_1 cgp_{it} + \beta_2 cgp_{jt} + \beta_3 cexp_{it} + \beta_4 cimp_{it} + \beta_5 gvt_{ijt}] * \epsilon_{ijt} \quad (2)$$

where μ_{it} and α_t are country fixed effects and time fixed effects.

To avoid the overfitting problem that leads to inconsistent estimates of parameters, the variable selection is of concerned. Second, a machine-learning regularisation technique is conducted for consistent variable selection to avoid the overfitting bias and out-of-sample error in a model. The regularisation algorithms can shrink overfitting and generalisation errors in the regression model (Tibshirani, 1996). This study thus utilises the adaptive lasso (i.e. least absolute shrinkage and selection operator) penalised (or regularisation) approach introduced by Zou (2006) to select the most decisive variables influencing the goodness fit model and to shrink the irrelevant variables to precisely zero.

The adaptive lasso estimates, $\hat{\beta}^{(n)}(adaptive\ lasso)$, are given by:

$$\hat{\beta}^{(n)}(adaptive\ lasso) = \underset{\beta}{\operatorname{argmin}} \|Y - X\beta\|^2 + \underbrace{\lambda_n \textstyle\sum_{j=1}^{P} \hat{\omega}_j |\beta_j|}_{Lasso\ penalty} \quad (3)$$

where λ_n is a non-negative regularisation parameter that varies with n, and $\hat{\omega}_j$ is a weight vector that equals $1/|\hat{\beta}^{(n)}|^{\gamma}$ when $\gamma > 0$. Finally, it estimates the post-lasso PPML regression model using a cross-fit partialing-out lasso Poisson regression developed by Chernozhukov et al. (2018) that renders debiased estimation and inference.

This study uses the panel dataset that is known to result in cross-section dependence (CD) and non-stationary regressor problems. The omission of these factors may result in inaccurate and spurious regression results. Before conducting regression analysis, it is necessary to test for the presence of CD, unit root, and normality. This study employs the Pesaran (2021) CD test. The Pesaran-CD statistic has a zero mean and constant variance under the null hypothesis of no CD, rendering the panel data model non-stationary, dynamic, and heterogeneous.

3.2. Data

Bilateral panel data are used between 15 RCEP countries and 80 partner countries worldwide.[5] The data cover exports, imports, and trade between RCEP nations and their partners from the first quarter of 2017 to the fourth quarter of 2022. This amounts around 33,840 observations (15 exporters x 94 partners x 24 periods). The sample selection is based on data availability. The independent variables include export ($\boldsymbol{exp}$), import ($\boldsymbol{imp}$), and trade ($\boldsymbol{trd}$) flows (a constant price of $1 million); trade balance ($\boldsymbol{trdbl}$) shown in the import–export ratio; trade resilience ($\boldsymbol{trdrs}$) shown in the normalised change in year-on-year quarterly trade; and trade competitiveness ($\boldsymbol{trdcp}$) shown in the share of an exporting country's share in destination markets' imports.[6] Data on bilateral exports, imports, and trade are taken from the International Trade Centre (ITC).[7]

The main regressors are COVID-19 government policies and COVID-19 temporary trade measures. The variables of COVID-19 government policies are proxied by the stringency index ($\boldsymbol{stgi}$), containment and health index ($\boldsymbol{chi}$), overall government response index ($\boldsymbol{gri}$), and economic support index ($\boldsymbol{esi}$). These data are gathered from OXCGRT, originally reported daily and then performed as quarterly averages (Hale et al., 2021). The variables of COVID-19 trade measures are proxied by the number of restrictive import measures ($\boldsymbol{rimp}$), restrictive export measures ($\boldsymbol{rexp}$), liberalising import measures ($\boldsymbol{limp}$), and liberalising export measures ($\boldsymbol{lexp}$). These data are obtained from ITC.[8] Regarding gravity model variables, data for GDPs (a constant price of $1 million) are sourced from the International Monetary Fund. Similarity in economic size between trading

[5] Target countries include 15 RCEP member countries (i.e. Australia, Brunei Darussalam, Cambodia, China, Indonesia, Lao People's Democratic Republic, Japan, Republic of Korea, Malaysia, Myanmar, New Zealand, Philippines, Singapore, Thailand, and Viet Nam) and 80 RCEP non-member countries (i.e. Algeria, Angola, Argentina, Austria, Bahamas, Bahrain, Bangladesh, Belgium, Benin, Brazil, Canada, Chile, Colombia, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, Ethiopia, Finland, France, Germany, Ghana, Greece, Guatemala, Hungary, India, Iran, Iraq, Ireland, Israel, Italy, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyz Republic, Lebanon, Liberia, Libya, Malta, Marshall Islands, Mexico, Mongolia, Morocco, Mozambique, Netherlands, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Peru, Poland, Portugal, Qatar, Romania, Russian Federation, Saudi Arabia, Senegal, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Tanzania, Togo, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Venezuela, and Yemen).

[6] Trade balance refers to the difference between the value of a country's exports and imports over a certain period expressed as an import–export ratio to avoid the problem of absolute figures in the investigation. Trade resilience is measured by the year-on-year monthly percentage change in exports and imports (Mena, Karatzas, and Hansen, 2022). Trade competitiveness is measured by the change in an exporting country's share in destination markets' imports times the initial share of partner countries' imports in world trade (Farole, Reis, and Wagle, 2010).

[7] ITC, Trade Map, https://www.trademap.org/ (accessed 15 November 2022).

[8] ITC, Tracking of COVID-19 Temporary Trade Measures, https://m.macmap.org/covid19 (accessed 15 November 2022).

countries is measured by the squared difference in two countries' GDPs. Geographical distance is the distance in kilometres between two capital cities of trading countries as gathered from CEPII (Mayer and Zignago, 2011). Another gravity model variable – the official enforcement of the RCEP agreement – is a dummy variable with the value of 1 when it occurs. It is assumed to enter into force on 1 January 2022. The descriptive statistics of all variables are demonstrated in Table 1.

Table 1: Descriptive Statistics

Variables	Unit	Mean	Standard Deviation	Min	Max	Jarque-Bera Test
exp_{ij}	$ million	915.244	4,596.945	0.000	165,566	2.7e+08*
imp_{ij}	$ million	817.358	3,407.404	0.000	58,643.40	1.3e+07*
trd_{ij}	$ million	1,732.603	7,565.625	0.000	214,005	5.8e+07*
$trdbl_{ij}$	Ratio	307.146	9,908.484	0.000	921,565	2.9e+10*
$trdrs_{ij}$	Ratio	0.005	0.032	0.000	1.027	7.7e+08*
$trdcp_{ij}$	Ratio	1.000	0.002	0.891	1.106	3.2e+08*
$stgi_i$	Index (0–100)	24.404	28.570	0.000	91.129	4,307*
$stgi_j$	Index (0–100)	22.506	27.961	0.000	86.806	4,831*
chi_i	Index (0–100)	26.888	29.515	0.000	84.193	4,196*
chi_j	Index (0–100)	24.515	27.927	0.000	84.444	4,183*
gri_i	Index (0–100)	26.355	28.855	0.000	81.484	4,346*
gri_j	Index (0–100)	23.797	27.322	0.000	85.830	4,212*
esi_i	Index (0–100)	22.622	33.816	0.000	100.000	7,445*
esi_j	Index (0–100)	18.770	29.716	0.000	100.000	1.0e+04*
$lexp_i$	Numbers	0.030	0.172	0.000	1.000	1.3e+06*
$rexp_i$	Numbers	0.280	0.564	0.000	3.000	3.8e+04*
$limp_j$	Numbers	0.758	1.159	0.000	5.000	1.9e+04*
$rimp_j$	Numbers	0.275	0.609	0.000	2.000	3.4e+04*
gdp_i	$ million	434,634	960,590	0.000	5,114,051	1.7e+05*
gdp_j	$ million	225,956	720,255	0.000	6,664,913	2.2e+06*
$sgdp_{ij}$	$ million	404,256	1,016,280	0.000	1.14e+07	4.6e+05*
$simgdp_{ij}$	Ratio	0.108	0.170	0.000	0.500	9,159*
$dist_{ij}$	Kilometres	9,466.327	4,618.489	315.543	19,812.04	822.2*
$rcep_{ij}$	Dummy	0.024	0.155	0	1	2.0e+06*

Notes:
1. The number of observations is 33,840.
2. The Jarque and Bera (1987) test is the normality test of whether the observed data have a normal distribution (i.e. null hypothesis).
3. * indicates significance at the 1% level.

Source: Author's calculations.

Table 1 also shows the results of the Jarque-Bera normality test that confirms the non-normal distributions in almost all observed variables in the estimation model (except for trade measures, distances, and RCEP membership). It implies that the lasso-penalised regression approach is suitable for the model estimation (Casella et al., 2010). Furthermore, before empirical analysis, diagnostic tests were conducted. The Levin-Lin-Chu unit root test, proposed by Levin, Lin, and Chu (2002), was employed to check whether the panel data variables are stationary, with the null hypothesis of the presence of the panel unit root test. The CD test proposed by Pesaran (2021) was also determined under the null hypothesis of no cross-section dependence.

Table 2 shows the results of panel unit root tests and CD for all variables used in the baseline model. First, the results of the Levin-Lin-Chu panel unit root test indicate that most variables (except for GDPs and sizes of the economies) are stationary at the level and at the first difference. Thus, the logarithm of GDPs and the similarity in countries' sizes are utilised in the estimation. Second, Pesaran CD statistics demonstrate that all variables have CD.

Table 2: Results of the Panel Unit Root Test and Cross-Section Dependence Test

Testing	**Levin-Lin-Chu**		**Pesaran**
	Level	**First Diff.**	
exp_{ij}	–75.434*	–1.6e+02*	303.664*
imp_{ij}	–1.8e+03*	–7.1e+02*	224.737*
trd_{ij}	–2.0e+02*	–1.7e+02*	412.241*
$trdbl_{ij}$	–2.0e+02*	–1.9e+02*	25.676*
$trdrs_{ij}$	–1.4e+02*	–2.1e+02*	3,664.949*
$trdcp_{ij}$	–5.5e+03*	–2.6e+03*	6.824*
$stgi_i$	–60.557*	–1.2e+02*	4,504.147*
$stgi_j$	–61.145*	–1.3e+02*	4,429.405*
chi_i	–54.445*	–1.2e+02*	4,676.220*
chi_j	–54.850*	–1.2e+02*	4,558.348*
gri_i	–53.304*	–1.2e+02*	4,698.839*
gri_j	–55.418*	–1.2e+02*	4,562.581*
esi_i	–49.759*	–1.1e+02*	3,303.755*
esi_j	–58.411*	–1.2e+02*	3,156.381*
gdp_i	–45.645	–-99.202	950.938*
gdp_j	–41.736	–1.0e+02	520.555*
$simgdp_{ij}$	–17.465	–72.464	320.100*

Note: * is the level of significance at 1%.
Source: Author's calculations.

4. Empirical Results

4.1. Baseline Results

Table 3 reports the results of the impacts of COVID-19 government policies and temporary COVID-19 trade measures on RCEP members' exports (Model 1), imports (Model 2), and trade flows (Model 3). The results are categorised into two groups for comparison: models without gravity model variables and models with gravity model variables. The estimated results of traditional PPML, adaptive lasso penalised regression, and PPML post-lasso are illustrated sequentially.

4.1.1. Model without Gravity Model Determinants

Based on Model 1, the results of the traditional PPML estimation (Column 1) show that most variables have statistically significant effects on RCEP members' export flows. The COVID-19 stringency policies enacted by both home and partner countries, containment and health policies, government responses, and economic support from partner countries had statistically significant impacts on RCEP members' exports. COVID-19 temporary export measures, both liberalising and restrictive, are found to have significantly impacted RCEP members' export flows.

Subsequently, the adaptive lasso penalised regression is performed, and coefficients that are non-zero emerge (Column 2). There are seven variables selected by the approach. These selected variables are re-estimated using the PPML approach. The results obtained from PPML post-lasso (Column 3) indicate that the estimated coefficients of COVID-19 stringency policies of both RCEP economies and their partner countries on RCEP members' exports are negative and statistically significant at the 1% level. The COVID-19 stringency measures of trading countries tended to restrict people's mobility and behaviours, leading to lower consumption and RCEP members' exports to partners. These results are in line with Barbero, de Lucio, and Rodríguez-Crespo (2021); Khorana, Martínez-Zarzoso, and Ali (2021); and Obayelu, Edewor, and Ogbe (2021).

As expected, the estimated coefficients of the COVID-19 government response and economic support measures are positive and statistically significant at the 1% level. This suggests that government response and financial support for the COVID-19 pandemic in RCEP countries fostered their export flows. The estimated coefficient of liberalising export measures on RCEP members' exports is negative and statistically significant at the 1% level, whereas the estimated coefficient of restrictive export measures is positive and statistically significant at the 1% level. These findings are in contrast with Koppenberg et al. (2020). Finally, the estimated coefficient of RCEP membership on RCEP members' exports is negative and statistically significant at the 1% level, showing that the RCEP agreement did not generate a benefit for RCEP members' exports.

Considering Model 2, the results of the traditional PPML estimation (Column 4) demonstrate that some variables have statistically significant effects on RCEP members' import flows. The COVID-19 stringency policies of exporting countries and liberalising and restrictive import measures had statistically significant effects on RCEP members' imports. Later, the adaptive lasso penalised regression is conducted, and non-zero coefficients emerge (Column 5).

Seven variables are selected by the adaptive lasso penalised regression approach. These selected variables are re-estimated using the PPML approach. The results obtained from PPML post-lasso (Column 6) reveal that the estimated coefficients of COVID-19 stringency policies of exporting countries and containment and health policies of importing countries on RCEP members' import flows are negative and statistically significant at the 1% level. The stricter the lockdown, containment, and health surveillance measures, the lower RCEP members' import flows were.

On the contrary, the estimated coefficients of exporting countries' containment and health policies and economic support measures for importing countries on RCEP members' imports are positive and statistically significant at the 1% level. The strictness of containment and health measures in exporting countries and the financial support of importing countries instilled confidence in RCEP importers. The estimated coefficients of liberalising and restrictive import measures on RCEP members' imports are positive and statistically significant at the 1% level, indicating the role of import measures in driving RCEP members' import flows. Finally, the estimated coefficient of RCEP membership on RCEP members' imports is negative and statistically significant at the 1% level, indicating that the RCEP agreement was underutilised.

According to Model 3, the results of the traditional PPML estimation (Column 7) demonstrate that many variables have statistically significant effects on RCEP members' trade flows. As a result, the lasso results (Column 8) show that the adaptive lasso penalised regression approach chose nine variables. These selected variables are re-estimated using the PPML approach. The results from PPML post-lasso (Column 9) reveal that the estimated coefficient of COVID-19 stringency policies of trading countries is negative and statistically significant at the 1% level. This confirms that the strictness of lockdown policies hindered RCEP members' trade flows. The estimated coefficients of containment and health policies of trading countries on bilateral trade are both negative and positive and statistically significant at the 1% level. The containment and health policies thus could help or harm RCEP members' trade flows.

Surprisingly, the estimated coefficient of the liberalising export measure on RCEP members' trade is negative and statistically significant at the 1% level, whereas the estimated coefficients of other trade measures on RCEP members' trade flows are positive and statistically significant at the 1% level. This suggests the significance of trade measures for RCEP members' trade changed. Finally, the estimated coefficient of RCEP membership on RCEP members' trade is negative and statistically significant at the 1% level, indicating the ineffectiveness of the RCEP agreement.

Table 3: Estimation Results of RCEP Trade Flows

	Model 1			Model 2			Model 3		
	PPML (1)	Lasso (2)	PPML Post-Lasso (3)	PPML (4)	Lasso (5)	PPML Post-Lasso (6)	PPML (7)	Lasso (8)	PPML Post-Lasso (9)
A. Without gravity model determinants									
$stgi_i$	–0.0297* (–7.30)	–0.030	–0.031* (–7.60)	0.004 (1.08)			–0.001 (–0.43)		
$stgi_j$	–0.015* (–4.17)	–0.009	–0.010* (–5.74)	–0.017* (–4.63)	–0.013	–0.015* (–4.55)	–0.016* (–4.65)	–0.013	–0.016* (–5.09)
chi_i	8.948 (0.60)			12.801 (1.09)	–0.013	–0.014* (–6.09)	3.384 (0.27)	–0.009	–0.010* (–5.05)
chi_j	–23.173*** (–1.86)			–3.443 (–0.34)	0.013	0.015* (3.50)	–12.445 (–1.17)	0.010	0.015* (3.62)
gri_i	–10.183 (–0.60)	0.045	0.046* (7.89)	–14.652 (–1.09)			–3.877 (–0.27)		
gri_j	26.491*** (1.86)			3.955 (0.34)			14.239 (1.17)		
esi_i	1.280 (0.60)	0.001	0.001 (1.52)	1.842 (1.09)	0.010	0.010* (12.52)	0.494 (0.27)	0.009	0.010* (11.63)
esi_j	–3.312*** (–1.86)			–0.494 (–0.34)			–1.780 (–1.17)		
$lexp_i$	–0.426* (–3.16)	–0.376	–0.444* (–3.27)				–0.628* (–5.39)	–0.625	–0.642* (–5.60)
$rexp_i$	0.744* (19.98)	0.736	0.738* (19.93)				0.189* (4.22)	0.171	0.185* (4.36)
$limp_j$				0.166* (10.39)	0.170	0.172* (11.12)	0.149* (9.13)	0.146	0.149* (9.37)
$rimp_j$				0.892*	0.875	0.881*	0.765*	0.772	0.773*

	Model 1			Model 2			Model 3		
	PPML (1)	Lasso (2)	PPML Post-Lasso (3)	PPML (4)	Lasso (5)	PPML Post-Lasso (6)	PPML (7)	Lasso (8)	PPML Post-Lasso (9)
				(27.63)		(28.27)	(19.16)		(21.52)
$rcep_{ij}$	–0.425*	–0.363	–0.394*	–0.152	–0.128	–0.170***	–0.307*	–0.253	–0.290*
	(–4.09)		(–3.86)	(–1.60)		(–1.79)	(–3.22)		(–3.09)
Constant	16.256*	16.220	16.241*	16.005*	13.018	16.031*	16.811*	16.783	16.800*
	(196.77)		(197.98)	(228.45)		(244.17)	(231.78)		(243.18)
Country-pair fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.125		0.124	0.179		0.178	0.171		0.170
Observations	33840		33,840	33,840		33,840	33,840		33,840
VIF	1.13e+08			1.13e+08			9.57e+07		
B. With gravity model determinants									
$stgi_i$	–0.013*	–0.011	–0.013*	–0.009*	–0.004	–0.007*	–0.015*	–0.012	–0.014*
	(–4.68)		(–4.58)	(–3.39)		(–2.82)	(–5.45)		(–5.46)
$stgi_j$	–0.010*	–0.009	–0.011*	–0.010*	–0.009	–0.010*	–0.011*	–0.010	–0.011*
	(–3.51)		(–3.80)	(–4.11)		(–4.08)	(–4.76)		(–5.04)
chi_i	–2.159	0.012	0.013*	9.879	0.003	0.007**	5.274	0.012	0.015*
	(–0.21)		(3.73)	(1.35)		(2.29)	(0.68)		(4.75)
chi_j	–18.031***	0.010	0.011*	1.630	0.013	0.014*	–8.702	0.012	0.013*
	(–1.76)		(3.44)	(0.22)		(4.58)	(–1.14)		(4.94)
gri_i	2.485			–11.278			–6.007		
	(0.21)			(–1.34)			(–0.68)		
gri_j	20.620***			–1.846			9.961		
	(0.76)			(–0.22)			(1.14)		
esi_i	–0.310			1.408			0.750		
	(–0.21)			(1.34)			(0.68)		

	Model 1			Model 2			Model 3		
	PPML (1)	**Lasso (2)**	**PPML Post-Lasso (3)**	**PPML (4)**	**Lasso (5)**	**PPML Post-Lasso (6)**	**PPML (7)**	**Lasso (8)**	**PPML Post-Lasso (9)**
esi_j	–2.578*** (–1.76)			0.230 (0.22)			–1.245 (–1.14)		
$lexp_i$	0.350* (3.52)	0.310	0.348* (3.65)				0.302* (4.06)	0.275	0.332* (4.63)
$rexp_i$	0.126* (4.25)	0.121	0.130* (4.59)				0.189* (6.58)	0.153	0.195* (6.64)
$limp_j$				–0.040* (–2.86)	–0.035	–0.038* (–2.92)	–0.048* (–3.04)	–0.036	–0.048* (–3.01)
$rimp_j$				–0.039 (–1.48)			–0.169* (–4.70)	–0.106	–0.152* (–4.51)
$lgdp_i$	0.859* (45.15)	0.856	0.860* (46.48)	0.774* (75.04)	0.766	0.769* (76.53)	0.825* (64.90)	0.818	0.823* (66.24)
$lgdp_j$	0.653* (42.55)	0.653	0.653* (41.95)	0.515* (67.62)	0.515	0.515* (67.18)	0.587* (55.88)	0.586	0.586* (54.98)
$lsimgdp_{ij}$	–0.153* (–9.71)	–0.152	–0.153* (–9.90)	–0.151* (–13.55)	–0.153	–0.154* (–13.92)	–0.148* (–12.39)	–0.150	–0.151* (–12.88)
$ldist_{ij}$	–0.342* (–12.94)	–0.336	–0.336* (–12.89)	–0.427* (–23.02)	–0.426	–0.424* (–22.88)	–0.384* (–19.59)	–0.382	–0.382* (–19.61)
$rcep_{ij}$	–0.048 (–0.83)			0.132* (2.84)	0.100	0.116* (2.52)	0.032 (0.73)		
Constant	–1.745* (–2.98)	–8.674	–8.730* (–15.08)	1.989* (7.31)	2.076	2.036* (7.39)	0.675* (1.73)	0.747	0.679*** (1.74)
Country-pair fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.747		0.745	0.829		0.828	0.827		0.826

	Model 1			Model 2			Model 3		
	PPML (1)	**Lasso (2)**	**PPML Post-Lasso (3)**	**PPML (4)**	**Lasso (5)**	**PPML Post-Lasso (6)**	**PPML (7)**	**Lasso (8)**	**PPML Post-Lasso (9)**
Observations	13,778		13,778	13,778		13,778	13,778		13,778
VIF	1.02e+08			1.02e+08			9.04e+07		

PPML = Poisson Pseudo-Maximum Likelihood, RCEP = Regional Comprehensive Economic Partnership, VIF = variance inflation factor.
Notes:
The PPML post-lasso column displays the PPML coefficients for variables selected by the adaptive lasso method.
t-statistics are in parentheses.
* significant with $p < 0.01$, ** significant with $p < 0.05$, and *** significant with $p < 0.1$.
Source: Author’s calculations.

4.1.2. Model with Gravity Model Determinants

Considering Model 1, the results of the traditional PPML estimation (Column 1) demonstrate that most variables have statistically significant effects on RCEP members' export flows. COVID-19 government policies and export measures have statistically significant impacts on RCEP members' exports, as shown in the model with gravity model determinants. Moreover, all gravity model determinants have statistically significant effects on exports between RCEP countries and their partners. Subsequently, the adaptive lasso penalised regression is performed, and coefficients that are non-zero emerge (Column 2). There are 10 variables selected by the adaptive lasso penalised regression approach. These selected variables are re-estimated using the PPML approach.

The results obtained from PPML post-lasso (Column 3) indicate that the estimated coefficients of COVID-19 stringency policies of both exporting and importing countries on export flows are negative and statistically significant at the 1% level, suggesting that the COVID-19 stringency measures of trading countries hindered RCEP members' exports to partners. The estimated coefficients of the containment and health policies and economic support measures are positive and statistically significant at the 1% level, indicating that these COVID-19 government policies unblocked RCEP members' bilateral exports. The estimated coefficients of liberalising and restrictive export measures on RCEP members' exports are positive and statistically significant at the 1% level, indicating an increase in export flows regardless of trade measures. Finally, the estimated coefficients of gravity model variables are statistically significant at the 1% level and correspond to the hypotheses. The larger market sizes of trading countries, difference in market sizes between trading countries, and geographical closeness between trading countries were likely to enhance RCEP members' export flows.

Based on Model 2, the results of traditional PPML estimation (Column 4) show that many variables have statistically significant effects on RCEP members' import flows. The adaptive lasso penalised regression is conducted, and non-zero coefficients emerge (Column 5). There are 10 variables selected by the adaptive lasso penalised regression approach. These selected variables are re-estimated using the PPML approach.

The results obtained from PPML post-lasso (Column 6) indicate that the estimated coefficients of COVID-19 stringency policies of exporting and importing countries on RCEP members' imports are negative and statistically significant at the 1% level. Meanwhile, the estimated coefficients of containment and health policies of exporting and importing countries on RCEP members' imports are positive and statistically significant at the 1% level. These findings support the hypotheses. The strictness of lockdown policies impeded RCEP members' imports, whereas containment and health measures contributed to the expansion of imports.

The estimated coefficient of liberalising import measures on RCEP members' imports is negative and statistically significant at the 1% level. The estimated coefficient of RCEP membership on RCEP members' imports is positive and statistically significant at the 1% level, demonstrating the effectiveness of the RCEP agreement. Lastly, the estimated coefficients of gravity model variables correspond to the hypotheses and are statistically significant at the 1% level.

According to Model 3, the results of the traditional PPML estimation (Column 7) demonstrate that many variables have statistically significant effects on RCEP members' trade flows. Subsequently, the lasso results (Column 8) exhibit 12 variables selected by the adaptive lasso penalised regression approach. These selected variables are re-estimated using the PPML approach.

The results from PPML post-lasso (Column 9) indicate that the estimated coefficients of the COVID-19 stringency policies of trading countries are negative and statistically significant at the 1% level. This implies a negative impact of COVID-19 stringency policies on RCEP members' trade flows. Conversely, the estimated coefficients of containment and health policies of trading countries on bilateral trade are positive and statistically significant at the 1% level, indicating the positive impact of containment and health policies on RCEP members' bilateral trade. The estimated coefficients of liberalising and restrictive export measures on RCEP members' trade flows are positive and statistically significant at the 1% level, indicating the positive impacts of export measures on RCEP members' trade regardless of the type of export measure. The estimated coefficients of the liberalising and restrictive import measures on RCEP members' trade are negative and statistically significant at the 1% level, suggesting negative impacts of import measures on RCEP members' trade. Finally, the estimated coefficients of gravity model variables are statistically significant at the 1% level and are consistent with the hypotheses.

In conclusion, the results reveal that COVID-19 stringency policies have statistically negative impacts on RCEP members' exports, imports, and trade flows, while the containment and health policies have statistically positive impacts on RCEP members' exports, imports, and trade flows. COVID-19 temporary export measures have statistically positive impacts on RCEP members' bilateral trade, whereas COVID-19 temporary import measures have statistically negative impacts on RCEP members' bilateral trade.

4.2. Alternative Results of Trade in Processed Food and Agro-Based Products

Table 4 shows how COVID-19 government policies and trade measures affected RCEP members' exports (Model 4), bilateral imports (Model 5), and bilateral trade (Model 6) in processed food and agro-based products.

Based on the model that includes gravity model determinants, COVID-19 stringency policies have statistically positive effects on RCEP members' exports, imports, and trade in food products. These findings contrast with the previous conclusions focussing on trade in all products, implying that trade in food products continued despite the pandemic and lockdown policies. Also, the containment and health policies have a statistically positive effect on RCEP members' trade in food products. Economic support regarding the COVID-19 pandemic has a statistically negative effect on RCEP members' trade in food products. It appears that restrictive export measures for food products have a statistically negative effect on RCEP members' trade, while liberalising import measures have a statistically positive effect. These findings are consistent with the hypotheses. Finally, the gravity model determinants have statistical effects on RCEP members' trade in food products.

In conclusion, the effects of COVID-19 government policies and trade measures on RCEP members' bilateral trade in total goods are distinct from their effects on bilateral trade in processed foods and agro-products. This is crucial for determining government policies that influence trade flows.

Table 4: Estimation Results of RCEP Trade in Processed Food and Agro-Based Products

	Model 4			Model 5			Model 6		
	PPML (1)	Lasso (2)	PPML Post-Lasso (3)	PPML (4)	Lasso (5)	PPML Post-Lasso (6)	PPML (7)	Lasso (8)	PPML Post-Lasso (9)
A. Without gravity model determinants									
$stgi_i$	0.005 (1.46)			–0.013* (–3.54)	–0.014	–0.015* (–10.61)	–0.005*** (–1.83)	–0.005	–0.006** (–2.17)
$stgi_j$	–0.011* (–3.46)	–0.006	–0.008* (–3.60)	–0.001 (–0.49)			–0.006* (–2.66)	–0.004	–0.006* (–3.19)
chi_i	–8.263 (–0.75)			–1.246 (–0.12)			–10.633 (–1.29)	–0.011	–0.010* (–2.84)
chi_j	–8.343* (–0.77)			–25.069* (-–.71)			–14.034*** (–1.86)		
gri_i	9.437 (0.75)			1.421 (0.12)			12.138 (1.29)		
gri_j	9.553 (0.77)	0.010	0.013* (4.73)	28.655* (2.71)	0.001	0.001 (1.05)	16.054*** (1.87)	0.012	0.014* (5.86)
esi_i	–1.178 (–0.75)	0.001	0.001*** (1.81)	–0.170 (–0.12)	0.006	0.006* (9.44)	–1.512 (–1.29)	0.004	0.004* (7.04)
esi_j	–1.192 (–0.77)			–3.580* (–2.71)	0.001	0.001*** (1.77)	–2.005*** (–1.86)		
$rexp_{i,agr}$	–0.878* (–8.27)	–0.886	–0.887* (–8.57)				–0.371* (–4.88)	–0.360	–0.379* (–4.99)
$limp_{j,agr}$				0.397* (13.43)	0.398	0.400* (13.67)	0.373* (15.83)	0.368	0.371* (15.78)
$rimp_{j,agr}$				0.753* (16.05)	0.741	0.748* (16.33)	0.682* (18.96)	0.679	0.683* (18.97)
$rcep_{ij}$	–0.138	–0.122	–0.138	–0.200**	–0.160	–0.174**	–0.226*	–0.188	–0.207*

	Model 4			Model 5			Model 6		
	PPML (1)	**Lasso (2)**	**PPML Post-Lasso (3)**	**PPML (4)**	**Lasso (5)**	**PPML Post-Lasso (6)**	**PPML (7)**	**Lasso (8)**	**PPML Post-Lasso (9)**
	(–1.52)		(–1.52)	(–2.28)		(–2.06)	(–3.39)		(–3.14)
Constant	5.011* (68.63)	4.993	5.021* (73.32)	5.361* (85.00)	5.352	5.361* (92.73)	5.741* (101.98)	5.722	5.732* (102.26)
Country-pair fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.136		0.136	0.197		0.196	0.263		0.263
Observations	33,840		33,840	33,840		33,840	33,840		33840
VIF	9.57e+07			9.57e+07			9.57e+07		
B. With gravity model determinants									
$stgi_i$	0.027* (5.68)	0.025	0.026* (5.66)	–0.006*** (–1.80)			0.008* (2.57)	0.001	0.001*** (1.72)
$stgi_j$	–0.012* (–3.25)	–0.012	–0.013* (–3.48)	0.007** (1.98)	0.001	0.001* (3.28)	–0.002 (–0.78)		
chi_i	–17.998 (–1.44)			8.394 (0.77)			–4.031 (–0.49)		
chi_j	–13.37 (–0.99)	0.005	0.007 (0.90)	–30.273* (–2.89)			–21.628* (–2.61)	0.001	0.001*** (1.70)
gri_i	20.542 (1.44)	–0.023	–0.026* (–4.39)	–9.584 (–0.77)			4.599 (0.49)		
gri_j	15.298 (0.99)	0.011	0.009 (1.43)	34.592* (2.89)			24.723* (2.61)		
esi_i	–2.572 (–1.44)	–0.001	–0.001 (–1.26)	1.198 (0.77)			–0.576 (–0.49)	–0.001	–0.002* (–3.31)

	Model 4			Model 5			Model 6		
	PPML (1)	**Lasso (2)**	**PPML Post-Lasso (3)**	**PPML (4)**	**Lasso (5)**	**PPML Post-Lasso (6)**	**PPML (7)**	**Lasso (8)**	**PPML Post-Lasso (9)**
esi_j	–1.911 (–0.99)			–4.325* (–2.89)			–3.090* (–2.61)		
$rexp_{i,agr}$	–1.418* (–10.09)	–1.400	–1.418* (–10.10)				–0.651* (–8.19)	–0.605	–0.638* (–8.10)
$limp_{j,agr}$				–0.011 (–0.41)			0.035*** (1.70)	0.038	0.043** (2.11)
$rimp_{j,agr}$				–0.044 (–0.88)			–0.022 (–0.59)		
$lgdp_i$	0.281* (20.79)	0.281	0.282* (20.99)	0.601* (37.70)	0.594	0.598* (39.18)	0.432* (35.23)	0.428	0.429* (36.54)
$lgdp_j$	0.458* (32.65)	0.458	0.458* (32.75)	0.277* (24.05)	0.270	0.273* (21.12)	0.364* (39.20)	0.362	0.363* (38.90)
$lsimgdp_{ij}$	–0.068* (–3.58)	–0.064	–0.066* (–3.51)	–0.023 (–1.44)			–0.082* (–6.05)	–0.079	–0.080* (–5.89)
$ldist_{ij}$	–0.325* (–11.59)	–0.322	–0.323* (–11.51)	–0.078* (–2.66)	–0.052	–0.068** (–2.24)	–0.202* (–10.01)	–0.199	–0.080* (–5.89)
$rcep_{ij}$	0.052 (0.52)	0.051	0.071 (0.70)	0.125 (1.36)	0.089	0.141*** (1.76)	0.067 (1.01)	0.048	0.072 (1.25)
Constant	–1.849* (–4.88)	–1.862	–1.892* (–5.01)	–5.333* (–12.65)	–5.325	–5.305* (–13.16)	–2.728* (–8.80)	–2.647	–2.681* (–8.71)
Country-pair fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.387		0.389	0.483		0.475	0.608		0.608
Observations	13,778		13,778	13,778		13,778	13,778		13,778

	Model 4			Model 5			Model 6		
	PPML (1)	Lasso (2)	PPML Post-Lasso (3)	PPML (4)	Lasso (5)	PPML Post-Lasso (6)	PPML (7)	Lasso (8)	PPML Post-Lasso (9)
VIF	9.04e+07			9.04e+07			9.04e+07		

PPML = Poisson Pseudo-Maximum Likelihood, RCEP = Regional Comprehensive Economic Partnership, VIF = variance inflation factor.
Notes:
The PPML post-lasso column displays the PPML coefficients for variables selected by the adaptive lasso method.
t-statistics are in parentheses.
* is significant with $p < 0.01$, ** is significant with $p < 0.05$, and *** is significant with $p < 0.1$.
Source: Author's calculations.

4.3. Heterogeneity Effects on Trade Indicators

To further illustrate the heterogeneity determined by RCEP members' trade indicators, the relationships between COVID-19 government policies and trade measures and trade indicators (i.e. trade balance, trade resilience, and trade competitiveness) are estimated in this study. Table 5 shows the effects of COVID-19 government policies and trade measures on RCEP members' trade indicators: trade balance (Model 7), trade resilience (Model 8), and trade competitiveness (Model 9). Trade balance represents the net trade (surplus or deficit) position for RCEP members; trade resilience refers to a RCEP country's ability to resist and to recover from disruptions in international trade; and the trade competitiveness model exhibits RCEP members' ability to penetrate the world market with their products.

Table 5: Estimation Results of RCEP Trade Indicators

	Model 7			Model 8			Model 9		
	PPML (1)	Lasso (2)	PPML Post-Lasso (3)	PPML (4)	Lasso (5)	PPML Post-Lasso (6)	PPML (7)	Lasso (8)	PPML Post-Lasso (9)
A. Without gravity model determinants									
$stgi_i$	–0.017 (–0.75)			–0.027* (–3.78)	–0.029	–0.027* (–4.18)	3.17e–06 (1.20)		
$stgi_j$	0.079* (3.74)	0.067	0.078* (4.09)	–0.006 (–1.30)	–0.004	–0.007 (–1.39)	–3.86e–06 (–1.16)	–1.53e–06	–1.56e–06 (–1.49)
chi_i	71.164 (1.04)			–8.501 (–0.54)	0.034	0.031* (3.93)	–0.004 (–0.33)		
chi_j	–23.159 (–0.62)			–5.378 (–0.38)	0.007	0.010 (1.57)	–0.011 (–1.21)		
gri_i	–81.292 (–1.04)	0.019	0.014 (1.05)	9.752 (0.54)			0.004 (0.33)		
gri_j	26.299 (0.61)	–0.158	–0.170* (–6.73)	6.159 (0.38)			0.013 (1.21)		
esi_i	10.186 (1.04)	0.023	0.024* (2.90)	–1.219 (–0.54)			–0.0006 (–0.33)	2.18e–06	2.21e–06* (2.74)
esi_j	–3.313 (–0.62)			–0.772 (–0.38)	–0.001	–0.002*** (–1.69)	–0.001 (–1.21)	–1.26e–06	–1.28e–06 (–1.50)
$lexp_i$	1.633* (2.55)	1.329	1.623* (2.48)	0.064 (0.31)			–0.0001* (–2.80)	-0.0001	–0.0001* (–2.83)
$rexp_i$	–0.098 (–0.33)			–0.375* (–4.96)	–0.376	–0.397* (–6.31)	0.0007*** (1.67)	0.00007	0.00007*** (1.77)
$limp_j$	–0.098 (–1.03)			–0.069* (–2.57)	–0.061	–0.071* (–2.65)	0.00002 (1.46)	0.00002	0.00002 (1.47)
$rimp_j$	0.419*	0.313	0.397	0.110	0.109	0.132**	0.0001*	0.0001	0.0001*

	Model 7			Model 8			Model 9		
	PPML (1)	Lasso (2)	PPML Post-Lasso (3)	PPML (4)	Lasso (5)	PPML Post-Lasso (6)	PPML (7)	Lasso (8)	PPML Post-Lasso (9)
	(1.63)		(1.23)	(1.48)		(1.92)	(3.53)		(3.20)
$rcep_{ij}$	–3.167* (–11.35)	–0.850	–3.114* (–11.46)	0.328* (3.15)	0.311	0.335* (3.19)	0.0002 (0.75)	0.0002	0.0002 (0.78)
Constant	3.879* (9.06)	4.074	3.801* (10.62)	–5.457* (–37.52)	–5.425	–5.452* (–39.69)	0.0006* (11.70)	0.0006	0.0006* (12.00)
Country-pair fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.017		0.017	0.006		0.006	0.007		0.007
Obser-vations	33,840		33,840	33,840		33,840	33,840		33,840
VIF	1.13e+08			1.13e+08			9.57e+07		
B. With gravity model determinants									
$stgi_i$				0.017 (1.39)			8.65e–07 (0.14)		
$stgi_j$				–0.020* (–3.27)	–0.009	–0.013** (–1.90)	2.95e–06 (0.40)		
chi_i				–16.413 (–0.58)			0.005 (0.21)		
chi_j				–1.793 (–0.06)	0.018	0.021* (2.91)	–0.030*** (–1.70)		
gri_i				18.737 (0.58)			–0.006 (–0.21)		
gri_j				2.084			0.034***		

	Model 7			Model 8			Model 9		
	PPML (1)	**Lasso (2)**	**PPML Post-Lasso (3)**	**PPML (4)**	**Lasso (5)**	**PPML Post-Lasso (6)**	**PPML (7)**	**Lasso (8)**	**PPML Post-Lasso (9)**
				(0.06)			(1.70)		
esi_i				–2.337 (–0.58)	0.004	0.004** (2.11)	0.0008 (0.21)		
esi_j				–0.267 (–0.07)	–0.005	–0.006* (–2.80)	–0.004*** (–1.70)		
$lexp_i$				–0.044 (–0.17)			–0.0003* (–2.60)		
$rexp_i$				–0.373* (–3.50)	–0.353	–0.373* (–4.13)	0.00005 (0.76)		
$limp_j$				–0.061 (–1.54)			–0.00003** (-0.87)		
$rimp_j$				0.397* (3.60)	0.392	0.410* (3.87)	–0.0001** (–2.09)		
$lgdp_i$				–0.220* (–5.82)	–0.219	–0.223* (–5.84)	0.0001* (8.24)	0.0001	0.0001* (7.78)
$lgdp_j$				–0.110* (–2.86)	–0.100	–0.115* (–3.11)	0.0001* (4.30)	0.0001	0.0001* (6.78*)
$lsimgdp_{ij}$				–0.098** (–2.28)	–0.095	–0.099** (–2.24)	0.00006* (2.74)	–0.0003	–0.0004* (–2.44)
$ldist_{ij}$				0.185* (2.80)	0.155	0.188* (2.81)	–0.0004* (–5.14)		
$rcep_{ij}$				0.491* (2.45)	0.466	0.449* (2.45)	0.0003 (0.64)		
Constant				–3.289* (–4.17)	–3.134	–3.180* (–3.68)	0.0005 (0.77)	0.0004	0.0005 (0.95)

	Model 7			Model 8			Model 9		
	PPML (1)	**Lasso (2)**	**PPML Post-Lasso (3)**	**PPML (4)**	**Lasso (5)**	**PPML Post-Lasso (6)**	**PPML (7)**	**Lasso (8)**	**PPML Post-Lasso (9)**
Country-pair fixed effect				Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect				Yes	Yes	Yes	Yes	Yes	Yes
R-square				0.015		0.014	0.022		0.020
Obser-vations				13,778		13,778	13,778		13,778
VIF				1.02e+08			9.04e+07		

PPML = Poisson Pseudo-Maximum Likelihood, RCEP = Regional Comprehensive Economic Partnership, VIF = variance inflation factor.
Notes:
The PPML post-lasso column displays the PPML coefficients for variables selected by the adaptive lasso method.
t-statistics are in parentheses.
* is significant with $p < 0.01$, ** is significant with $p < 0.05$, and *** is significant with $p < 0.1$.
Source: Author's calculations.

Considering the model with gravity model determinants, the empirical results of the trade resilience model are appropriate for this study. The COVID-19 stringency policies have statistically negative impacts on RCEP members' trade resilience. The strictness of lockdown policies tended to limit RCEP countries' ability to resist and to recover from disruptions in bilateral trade. These findings are similar to the conclusion on bilateral trade flows. Containment and health policies statistically positively affect RCEP members' trade resilience. The stronger the containment and health policies were, the better the RCEP members' trade resistance and recovery from disruptions. These results are in line with the conclusion on trade flows.

Economic support measures adopted by RCEP nations have statistically positive impacts on their trade resilience; however, the economic support measures adopted by partner countries have statistically negative impacts on RCEP members' trade resilience. The higher the economic support measures taken by home countries, the greater their trade resilience. Meanwhile, the higher the economic support measures by destination countries, the lower the home countries' trade resilience. This suggests that economic support for the COVID-19 pandemic in RCEP countries could increase or decrease the degree of their trade resilience. The restrictive export and import measures statistically negatively and positively affect RCEP members' trade resilience, respectively, indicating that restrictive trade measures supported their trade resilience.

Table 6 demonstrates the results of RCEP members' trade balance in processed food and agro-based products (Model 10) and their trade resilience in food products (Model 11). Regarding the model with gravity model determinants, the empirical results of the trade resilience model are suitable for this study. The COVID-19 stringency policies statistically positively impact RCEP members' trade resilience in food products. These findings are in contrast with the trade resilience of total products. The strictness of lockdown policies tended to improve RCEP countries' ability to resist and to recover from disruptions in bilateral trade in food products. The government responses statistically positively affect RCEP members' trade resilience. The larger the government responses, the greater the degree of their trade resilience.

In sum, it is worth noting that COVID-19 government policies and trade measures between exporting and importing countries significantly impacted RCEP members' trade flows and trade resilience. Thus, policies regarding comprehensive and specific trade development are needed.

Table 6: Estimation Results of RCEP Trade Indicators in Processed Food and Agro-Based Products

	Model 10			Model 11		
	PPML (1)	Lasso (2)	PPML Post-Lasso (3)	PPML (4)	Lasso (5)	PPML Post-Lasso (6)
A. Without gravity model determinants						
$stgi_i$	0.040*** (1.73)			0.007*** (1.67)	0.004	0.006 (1.50)
$stgi_j$	–0.046* (–2.68)			0.009* (2.60)	0.008	0.010* (2.62)
chi_i	20.254 (0.46)			–0.987 (–0.08)		
chi_j	47.530 (1.29)	0.015	0.016* (4.03)	–5.931 (–0.47)	–0.008	–0.010** (–2.32)
gri_i	–23.204 (–0.46)			1.121 (0.08)		
gri_j	–54.238 (–1.29)			6.767 (0.47)		
esi_i	2.906 (0.46)	0.003	0.004 (1.35)	–0.142 (–0.08)	–0.001	–0.005 (–0.96)
esi_j	6.750 (1.28)	–0.028	–0.029* (–7.66)	–0.844 (–0.46)	0.001	–0.001 (–1.12)
$rexp_{i,agr}$	–1.433** (–1.90)	–1.180	–1.438** (–1.94)	–0.398* (–5.05)	–0.346	0.001*** (1.78)
$limp_{j,agr}$	0.368* (2.99)	0.450	0.422* (3.98)	–0.043 (–1.05)		
$rimp_{j,agr}$	0.357* (2.51)	0.170	0.229* (2.69)	0.037 (0.72)	–0.015	–0.385* (–5.25)
$rcep_{ij}$	0.104 (0.16)			–0.011 (–0.17)		
Constant	5.901* (9.94)	5.832	5.916* (11.23)	–5.542* (–59.09)	–5.500	–5.534* (–71.46)
Country-pair fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.001		0.0008	0.006		0.006
Observations	33,840		33,840	33,840		33,840
VIF	9.57e+07			9.57e+07		
B. With gravity model determinants						
$stgi_i$				0.007 (1.35)	0.007	0.004* (2.96)
$stgi_j$				–0.0003 (–0.06)		
chi_i				14.766		

	Model 10			Model 11		
	PPML (1)	**Lasso (2)**	**PPML Post-Lasso (3)**	**PPML (4)**	**Lasso (5)**	**PPML Post-Lasso (6)**
				(0.99)		
chi_j				23.546* (1.64)		
gri_i				–16.876 (–0.99)		
gri_j				–26.906* (–1.64)	0.001	0.004* (3.21)
esi_i				2.107 (0.99)		
esi_j				3.364* (1.64)		
$rexp_{i,agr}$				–0.239*** (–1.72)		
$limp_{j,agr}$				0.083 (1.48)	0.012	0.030 (0.70)
$rimp_{j,agr}$				–0.044 (–0.63)		
$lgdp_i$				–0.016 (–0.65)		
$lgdp_j$				–0.042** (–1.89)	–0.007	–0.053* (–2.57)
$lsimgdp_{ij}$				0.0006 (0.04)		
$ldist_{ij}$				0.129* (3.32)	0.054	0.070** (2.00)
$rcep_{ij}$				0.198** (2.06)		
Constant				–5.883* (–12.44)	–5.734	–5.116* (–12.66)
Country-pair fixed effect				Yes	Yes	Yes
Year fixed effect				Yes	Yes	Yes
R-square				0.012		0.006
Observations				13,778		13,778
VIF				9.04e+07		

PPML = Poisson Pseudo-Maximum Likelihood, RCEP = Regional Comprehensive Economic Partnership, VIF = variance inflation factor.

Notes:

The PPML post-lasso column displays the PPML coefficients for variables selected by the adaptive lasso method.

t-statistics are in parentheses.

* is significant with $p < 0.01$, ** is significant with $p < 0.05$, and *** is significant with $p < 0.1$.

Source: Author's calculations.

5. Conclusions and Policy Implications

The study examined the impacts of COVID-19 government policies and temporary COVID-19 trade measures on trade flows amongst RCEP members. The stringency index, containment and health index, total government response index, and economic support index were used to measure COVID-19 government policies, whereas temporary COVID-19 trade measures comprised liberalising and restrictive import and export trade measures. A penalised PPML regression was used to investigate the impacts of COVID-19 government policies and trade measures on trade performance (i.e. exports, imports, trade flows, trade balance, trade resilience, and trade competitiveness) from January 2017 to December 2022.

The main findings demonstrate that COVID-19 government policy measures significantly influenced RCEP members' exports, imports, trade flows, and trade resilience. COVID-19 stringency policies implemented by RCEP and partner counties negatively impacted RCEP countries' exports, imports, trade flows, and trade resilience. The containment and health policies implemented by RCEP and partner countries positively affected the exports, imports, and trade flows of RCEP economies. RCEP members' income support and debt relief measures positively affected their trade resilience, while partner countries' income support and debt relief measures negatively affected their trade resilience. Second, liberalised and restrictive export measures had positive effects on RCEP members' trade flows, while liberalised and restrictive import measures had negative effects on RCEP members' trade flows.

In light of the above empirical results, the following policy implications can be drawn. First, COVID-19 stringency policies taken by RCEP and partner countries negatively impacted RCEP countries' trade flows, turning them into foreign trade barriers. RCEP governments should thus take advantage of the RCEP agreement to facilitate trade. Policies aimed at eliminating pandemics, such as regulations and measures of infectious disease protection, should be tailored and employed as needed.

Second, economic support measures taken by RCEP nations positively affected their trade resilience, while the actions taken by partner countries negatively impacted RCEP members' trade resilience. Therefore, policies and measures that promote RCEP members' trade post-pandemic should be continuously enhanced to maximise well-being in international trade.

Third, liberalising and restrictive trade measures statistically affected RCEP members' bilateral trade. To support the complementarity of foreign trade, governments should implement policies to tackle trade barriers while simultaneously improving the efficient utilisation of the RCEP agreement. However, governments should implement permissive policies for sustainable trade to support a path towards trade substitution.

Fourth, governments should strive to improve RCEP members' cooperation and exchanges on sustainable development, promote the idea that trade benefits regions, and set up and support the trade ecosystem in the region. Governments should create trade opportunities to help firms improve, create jobs, upskill people, and facilitate regional value chains to help RCEP countries get their economies back on track post-pandemic.

Lastly, the governments of RCEP members should strengthen trade development cooperation, engagement with the national and international private sectors, and coordination between multi-stakeholder partnerships.

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