TRADE INTERDEPENDENCIES IN COVID-19-RELATED ESSENTIAL MEDICAL GOODS

ROLE OF TRADE FACILITATION AND COOPERATION FOR THE ASIAN ECONOMIES

Sanchita Basu Das and Rahul Sen

NO. 666

July 2022

ADB ECONOMICS WORKING PAPER SERIES

ASIAN DEVELOPMENT BANK

ADB Economics Working Paper Series

Trade Interdependencies in COVID-19-Related Essential Medical Goods: Role of Trade Facilitation and Cooperation for the Asian Economies

Sanchita Basu Das and Rahul Sen
No. 666 | July 2022

Sanchita Basu Das (sbasudas@adb.org) is an economist at the Economic Research and Regional Cooperation Department, Asian Development Bank (ADB). Rahul Sen (rahul.sen@aut.ac.nz) is a senior lecturer at the Faculty of Business, Economics and Law, Auckland University of Technology (AUT), Auckland, New Zealand. The authors thank Jerome Abesamis, consultant with ADB, for his support with data. The usual disclaimer applies.

ASIAN DEVELOPMENT BANK

6 ADB Avenue, Mandaluyong City, 1550 Metro Manila, Philippines
Tel +63 2 8632 4444; Fax +63 2 8636 2444
www.adb.org

ISSN 2313-6537 (print), 2313-6545 (electronic)
Publication Stock No. WPS220292-2
DOI: http://dx.doi.org/10.22617/WPS220292-2

Notes:
In this publication, "$" refers to United States dollars.
ADB recognizes "China" as the People's Republic of China.

The *ADB Economics Working Paper Series* presents data, information, and/or findings from ongoing research and studies to encourage exchange of ideas and to elicit comment and feedback about development issues in Asia and the Pacific. Since papers in this series are intended for quick and easy dissemination, the content may or may not be fully edited and may later be modified for final publication.

CONTENTS

TABLES AND FIGURE

ABSTRACT

This paper empirically investigates the state of trade interdependency for coronavirus disease (COVID-19) essential medical goods—vaccines and their value chains, personal protective equipment, and diagnostic test kits—across 29 Asia and the Pacific economies. Expanding on Hayakawa and Imai (2022), the analysis investigates whether trade facilitation, proxied by membership in regional trade agreements (RTAs), can help mitigate any adverse impact on trade in essential medical goods. The results confirm that while trade is critical for Asian economies, its nature differs. Low-income economies are largely dependent on imports, whereas selected middle- and high-income economies are part of two-way trade and engaged in low end of vaccine value chain. We find that onset of the pandemic had hurt exports of these goods. This adverse effect is found to be lowered for economies engaged in RTAs. This emphasizes role of governments in committing to RTAs and implementing trade facilitation measures.

Keywords: COVID-19, vaccine supply chain, essential medical goods, regional trade agreements

JEL codes: F12, F13, R11

I. INTRODUCTION

The coronavirus disease (COVID-19) pandemic has created global havoc since 2020. Starting as a major health crisis, adverse impact of the virus was soon felt in the larger parts of economies. International trade came under pressure in 2020 and the pain was felt differently in different regions and commodity groups (Arriola, Kowalski, and van Tongeren 2021). While in some cases inventories built up due to a fall in demand, in others the concept of lean manufacturing and just-in-time inventory systems backfired due to supply shortages. Nonetheless, for selected product categories such as essential medical goods and food supplies cross-border trade continued. Thus, global trade fell much less than earlier expected (WTO 2020, 2021a).

The COVID-19 pandemic is ongoing. While the vaccine rollout beginning in early 2021 has brought relief, administering the vaccine remains uneven across economies. For example, as of end-March 2022, vaccine doses administered per 100 people in Asia was high (more than 200) for economies such as the People's Republic of China (PRC), the Republic of Korea (ROK), Malaysia, and Singapore. It is relatively low for Bangladesh, the Lao People's Democratic Republic (Lao PDR), Nepal, and Indonesia (below 140). Availability of other COVID-19-related medical goods is also uneven across economies.

Several reasons explain the disparities. Not all economies are self-sufficient in producing essential medical goods (OECD 2020a), for example. The United States (US), Germany, and the PRC are top three traders of medical goods. Production capacity and hence exports of essential medical goods are concentrated in a handful of economies (WTO 2021b). Other economies import all medical goods. This provides a strong case for international trade for adequate supply of essential medical goods across the globe.

In addition, trade encountered its own limitations in resolving all supply shortages. Major suppliers of medical goods have imposed export bans during high COVID-19 burden in their own economies (Hayakawa and Imai 2022). This had wider implications for importing economies as well as manufacturers that rely on ingredients from other economies, affecting part of the global value chain for producing medical goods. Supplies of COVID-19 medical goods also suffered, as economies such as the PRC, Malaysia, and Thailand—which accounted for major share of medical goods production (face masks, gloves)—experienced local shocks, like worker illness, strict lockdown, and manufacturing shutdowns. International trade also suffered at peak of the pandemic due to transport and shipping constraints or port congestion due to workers' illness or social distancing measures, leading to supply chain disruptions (ESCAP and ADB 2021).

The aim of our paper is thus two-fold: we first evaluate extent and nature of trade interdependencies of Asia and the Pacific economies for these essential medical goods. Second, we aim to understand importance of trade facilitation and regional cooperation for the cross-border supply chain of the same. We stress the importance of trade facilitation in terms of trade barriers, customs efficiency, and other "hard" and "soft" cooperation measures to enhance trade. All these together, part of regional trade agreements (RTAs), are prerequisites for the smooth operation of supply chains for these goods.

The paper extends the analysis of OECD (2020a) and Hayakawa and Imai (2022), covering Asia, Europe, and North America.[1] It deploys the trade value of medical products globally and follows World Trade Organization's (WTO 2021b) three of four categorization of medical goods: medical supplies, including test kits; medicines, including vaccines for human medicine; and personal protective equipment (PPE), which includes hand soap, hand sanitizer, face masks, protective eyewear or spectacles, and other cleaning products.

For vaccines, the paper examines the global value chain of vaccine manufacturing and distribution and hence looks at three other categories, called ingredients, primary packaging, and secondary packaging (storage, distribution, and administration) based on the Organisation for Economic Co-operation and Development (OECD 2021) compilation of vaccine-related inputs. A list of six-digit level codes in the Harmonized System (HS) 2017 for these seven product categories are presented in Appendix 1.[2] The original data set thus comprises 29 economies and 29 medical goods products,[3] sourced from United Nations Commodity Trade Database. The analyses are carried out over two time points, i.e., 2019 (pre-COVID-19) and 2020 (during COVID-19),[4] using annual data to identify trade interdependencies and bilateral monthly data to analyze the role of trade facilitation or RTAs at the onset of the pandemic.

The remainder of the paper is organized as follows. Section II discusses existing literature. Section III examines state of trade of these essential medical goods, with focus on Asia. A brief discussion on methodology used is provided in Section IV. Section V analyzes nature of trade interdependence—one-way or two-way trade—among these economies. Section VI undertakes an empirical analysis estimating the impact of COVID-19 on bilateral trade involving these economies, and role of RTAs. We conclude with policy recommendations in Section VII.

II. LITERATURE REVIEW

Since the outbreak of the COVID-19 pandemic, several studies have analyzed patterns of international trade in relation to medical goods and the issues and challenges they have faced. The section thus reviews the existing literature, broadly categorizing them into (i) the importance of international trade, (ii) the geographic concentration in production, and (iii) the global value chain of production and distribution. The studies allude to several ways to supply chain breakdowns, including spikes in demand for essential medical goods in producing economies, trade restricting policy measures, shortages in vital ingredients, and transport and shipping bottlenecks.

A. Importance of International Trade for Supply of Medical Goods

In first year of the pandemic, OECD (2020a) reveals that no country was able to efficiently produce all the goods needed to fight the virus, highlighting high degree of trade interdependency

[1] Asia includes Southeast Asian economies, as well as the PRC, India, Japan, and the ROK, as well as Australia and New Zealand; North America includes Canada, Mexico, the United States and Europe includes seven members of the European Union, as well as Switzerland, and the United Kingdom.
[2] The appendixes are available at http://dx.doi.org/10.22617/WPS220292-2.
[3] The 29 economies constitute 9 from Europe, 3 from North America, and 17 from Asia and the Pacific; and 17 out of the 29 product categories comprise vaccine production and value chain products, while the remaining 12 constitute 8 PPE and 4 diagnostic testing kit products.
[4] Annual data for 2021 was not available for all economies uniformly during the writing of this paper.

between economies. For example, OECD (2020b) reports that the PRC's medical, transport and manufacturing workers alone would have required 240 million face masks per day, much higher than the 20 million it produced daily in January 2020. It categorically noted that "no country can meet increased demand for face masks alone" (OECD 2020b, 9), implying that cross-border supply would be necessary to curb adversity of the pandemic.

In a subsequent study, OECD (2021, 2) emphasizes that "all countries need vaccines but not all are able to produce them." While 208 economies were said to be importing vaccines, 90 were exporting them, making international trade an integral part of vaccine supply. Strong trade interdependencies also exist for vaccine production and distribution. This is because vaccine supply chain comprises four stages, including drug discovery, production, and distribution and administration. Each of these stages can be located across different economies. Even if vaccine production is concentrated in a few, the ingredients are procured from many economies. Production of packaging material for vaccine transportation, storage, and administration are also spread across several economies. This implies that trade does play a crucial role in essential medical goods, particularly vaccines.

B. Geographic Concentration of Medical Goods Production

The location of COVID-19 vaccine manufacturers and distributors is highly concentrated in high income and emerging economies (ADB 2020). Few firms are registered as vaccine distributors in South America or Southeast Asia. This geographic concentration of production and distribution capacities emphasizes importance of trade and logistics efficiency for vaccine delivery globally.

Brown (2020) notes that the PRC—largest supplier of face masks, medical goggles, and protective gowns to the global economy in 2019—directed these for its own use in 2020, lowering exports. The country also started importing many of these goods from other economies in early 2020 and, on a net basis, the PRC's exports of face masks to the world economy fell 24% in January–February 2020 compared to the same period in 2019. Given growing demand for these goods globally, the prices of facemasks skyrocketed, meaning that, primarily, only the rich economies such as Japan or the US could afford at that time. This highlights the ill-effect of geographic concentration of production of COVID-19 medical goods, where trade itself could not resolve supply shortages.

C. Global Value Chain or Supply Chain Disruption

Evenett (2020), taking a supply chain perspective, mentions that as of 4 September 2020 medical goods and medicine sectors were subject to around 459 trade policy interventions, though only half were trade restricting measures. In 2020, several economies introduced export controls, and other restrictive measures that disrupted operations.[5] Yet, other economies undertook trade policy reforms to ease imports of medical goods in their jurisdictions.

Evenett et al. (2022) make similar observations. The incidence of trade policy measures, a combination of export controls and import liberalization-cum-facilitation, increased during first

[5] The highest number of export control measures came in March–April 2020.

quarter of 2020, in line with rise in COVID-19 cases. While some of them seem to be temporary in nature, some are left as open-ended, depending on the economy or region. Around two-thirds of trade policy measures during the pandemic were targeted towards medical goods and PPE, as compared to agriculture and food products.

Gopalakrishnan, Vickers, and Ali (2020), analyzing economies from Commonwealth grouping, find that while production of high-end medical goods, such as ventilators and oxygen therapy equipment, are concentrated in European Union and the US, the PRC dominates manufacturing of PPE. Within Commonwealth, developed economies are leading exporters and large developing economies the importers. The prevalence of export restrictions and high tariffs weakens resilience of supply chains from shocks like COVID-19.

Gereffi (2020) describes value chain of producing N95 face masks, which requires at least three layers of non-woven specialized fabric, which in turn is manufactured from polypropylene after being "melt-blown" to obtain fibers that can trap small particles. Despite a relatively simple value chain, the melt-blown, non-woven fabric is only made by a limited number of companies globally and hence scaling up of production is time-consuming.

Park et al. (2020), discussing supply chain issues in PPE goods, identifies five sources of disruption. Apart from a shortage of raw materials, geographic concentration of manufacturers, and export bans, it also highlights challenges in transport and shipping due to lockdown and quarantine measures, limited availability of freight containers and low capacity of workforce due to illness or social distancing measures. This led to supply chain disruptions, causing delays and shortages of goods in importing economies.

Hayakawa and Imai (2022) acknowledge that several economies adhered to export bans to match domestic demand for medical goods such as face masks during peak pandemic when they had faced large numbers of COVID-19 confirmed cases. Using bilateral trade values of medical products for 35 reporting and 250 partner economies, they conclude that even though burden of COVID-19 cases led to lower exports, the decrease was smaller when exporting to partner economies with political or economic ties.

Notwithstanding above observations, these studies reiterate importance of international trade in the production and supply of medical goods, and demonstrate potential of policy measures, often governed by economies' own priorities and driven by the burden of the COVID-19 pandemic, to cause disruption in existing supply chains. Economies attempt to control trade or to relocate supply chains may not be an easy alternative. Retaliatory actions by economies can destroy manufacturing productive capacity of these essential goods, hampering economic recovery and prolonging the pandemic (Baldwin and Freeman 2020). Alternatively, economies need to pay attention to trade liberalization-and-facilitation (regional cooperation) measures to see how fast and efficiently COVID-19-related medical goods could be transported and distributed to all economies to manage pandemic risks.

Our paper adds value to analysis of trade interdependency by extending OECD (2020a) discussion to developing Asia. It contributes to existing literature on trade in medical goods by Hayakawa and Imai (2022) in the following manner. First, we focus the discussion on developing Asia. Second, as opposed to four broad medical goods trade categories in Hayakawa and Imai (2022), we disaggregate COVID-19-related essential medical goods to seven categories, specifically focusing on vaccine production and value chain. The value chain discussion has not been attempted in empirical literature and hence is a key contribution of our paper. We contribute to understanding of how regional cooperation agreements involving trade facilitation, may or may

not have mitigated adverse impact on global value chain of vaccines, critical for post-pandemic recovery.

III. STATE OF TRADE

This section examines global trends and identifies the top 20 economies involved in exports and imports of these goods in 2019 and 2020. Focused discussion on developing Asia is presented simultaneously, along with brief discourse on trade overlap among them.

A. Global Trends

Table 1 presents global trends in exports of essential medical goods across the seven product categories mentioned earlier. Between 2019 and 2020, these medical goods together grew 20% to $588 billion, mainly led by PPE product growth (45.8%), followed by testing and diagnostic kits (24.3%). This reflects growing demand for these medical goods as the pandemic continues to evolve with new variants across the globe. While Belgium, Germany, Switzerland, and the US were major exporters of these goods during 2019 and 2020, the PRC accounted for more than a third of the global share in PPE and vaccine ingredient exports, particularly in 2020. This suggests dominance of developed economies as leading exporters for most of these goods.

Table 1: Global Trends in Exports of Essential Medical Goods

Product Category	2019	2020	2019	2020	Growth in 2020
	Value ($ billion)		Top Exporter (%)		%
Testing and diagnostic kits	148.0	184.0	Switzerland (21%)	Switzerland (19%)	24.3
Vaccines	30.0	30.5	Belgium (31%)	Belgium (38%)	1.7
Vaccine ingredients	11.2	10.6	PRC (33%)	PRC (37%)	-6.0
Vaccine primary packaging	23.8	23.1	Germany (14%)	Germany (15%)	-3.1
Vaccine secondary packaging: Storage and distribution	103.1	102.3	US (18%)	US (17%)	-0.8
Vaccine secondary packaging: Vaccine administration	37.6	36.4	US (21%)	US (19%)	-3.3
PPE	138.2	201.6	PRC (18%)	PRC (39%)	45.8
Total essential medical goods	492.1	588.5			19.6

PPE = personal protective equipment, PRC = People's Republic of China, US = United States.

Source: Authors' calculations based on data from United Nations. UN Comtrade Database. https://comtrade.un.org/ (accessed 30 December 2021).

Table 2 shows growth of around 21% in 2020 global imports compared to 2019. This was primarily driven by import growth of PPE products (49.8%) followed by testing and diagnostic kits (25.7%), reflecting economies' interest in testing and prevention measures. The US dominated global imports of these goods across all categories, except for vaccines and vaccine ingredients,

in which Belgium and India were major importers in 2020. The US accounted for nearly a fifth of the global share in PPE, diagnostic testing kits as well as primary and secondary packaging of vaccines. Like that of exports, developed economies were leading importers of these goods, though India replaced Italy as a top importer of vaccine ingredients in 2020, mirroring its significant role as a COVID-19 vaccine manufacturer. This not only suggests global concentration of demand and supply for COVID-related essential medical goods, but also highlight role of trade and supply chain for availability of these goods in other economies suffering in the pandemic.

Table 2: Global Trends in Imports of Essential Medical Goods

Product Category	2019	2020	2019	2020	Growth in 2020
	Value ($ billion)		Top Importer (%)		%
Testing and diagnostic kits	139.0	174.6	US (19%)	US (20.5)	25.7
Vaccines	31.2	32.2	Belgium (24%)	Belgium (24%)	3.1
Vaccine ingredients	12.9	11.9	Italy (12%)	India (12.2%)	-7.7
Vaccine primary packaging	23.4	22.0	US (14%)	US (14%)	-5.9
Vaccine secondary packaging: Storage and distribution	101.2	99.6	US (18%)	US (19%)	-1.6
Vaccine secondary packaging: Vaccine administration	35.0	33.5	US (20%)	US (19%)	-4.3
PPE	138.8	208.0	US (13%)	US (17%)	49.8
Total essential medical goods	481.5	581.8			20.8

PPE = personal protective equipment, US = United States.

Source: Authors' calculations based on data from United Nations. UN Comtrade Database. https://comtrade.un.org/ (accessed 30 December 2021).

B. Developing Asia—Exports

This section analyzes data trends in developing Asia in trade of these goods. Appendixes 2 and 3 rank the top 20 exporters of these goods for 2019 and 2020, covering about 85% of global exports. Four out of seven product categories—vaccines, ingredients, vaccine administration, and COVID-19 diagnostic kits—suggests high concentration in the supply chain of these goods, with nearly half or more of global exports of these goods dominated by top three economies.

Economies from developing Asia feature among top 20 exporters of these goods during 2019 and 2020 (Tables 3a and 3b), although this was led by middle- and high-income economies. The PRC is a leading exporter of PPE, packaging for vaccine administration and distribution, and vaccine ingredients, although its position drops to 15 for vaccines. The PRC's share in global exports of testing kits moved from 15 to 7 during 2019-2020. This shows the PRC's importance for vaccine value chain and supplies of PPE to the global economy. India is important as a supplier of vaccines, vaccine ingredients, and primary and secondary packaging for vaccine administration. Japan, the ROK, and Singapore are notable for their capacity to export testing kits, vaccine ingredients, and packaging material. Middle-income economies of Southeast Asia, i.e., Indonesia, Malaysia, Thailand, and Viet Nam, contribute to global exports in one or two categories. Between 2019 and 2020, Viet Nam moved from 19th to 12th rank in PPE exports.

Most other economies did not show any major change in trend of their exports over the same period.

Table 3a: Share and Ranking of Selected Asia and Pacific Economies in Top 20 Exporters of Essential Medical Goods, 2019

Product Category	PRC	HKG	JPN	ROK	SIN	INO	THA	MAL	VIE	IND	AUS	Top 4 Exporters and Share (%)
Testing kits	0.9 (15)	0.8 (16)	1.8 (11)	0.9 (14)	1.9 (10)	...	...	...	...	...	...	Switzerland 20.6, Germany 18.0, US 15, Ireland 13.3
Vaccines	0.4 (15)	...	...	0.5 (14)	...	0.3 (18)	...	...	...	2.6 (7)	0.3 (17)	Belgium 30.7, Ireland 17.8, France 14.2, UK 11.4
Vaccine ingredients	33.4 (1)	...	1.7 (13)	2.1 (10)	2.7 (8)	0.4 (20)	...	...	...	8.4 (4)		PRC 33.4, Switzerland 14.9, Italy 8.9, India 8.4
Vaccine primary packaging	12.6 (2)	...	3.3 (8)	1.5 (17)	...	...	2.7 (11)	...	...	2.0 (14)	...	Germany 14.4, PRC 12.6, Italy 6.7, Poland 5.5
Vaccine secondary packaging: Storage and distribution	10.9 (3)	...	1.5 (15)	1.4 (17)	1.9 (10)	...	...	...	...	...	...	US 17.7, Germany 11.4, PRC 10.9, Netherlands 7.0
Vaccine secondary packaging: Vaccine administration	6.1 (6)	...	3.0 (8)	...	1.7 (12)	...	...	2.1 (11)	0.9 (19)	1.0 (18)	...	US 21.1, Netherlands 13.8, Ireland 11.4, Mexico 8.1
PPE	18.4 (1)	2.0 (14)	4.7 (4)	2.0 (13)	...	...	...	...	1.4 (19)	...	...	PRC 18.4, Germany 12.5 US 10.1 and Japan 4.7

AUS = Australia; HKG = Hong Kong, China; IND = India; INO = Indonesia; JPN = Japan; MAL = Malaysia; PPE = personal protective equipment; PRC = People's Republic of China; ROK = Republic of Korea; SIN = Singapore; THA = Thailand; UK = United Kingdom; US = United States; VIE = Viet Nam.

Notes: Share is percent of total; '…' denotes that these economies do not feature as top 20 exporters in Asia and the Pacific. Numbers in parentheses show the ranking of economies in each category. A detailed table is presented in Appendix 2.

Source: Authors' calculations based on data from United Nations. UN Comtrade Database. https://comtrade.un.org/ (accessed 30 December 2021).

Table 3b: Share and Ranking of Selected Asia and the Pacific Economies in Top 20 Exporters of Essential Medical Goods, 2020

Product Category	PRC	HKG	JPN	ROK	SIN	INO	THA	MAL	VIE	IND	AUS	Top 4 Exporters and Share (%)
Testing kits	3.4 (7)	1.0 (15)	1.9 (12)	2.8 (10)	1.7 (14)	…	…	…	…	…	…	Switzerland 19.3, Germany 16.6, Ireland 13.7, US 13
Vaccines	0.9 (14)	…	…	0.6 (15)	…	…	…	…	…	2.4 (7)	0.3 (18)	Belgium 37.9, Ireland 16.7, France 14.4, US 5.8
Vaccine Ingredients	36.6 (1)	…	1.5 (11)	2.1 (9)	2.7 (7)	…	…	…	…	9 (3)		PRC 36.6, Switzerland 12.9, India 9, Italy 8.6
Vaccine primary packaging	13.3 (2)	…	2.9 (10)	1.4 (18)	…	…	2.3 (11)	…	…	1.8 (16)	…	Germany 14.6, PRC 13.3, Italy 6.8, USA 5.4
Vaccine secondary packaging: Storage and distribution	12.5 (2)	…	1.5 (15)	…	2.1 (9)	…	…	…	…	…	…	US 16.6, PRC 12.5, Germany 11.6, Netherlands 7.1
Vaccine secondary packaging: Vaccine administration	6.9 (6)	…	2.7 (9)	…	1.5 (13)	…	…	2.0 (11)	0.9 (20)	0.9 (19)	…	US 19.5, Netherlands 14.2, Ireland 10, Mexico 8.5
PPE	38.8 (1)	1.8 (10)	3.3 (4)	1.7 (11)	…	…	…	…	1.7 (12)	…	…	PRC 38.8, Germany 9.1, US 7.1 and Japan 3.3

AUS = Australia; HKG = Hong Kong, China; IND = India; INO = Indonesia; JPN = Japan; MAL = Malaysia; PPE = personal protective equipment; PRC = People's Republic of China; ROK = Republic of Korea; SIN = Singapore; THA = Thailand; US = United States; VIE = Viet Nam.

Notes: The share is the percent of total. "…" denotes that these economies do not feature as top 20 exporters in Asia and Pacific. Numbers in the parentheses show ranking of economies in each category. A detailed table is presented in Appendix 3.

Source: Authors' calculations based on data from United Nations. UN Comtrade Database. https://comtrade.un.org/ (accessed 30 December 2021).

C. Developing Asia—Imports

Appendixes 4 and 5 rank top 20 importers of these goods over 2019 and 2020. In both years, these importers constituted more than 80% of global imports of four (vaccines, ingredients, vaccine administration, and COVID-19 diagnostic kits) out of seven product categories,

suggesting high concentration of import demand for these goods, and possibility of high two-way trade and interdependencies.

Like exports, developing economies from Asia feature among top 20 importers (Tables 4a and 4b), but only selected ones take a lead. Apart from the PRC, India, and Japan (in two categories), most of these economies rank between 15–20. The PRC is a leading importer for all of these medical goods, with its share in global imports going up for vaccine, primary, and secondary packaging during 2019 and 2020. India, except for vaccine ingredients, ranks among the bottom 10 for other categories. Its ranking in vaccine imports dropped from 13th to 16th, suggesting increased reliance on domestically manufactured vaccines. Japan and the ROK were importers for almost all these medical goods, and both had a higher share of vaccine imports in 2020. Economies in Southeast Asia had small shares in imports for a few of these categories. While Singapore increased its imports for vaccine storage and distribution packaging in 2020, Indonesia, Thailand, and Viet Nam remained at the low end of top 20 importers for these essential medical goods.

Table 4a: Share and Ranking of Selected Asia and the Pacific Economies in Top 20 Importers of Essential Medical Goods, 2019

Product Category	PRC	HKG	JPN	ROK	SIN	INO	THA	MAL	VIE	IND	AUS	Top 4 Importers and Share (%)
Testing kits	8.7 (3)	...	6.1 (4)	1.9 (13)	0.9 (19)	...	...	...	0.8 (19)	0.8 (20)	1.2 (15)	US 19.3, Germany 10.0, PRC 8.7, Japan 6.1
Vaccines	4.3 (4)	...	1.2 (14)	0.9 (18)	...	...	...	...	1.3 (13)	1.2 (13)	1.0 (15)	Belgium 24.0, US 23.4, UK 6.6. PRC 4.8,
Vaccine ingredients	5.5 (5)	...	3.4 (8)	1.9 (14)	...	...	...	...	2.1 (13)	10.6 (3)	...	Italy 12.0, India 10.6 Germany 9.7, US 6.9
Vaccine primary packaging	3.6 (6)	...	2.2 (12)	...	...	...	2.0 (13)	...	...	1.4 (19)	1.4 (20)	US 13.8, Germany 8.3, France 7.2, Italy 3.9
Vaccine secondary packaging: Storage and distribution	4.1 (6)	1.1 (19)	3.4 (8)	1.7 (15)	1.7 (16)	...	...	...	...	...	2.0 (13)	US 17.9, Germany 7.2, Netherlands 5.9, France 5.1
Vaccine secondary packaging: Vaccine administration	7.0 (4)	...	6.4 (5)	1.6 (14)	1.2 (17)	...	...	...	...	1.1 (19)	1.0 (20)	US 19.9, Netherlands 10.5, Germany 7.8, PRC 7.0
PPE	7.5 (3)	1.5 (20)	4.1 (5)	2.5 (10)	...	...	1.6 (18)	...	1.8 (15)	...	...	US 13.3, Germany 8.3, PRC 7.5, France 4.3

AUS = Australia; HKG = Hong Kong, China; IND = India; INO = Indonesia; JPN = Japan; MAL = Malaysia; PPE = personal protective equipment; PRC = People's Republic of China; ROK = Republic of Korea; SIN = Singapore; THA = Thailand; UK = United Kingdom; US = United States; VIE = Viet Nam.

Notes: Share is percent of total; ... denotes that these economies do not feature as top 20 importers in Asia and Pacific. Numbers in parentheses show ranking of the economies in each category. A detailed table is presented in Appendix 4.

Source: Authors' calculations based on data from United Nations. UN Comtrade Database. https://comtrade.un.org/ (accessed 30 December 2021).

Table 4b: Share and Ranking of Selected Asia and the Pacific Economies in Top 20 Importers of Essential Medical Goods, 2020

Product Category	PRC	HKG	JPN	ROK	SIN	INO	THA	MAL	VIE	IND	AUS	Top 4 Importers and Share (%)
Testing kits	7.3 (3)	...	5.4 (4)	1.9 (13)	0.9 (20)	...	...	...	...	...	1.2 (16)	US 20.5, Germany 10.3, PRC 7.3, Japan 5.4
Vaccines	7.6 (3)	...	1.6 (11)	1.1 (15)	...	...	...	...	1.3 (13)	1.1 (16)	0.9 (17)	Belgium 24.1, US 23.3, PRC 7.6, Germany 4.6
Vaccine ingredients	3.5 (8)	...	3.1 (10)	2.1 (13)	...	...	...	...	2.3 (12)	12.2 (1)	...	India 12.2, Italy 11.8, Germany 9.3, US 5.8
Vaccine primary packaging	4.0 (5)	...	2.2 (12)	...	...	...	2.1 (14)	...	...	...	1.5 (18)	US 14.3, Germany 8.2, France 7.6, Italy 4.2
Vaccine secondary packaging: Storage and distribution	4.4 (5)	1.1 (20)	3.1 (9)	1.7 (16)	2.0 (14)	...	...	...	...	...	2.0 (13)	US 19, Germany 7.3, Netherlands 6.0, France 5.1
Vaccine secondary packaging: Vaccine administration	6.4 (5)	...	6.8 (4)	1.7 (15)	1.0 (19)	...	...	...	...	...	...	US 19.2, Netherlands 10.1, Germany 9.0, Japan 6.8
PPE	6.0 (3)	...	4.6 (6)	1.9 (12)	...	...	...	...	1.5 (17)	...	1.8 (13)	US 17.4, Germany 8.9, PRC 6.0, France 6.0

AUS = Australia; HKG = Hong Kong, China; IND = India; INO = Indonesia; JPN = Japan; MAL = Malaysia; PPE = personal protective equipment; PRC = People's Republic of China; ROK = Republic of Korea; SIN = Singapore; THA = Thailand; US = United States; VIE = Viet Nam.

Notes: Share is percent of total; '...' denotes that these economies do not feature as a top 20 importer in Asia and the Pacific. Numbers in parentheses show ranking of the economies in each category. A detailed table is presented in Appendix 5.

Source: Authors' calculations based on data from United Nations. UN Comtrade Database. https://comtrade.un.org/ (accessed 30 December 2021).

D. Trade Overlap

On average, 15 out of top 20 economies feature in both exports and imports in 2020, suggesting a pattern of trade overlap and possible two-way trade among them (Tables 3b and 4b). This overlap is highest among the PRC, the US, United Kingdom (UK), and European Union (EU) members, including Belgium, Germany, France, and Italy, covering all seven categories of essential medical goods. This is followed by Japan, Canada, the ROK, Mexico,

and Switzerland, wherein there is export and import overlap in at least four categories, although these are not uniform across these economies.

Likewise, Singapore and India demonstrate trade overlap across exports and imports of two product categories. These are COVID-19 test kits and secondary packaging for Singapore and vaccine production and ingredients for India. Thailand and Viet Nam provide similar evidence, but only across primary packaging and PPE product categories only.

The above suggests that international trade of these essential medical goods has been concentrated among a few developed economies and selected developing economies in Asia, well before the onset of the pandemic. The PRC dominates for Asia for most of the categories in both exports and imports. However, other economies, such as India, Japan, the ROK, and Singapore feature well in the top 20 list for some of these goods. These are either high- or middle-income economies in Asia. Other Southeast Asian economies do not have significant presence for most of these goods under both exports and imports, highlighting their vulnerability to COVID-19. While trade becomes important for these economies for domestic accessibility, it also faces challenges from supply chain shocks, arising from availability, trade restrictions, distribution bottlenecks, and customs inefficiencies.

IV. METHODOLOGY

This section identifies whether there is one or two-way trade in these medical goods, using the FF-index method postulated by Fontagné and Freudenberg (1997). Trade is defined as "two-way" when the value of minority flow of either exports or imports represents at least 10% of the majority flows for the same.[6] Formally this is expressed as:

$$\frac{Min(X_i,M_i)}{Max(X_i,M_i)} \geq 10\% \quad (1)$$

Economies falling in two-way trade category among 26 economies, are further analyzed to estimate trade interdependencies applying intra-industry trade indices as discussed in Grubel and Lloyd (1975). The Grubel–Lloyd (G–L) index is used to compute two-way trade for each HS product category and across seven broad categories of essential medical goods. This is expressed as follows:

$$G-L = \{1 - \frac{|X_i - M_i|}{X_i + M_i}\} \times 100 \quad (2)$$

where X_i and M_i are values of exports and imports of product category i in a particular economy. The G–L index varies between 0 (complete *inter*-industry or one-way trade) and 100 (complete two-way or *intra*-industry trade). We calculate these to estimate the trade interdependency of each economy in essential medical goods with respect to the rest of the world.[7]

To analyze impact of RTAs as a form of trade facilitation, we apply Hayakawa and Imai (2022) to the chosen category of essential medical goods. We only focus on bilateral import and

[6] If the value of the minor flow is below 10%, trade is classified as one-way in nature, which also implies there are no trade interdependencies involved, as there is either a complete dependency on imports or a complete concentration in exports of the traded good.

[7] See Jambor (2015) on application of Grubel Lloyd and intra-industry trade indices in the European context.

export statistics for 26 pairs of economies in the data set based on United Nations Commodity Trade Database.[8] These economies feature at least once among top 20 exporters or importers of the seven medical goods categories we analyzed in Section III. The aggregated values at the HS six-digit level according to the seven categories of medical products forms our baseline model that's specified as follows:

$$Trade_{ijy} = \exp\left[\alpha_1 COVID_{iy} + \beta_1 COVID_{jy} + \delta_{ij} + \delta_{yf}\right] \times \varepsilon_{ijy} \quad (3)$$

Where $Trade_{ijy}$ is the sum of export values from economies *i* to *j* during January–December in year *y*. $COVID_{jy}$ and $COVID_{iy}$ are the COVID-19 incidence variables in exporting economies and importing economies, respectively. Our model controls for two fixed effects, δ_{ij} and δ_{yf} refer to the pair of economies and the trade flow-year fixed effects. The subscript '*f*' indicates the trade flow (i.e., exporter or importer fixed effects). We estimate this equation for each of the seven categories of essential medical products. A Poisson pseudo-maximum likelihood (PPML) method is applied as per the empirical trade literature, following Santos Silva and Tenreyro (2006, 2011). This is consistent with the fact that there are zero trade flow data observations we need to include in our model among pairs of economies. As an example, the PRC's hand sanitizer exports to Malaysia are recorded as zero from February to December 2019, while there are positive export values observed from January to December 2020.

We use two COVID-19 incidence variables in the model to check for robustness. One is the sum of number of confirmed cases and the other is number of deaths from January to December. Given no COVID-19 incidence in 2019, we set those values to zero. However, for estimation, we add a value of one to them, incorporating their log specifications in our model.[9] The coefficients for these variables demonstrate the effect of COVID-19 on trade in these essential medical goods, including those in the vaccine value chain.

To analyze impact of trade facilitation measures, which are often part of RTAs, we extend our model by introducing the interaction terms of COVID-19 variables with an RTA dummy as follows:

$$Trade_{ijy} = \exp\left[\alpha_1 COVID_{iy} + \alpha_2 COVID_{iy} \times RTA_{ij} + \beta_1 COVID_{jy} + \beta_2 COVID_{jy} \times RTA_{ij} + \delta_{ij} + \delta_{yf}\right] \times \varepsilon_{ijy} \quad (4)$$

In this, RTA_{ij} specifies a dummy variable that takes the value 1 if both the exporting and importing economy are part of an enforced RTA for that period, and 0 otherwise. As an example, in our model, bilateral trade values for vaccine exports between the PRC and Singapore takes a value 1 due to an enforced RTA between them, but same between Belgium and India takes a value 0. The information on the presence of an RTA or not are obtained from the WTO RTA database[10] and updated for 2020 using the information available on the WTO website.

[8] From our original dataset of 29 economies, we find 3 (Brunei Darussalam, Cambodia, and the Lao PDR to be completely import dependent, in Section V, hence, we exclude them in our regression model.

[9] As analyzed in Hayakawa and Imai (2022), these incidence variables are a reasonably good measure of the economic impact of COVID-19, although other measures such as the government stringency index calculated daily by the Oxford university research exist. The stringency index was not employed in our estimation as its time series characteristics are likely to be different than case or death numbers with a stable trend reflecting same level of restrictions (higher or lower) over a given period of time.

[10] See World Trade Organization. Regional Trade Agreements Database. https://rtais.wto.org/UI/PublicMaintainRTAHome.aspx (accessed 31 March 2022).

V. TRADE INTERDEPENDENCIES—ONE- OR TWO-WAY TRADE

This section identifies the economies involved in two-way trade of these essential medical goods, followed by discussion of the extent of trade interdependencies in these goods between advanced and Asian economies.

Data trends in Section III, while suggestive, do not clearly indicate the nature of trade dependency. FF-index is therefore applied to analyze whether these 29 HS-product categories are involved in one- or two-way trade in the original dataset of 29 economies, the results shown in Table 5. The Southeast Asian economies, particularly Brunei Darussalam, Cambodia, and the Lao PDR are involved in one-way trade for these goods, i.e., are major importers of these products for 2019 and 2020. Thailand, the Philippines, Singapore, and Viet Nam (2020 only) and Malaysia (2019 only) show one-way trade in vaccine manufacturing as well as COVID-19 diagnostic testing kits (imports) while being involved in two-way trade of vaccine global value chain products. Notably, while the PRC moved from one-way trade for vaccines to two-way trade between 2019 and 2020, Singapore engaged in one-way trade in 2020. Among Australia and New Zealand, the former is involved in one-way trade (i.e., imports) for almost all essential medical goods.

Among developed economies, Germany and Canada moved from one-way to two-way trade in vaccine manufacturing and its supply chains over 2019–2020. It is noteworthy that all European and North American economies (except Mexico), which received the brunt of COVID-19 cases globally in the pandemic's early stages, demonstrated presence of two-way trade in these medical goods, suggesting interdependence on the rest of the world for manufacturing and supply of these critical medical goods.

Table 5: Economies Involved One-Way Trade in Essential Medical Goods

Product Category	2019	2020
Vaccine	Brunei Darussalam, Cambodia, Lao PDR, Viet Nam, Philippines, Thailand, Malaysia, PRC, New Zealand, Mexico	Brunei Darussalam, Cambodia, Lao PDR, Viet Nam, Philippines, Thailand, Malaysia, Singapore, Japan, Mexico
Vaccine GVC: Ingredients	Brunei Darussalam, Cambodia, Lao PDR, Philippines, Viet Nam, Australia, Canada, Germany	Brunei Darussalam, Cambodia, Lao PDR, Philippines, Australia, Mexico
Vaccine GVC: Primary packaging	Brunei Darussalam, Cambodia, Lao PDR, Australia	Brunei Darussalam, Cambodia, Lao PDR, Australia
Vaccine GVC: Secondary packaging (distribution/storage)	Brunei Darussalam, Cambodia, Lao PDR	Brunei Darussalam, Cambodia, Lao PDR
Vaccine GVC: Secondary packaging (administration)	Brunei Darussalam, Cambodia, Lao PDR, Australia	Brunei Darussalam, Cambodia, Lao PDR, Australia
PPE		Brunei Darussalam, Cambodia, Lao PDR, Australia
COVID-19 test kits and Instruments	Brunei Darussalam, Cambodia, Lao PDR, Viet Nam, Philippines, Thailand, Australia	Brunei Darussalam, Cambodia, Lao PDR, Indonesia, Thailand, Viet Nam, Philippines, Australia

COVID-19 = coronavirus disease, GVC = global value chain, Lao PDR = Lao People's Democratic Republic, PPE = personal protective equipment.

Source: Authors.

Further, to understand the degree and level of two-way trade involving these products, intra-industry trade index is calculated for 2019 and 2020 using the G–L index formula. These are presented for the top 20 economies in Appendixes 6 and 7. Estimates for selected Asia and the Pacific economies are summarized in Tables 6a and 6b. The estimates range from 0 (no intra-industry trade [IIT] or one-way trade) to 100 (complete IIT) and are presented across three ranges: high, ranging from 70 to 100; medium from 50 to 70; and low from 10 to 50. Values below 10 are evidence of no trade interdependency or one-way trade.

Table 6a: Degree of Trade Interdependencies of Selected Asia and the Pacific Economies Involving Essential Medical Goods, 2019

Product Category	PRC	JPN	ROK	SIN	INO	THA	MAL	VIE	PHI	IND	AUS	Top 4 IIT Economies Globally
Testing kits	19.73 (L)	47.59 (L)	67.92 (M)	63.01 (M)	25.97 (L)	12.93 (L)	27.14 (L)	...	13.70 (L)	33.75 (L)	14.68 (L)	Italy, Poland, UK, Belgium
Vaccines	13.93 (L)	27.21 (L)	69.12 (M)	97.95 (H)	96.70 (H)	16.49 (L)	...	...	...	65.8 (M)	49.32 (L)	SIN, IND, Canada, Poland
Vaccine ingredients	31.65 (L)	60.2 (M)	99.72 (H)	54.57 (M)	54.26 (M)	32.38 (L)	38.00 (L)	...	...	81.69 (H)	...	ROK, Belgium, New Zealand, Netherlands
Vaccine primary packaging	43.42 (L)	80.0 (H)	71.46 (H)	89.43 (H)	46.09 (L)	84.53 (H)	92.61 (H)	72.96 (H)	64.60 (M)	81.24 (H)	17.00 (L)	Netherlands, MAL, Mexico, SIN
Vaccine secondary packaging: Storage and distribution	53.65 (M)	60.45 (M)	90.16 (H)	92.75 (H)	51.59 (M)	90.95 (H)	75.84 (H)	91.75 (H)	37.47 (L)	67.64 (M)	33.74 (L)	US, Switzerland, Belgium, SIN
Vaccine Secondary packaging: Vaccine administration	97.14 (H)	66.51 (M)	30.41 (L)	78.61 (H)	45.53 (L)	82.24 (H)	43.37 (L)	38.55 (L)	71.73 (M)	99.45 (H)	11.76 (L)	IND, Switzerland, PRC, Poland
PPE	58.15 (M)	92.88 (H)	88.83 (H)	96.77 (H)	82.02 (H)	91.73 (H)	86.38 (H)	88.48 (H)	40.73 (L)	95.08 (H)	30.58 (L)	France, SIN, IND, Japan
Total essential medical goods	81.0 (H)	75.34 (H)	82.51 (H)	82.11 (H)	63.31 (M)	90.15 (H)	82.82 (H)	81.32 (H)	45.11 (L)	86.66 (H)	26.96 (L)	Mexico, Belgium, France, Italy

AUS = Australia; HKG = Hong Kong, China; IIT = intra-industry trade; IND = India; INO = Indonesia; JPN = Japan; MAL = Malaysia; PPE = personal protective equipment; PRC = People's Republic of China; ROK = Republic of Korea; SIN = Singapore; THA = Thailand; UK = United Kingdom; US = United States; VIE = Viet Nam.

Notes: Degree of trade interdependencies measured by the Grubel-Lloyd index takes values from 0 to 100; Letters in parentheses show degree of IIT involving the economies in each category. H refers to High (index value between 70–100; M refers to medium (index value between 50 and 70), and L refers to low (index values between 10 and 50). '...' denotes that these economies do not involve two-way trade in the specified product categories. A detailed table is presented in Appendix 6.

Source: Authors' calculations.

Table 6b: Degree of Trade Interdependencies of Selected Asia and the Pacific Economies Involving Essential Medical Goods, 2020

Product Category	PRC	JPN	ROK	SIN	INO	THA	MAL	VIE	PHI	IND	AUS	Top 4 IIT Economies Globally
Testing kits	65.42 (M)	55.11 (L)	77.86 (H)	65.52 (M)	10.20 (L)	17.37 (L)	19.86 (L)	...	...	38.16 (L)	15.22 (L)	France, UK, Belgium, Italy
Vaccines	20.70 (L)	13.6 (L)	66.70 (M)	...	62.90 (M)	14.00 (L)	...	...	...-	62.6 (M)	41.8 (L)	Poland, Canada, Switzerland, UK
Vaccine ingredients	19.28 (L)	60.2 (M)	94.62 (H)	53.39 (M)	55.20 (M)	29.05 (L)	41.07 (L)	...	15.66 (L)	79.56 (H)	...	Belgium, France, Netherlands, New Zealand
Vaccine primary packaging	44.60 (L)	83.26 (H)	76.99 (H)	80.92 (H)	61.88 (M)	93.54 (H)	99.49 (H)	76.43 (H)	63.12 (M)	82.06 (H)	17.46 (L)	MAL, Mexico, Netherlands, THD
Vaccine secondary packaging: Storage and distribution	51.06 (M)	66.70 (M)	84.68 (H)	95.45 (H)	53.33 (M)	99.46 (H)	79.34 (H)	96.41 (H)	46.83 (L)	74.37 (M)	35.39 (L)	THD, Switzerland, VNM, SGP,
Vaccine secondary packaging: Vaccine administration	92.21 (H)	60.18 (M)	28.41 (L)	75.74 (H)	54.21 (M)	76.73 (H)	39.42 (L)	38.30 (L)	61.33 (M)	87.43 (H)	11.20 (L)	Germany, Poland, Switzerland, US
PPE	27.65 (L)	81.08 (H)	93.70 (H)	81.40 (H)	88.07 (H)	89.68 (H)	98.23 (H)	96.50 (H)	54.20 (M)	82.00 (H)	17.45 (L)	Germany, Belgium, MAL, Poland
Total essential medical goods	49.83 (L)	68.92 (M)	98.13 (H)	91.08 (H)	59.92 (M)	86.20 (H)	91.14 (H)	92.61 (H)	50.94 (M)	83.27 (H)	21.92 (L)	Rep. of Korea, Italy, Poland, Mexico

AUS = Australia, IND = India, INO = Indonesia, IIT = intra-industry trade, JPN = Japan, MAL = Malaysia, PPE = personal protective equipment, PRC = People's Republic of China, ROK = Republic of Korea, SIN = Singapore, THA = Thailand, UK = United Kingdom, US = United States, VIE = Viet Nam.

Notes: Degree of trade interdependencies measured by the Grubel-Lloyd index takes values from 0 to 100. Letters in the parenthesis show degree of IIT involving the economies in each category. H refers to High (index value between 70–100; M refers to medium (index value between 50 and 70), and L refers to low (index values between 10 and 50). A detailed table is presented in Appendix 7.

Source: Authors' calculations.

The results show that for vaccine manufacturing and ingredients, European economies (Poland, Belgium, Switzerland, the UK, the Netherlands, and Italy) and North America (the US and Canada) are consistently present for high IIT both during 2019 and 2020. Five Asian economies, though, were part of high IIT in 2019 (Singapore, Indonesia, the ROK, New Zealand, and India), dropped to medium or low in 2020. Indonesia is the only exception, moving up to moderate IIT in both categories in 2020. A possible reason could be that, as the pandemic unfolded in 2020, the high research and development costs involved in new vaccine manufacturing made it difficult for the developing economies in Asia to participate. Developed economies have traditionally been faster in discovering and manufacturing of new vaccines even

before the COVID-19 pandemic. In 2020, these economies increased their manufacturing and trading capacities.

For vaccine primary and secondary packaging products (storage and distribution), Asian economies add more value compared to vaccine manufacturing and ingredients. Besides the presence of European and North American economies in high IIT, both during 2019 and 2020, several economies from Asia—Malaysia, Singapore, Thailand, India, Japan, Viet Nam, and the ROK—feature in high IIT. Again, Indonesia moved up from the low to medium category of IIT for both primary and secondary packaging products during 2019–2020. For vaccine secondary packaging products for administration, five economies from Asia show high IIT in 2019 (India, the PRC, Thailand, Singapore, and the Philippines), with minor change for the Philippines (move down to medium IIT) and Indonesia (move up to medium IIT) in 2020. This reflects Asia's participation in global value chain of vaccine, particularly for relatively low-end packaging products.

PPE saw drop in number of high IIT from 18 to 15 during 2019 and 2020. The category shows high IIT for all economies, except for Canada and the PRC. The high ranked IIT economies from Asia include Singapore, India, Japan, the ROK, Thailand, Viet Nam, Malaysia, and Indonesia and they remain the same for both 2019 and 2020. This implies that Asian economies have played an important role in global trade in PPE products. Finally, for COVID-19 diagnostic test kits, Asia is yet to feature prominently under high or moderate IIT. Out of top 20 economies in 2019, the seven economies that show high IIT are from Europe (Italy, Poland, UK, Belgium, Netherlands, France) and North America (the US). In 2020, the six economies recording high IIT continue to be from Europe. The ROK is the only Asian economy in 2020 that moves up to a high IIT from moderate, suggesting that Asian economies are largely less dependent on domestic production of diagnostic test kits than their western counterparts.

The overall results for all seven product categories suggest that, in 2019, 17 economies in the dataset show a high degree of trade interdependencies in two-way trade in the selected category of medical goods. These include seven economies from Asia (Thailand, India, Malaysia, the ROK, Singapore, Viet Nam, the PRC, and Japan, in that order), seven from Europe (Belgium, France, Netherlands, the UK, Italy, Poland, and Germany) and two from North America (the US and Mexico). In 2020, this trend changed, with 14 economies showing a high degree of two-way trade in our chosen category of medical goods. These include six economies from Asia (the ROK, Viet Nam, Malaysia, Singapore, Thailand, and India, in that order), six from Europe (Italy, Poland, Germany, the Netherlands, Belgium, and France) and two from North America (the US and Mexico). Compared to 2019, four more economies joined the medium category IIT range in 2020 (the PRC, Japan and the Philippines from Asia and the UK from Europe). The US remained in the high IIT category, but its degree of trade interdependence declined in 2020 compared to 2019.

This section highlights three observations:

1. Evidence exists that, compared to 2019, the degree of global trade interdependence in these categories of essential medical goods declined in 2020, with only 8 economies improving on the degree of intra-industry trade out of 20 economies analyzed. This is indicative of the fact that governments prioritized their own populations over others as infection rate grew in these economies, evident in the temporary export restrictions applied by a number of these economies, as analyzed by Gopalakrishnan, Vickers, and Ali (2020) and Evenett et al. (2022).

2. In Asia, the PRC and Japan were two economies whose overall higher degree of trade interdependency in these goods dropped in 2020 compared to 2019. This may be explained by high initial incidence of COVID-19 in these economies, prioritizing the domestic market over global one.
3. The trade interdependencies are higher for Asian economies in PPE and lower end of the vaccine value chain, through primary and secondary packaging as well as vaccine administration. Developed economies in Europe and North America tend to dominate test kits and the upper end of the value chain (ingredients) as well as final production in vaccines. This implies mutual complementarity in vaccine global value chain, and both developed and developing economies would benefit from closer economic cooperation in facilitating access to this, crucial for a quick recovery from COVID-19.[11]

The above, in turn, highlight the potential role of RTAs among these economies. Particularly, for the economies in Asia wherein trade dependency is high, RTAs and committing to trade facilitation initiatives provide insurance for access to these essential medical goods. Being part of an RTA strengthens Southeast Asian economies participation in vaccine global value chains. RTAs among the Asian economies or among developed and developing economies is beneficial, looking at the above analysis. This emphasizes role of existing RTAs, i.e., ASEAN Economic Community (AEC), Asia-Pacific Economic Cooperation (APEC); and future ones, such as Regional Cooperation Economic Partnership (RCEP) and Comprehensive and Progressive Trans-Pacific Partnership (CPTPP). Most of the economies discussed so far are part of one or more of these important RTAs in the region. One notable exception is India, which, although features significantly in vaccine value chains and PPE trade, is not part of most of these mentioned RTAs. India has bilateral free trade agreements with selected East and Southeast Asian economies, including Singapore, Malaysia, Thailand, Japan, and the ROK, and a regional agreement with the Association of Southeast Asian Nations (ASEAN).

This finding links to the next section, which empirically proves that RTAs matter, particularly when COVID-19 infection rates rose, and economies were looking inward to protect their own populations.

VI. ROLE OF REGIONAL TRADE AGREEMENTS AND TRADE BARRIERS IN MITIGATING SLOWING TRADE

This section presents the empirical estimation results of the impact of the COVID-19 pandemic, and then links them with the observed trends in tariff barriers or the extent of implementation of trade facilitation measures to understand what has been and can be the potential role of RTAs in mitigating adverse effects of the pandemic. Do RTAs help to mitigate some of the adverse impacts of lower trade during times of crises? The section looks at the time of peak pandemic to observe the difference.

[11] An important caveat here is that current vaccine production and global value chain trade data is only available up to 2020. This does not include COVID-19 specific vaccine trade information, and, with both India and the PRC developing and exporting these vaccines in 2021, the nature of these interdependencies may have changed as of 2022.

A. Empirical Estimations Results

Based on the specifications of equations (3) and (4) in Section IV, we estimate four sets of regressions for seven categories of COVID-19-related essential medical goods, as specified in Appendix 1, using cases and deaths respectively as the COVID-19 incidence variables. This allows us to check whether the results are robust for more than one COVID-19 incidence variable. For all estimations, we cluster the standard errors by pairs of economies as per PPML modelling exercise norms.[12] Estimation results for equation (3) are shown in Tables 7a and 7b for cases and deaths as the incidence variable, respectively.

Table 7a: Baseline Model Results of Impact of COVID-19 Cases on Trade in Essential Medical Goods

Variables	PPE Products	Test Kits	Vaccines	Vaccine Ingredients	Vaccine Primary Packaging	Vaccine Storage and Distribution	Vaccine Administration
Export partner COVID-19	-0.059***	0.001	0.031	-0.023*	0.009**	-0.01**	0.003
	[0.012]	[0.012]	[0.024]	[0.014]	[0.003]	[0.005]	[0.004]
Import partner COVID-19	0.059***	0.024**	-0.003	0.004	-0.007*	0.013**	0.001
	[0.008]	[0.012]	[0.025]	[0.006]	[0.003]	[0.005]	[0.003]
Pseudo log likelihood	-3.34E+11	-2.34E+11	-1.91E+10	-3.72E+10	-2.14E+10	-1.99E+11	-4.08E+10
Pseudo R^2	0.494	0.600	0.683	0.404	0.57	0.434	0.613
Observations	115,473	57,327	14,064	86,400	28,800	86,400	28,800

COVID-19 = coronavirus disease, PPE = personal protective equipment.

Notes: Estimation results reported by the Poisson pseudo-maximum likelihood method. ***, ** and * denote 1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in square brackets are those clustered by pairs of economies. In all specifications, we control for economy-pair fixed effects and trade flow-year fixed effects. 'COVID-19' indicates the number of confirmed cases.

Source: Authors' calculations.

Table 7b: Baseline Model Results of Impact of COVID-19 Deaths on Trade in Essential Medical Goods

Variables	PPE Products	Test Kits	Vaccines	Vaccine Ingredients	Vaccine Primary Packaging	Vaccine Storage and Distribution	Vaccine Administration
Export partner COVID-19	-0.044***	0.006	0.041*	-0.015*	0.002	-0.014**	0.0004
	[0.009]	[0.012]	[0.023]	[0.009]	[0.003]	[0.006]	[0.004]
Import partner COVID-19	0.065***	0.018	-0.022	0.004	-0.01***	0.01*	-0.001
	[0.010]	[0.012]	[0.025]	[0.008]	[0.003]	[0.005]	[0.004]
Pseudo Log likelihood	-3.34E+11	-2.34E+11	-1.91E+10	-3.72E+10	-2.14E+10	-1.99E+11	-4.08E+10
Pseudo R^2	0.495	0.60	0.683	0.404	0.57	0.434	0.613
Observations	115,473	57,327	14,064	86,400	28,800	86,400	28,800

COVID-19 = coronavirus disease, PPE = personal protective equipment.

Notes: Estimation results reported by the Poisson pseudo-maximum likelihood method. ***, ** and * denote 1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in square

[12] See Yotov, Piermartini, and Larch (2016) for details of the gravity model and application of PPML models.

brackets are those clustered by pairs of economies. In all specifications, we control for economy-pair fixed effects and trade flow-year fixed effects. ‘COVID-19’ indicates the number of confirmed deaths.

Source: Authors’ calculations.

Results are reported for five vaccines and their global value chain product categories, and PPE and COVID-19 test kits separately. The coefficient for exporting partner COVID impact is negative and significant for PPE products, and for vaccine ingredients, and storage and distribution products within its value chain, confirming that those top 20 economies hurt more by COVID-19 in cases and deaths reduced their exports of these critical and essential medical goods. The adverse impact is most severe for PPE products by magnitude and weakest for vaccine ingredients. This explains the possible observed decline in overall trade interdependence with the advent of COVID-19 in 2020, led by a decline in bilateral exports of PPE products as well as some products in the vaccine supply chain.

The coefficient for importer's COVID-19 incidence by cases was found to be significant and positive for trade in PPE, test kits, and vaccine storage and distribution, indicating that economies in our dataset with a larger number of cases increased their imports of these three categories of essential medical goods. This is expected given that economies with many COVID-19 cases required greater imports of both PPE and test kits to contain the spread of infection and “flatten the curve.” The same coefficients by number of deaths report similar results for PPE and vaccine storage/distribution products, while for test kits, trade is positive but not significant. The positive impact of COVID-19 in the importing economy driving bilateral exports is strongest for PPE and weakest for vaccine secondary packaging (storage and distribution). Vaccine primary packaging exports seem to be undermined by COVID-19 cases and deaths in the importing partner, although the effect is stronger with respect to deaths. The impact of COVID-19 is found to be insignificant for both trade in vaccine administration (syringes and needles) and vaccines. The latter is likely, since 2020 data does not capture trade involving COVID-19 specific vaccines. These results confirm Hayakawa and Mukunoki (2021) finding that the pandemic has had a heterogenous impact across industries, adversely affecting some but not all industries in a similar manner.

Moving on to the role of regional economic cooperation or RTAs, specifically of both exporting and importing members in an RTA partnership, estimation of equation (4) is undertaken. The results are reported in Tables 8a and 8b (COVID-19 cases and deaths, respectively). We observe that RTA coefficient for the exporting economy is positive and significant for all essential medical goods categories in terms of deaths and all but vaccine administration products in terms of cases. This indicates that economies in RTAs were more likely to engage in trade in these essential medical goods; this also played a vital role in mitigating any initial adverse impact of the pandemic on the vaccine supply chain and test kits trade among these RTA member economies. Our study also finds that economies were more likely to import those essential medical products from RTA partners involved in the primary and secondary packaging and distribution stage of the vaccine value chain. Vaccine ingredients, a critical component of the vaccine development supply chain, increase their exports when an RTA is present, but the same has an insignificant impact if it is an importing economy.

Table 8a: Effect of Regional Trade Agreements on Trade in Essential Medical Goods Due to COVID-19 Cases

Variables	PPE	Test kits	Vaccines	Ingredients	Vaccine Primary Packaging	Vaccine Storage and Distribution	Vaccine Administration
Export partner COVID-19	-0.116***	-0.015	-0.006	-0.047***	-0.047***	-0.046***	-0.009
	[0.017]	[0.017]	[0.034]	[0.015]	[0.011]	[0.015]	[0.010]
RTA	0.133***	0.043*	0.101**	0.090***	0.082***	0.060***	0.010
	[0.025]	[0.023]	[0.051]	[0.023]	[0.023]	[0.023]	[0.022]
Import partner COVID-19	0.050***	0.019	-0.020	0.008	-0.039***	-0.019	-0.042***
	[0.010]	[0.016]	[0.035]	[0.008]	[0.007]	[0.011]	[0.014]
RTA	-0.015	0.016	-0.030	-0.033	0.067***	0.070***	0.11***
	[0.022]	[0.024]	[0.051]	[0.03]	[0.02]	[0.022]	[0.025]
Log pseudo likelihood	-3.24E+11	-2.31E+11	-1.88E+10	-3.71E+10	-1.92E+10	-1.90E+10	-3.82E+10
Pseudo R^2	0.5095	0.6047	0.7245	0.4234	0.6134	0.4595	0.6370
Observations	115,473	57,327	14,064	86,400	28,800	86,400	28,800

COVID-19 = coronavirus disease, PPE = personal protective equipment, RTA = regional trade agreement.

Notes: Estimation results shown by the Poisson pseudo-maximum likelihood method. ***, ** and * denote 1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in square brackets are those clustered by pairs of economies. In all specifications, we control for economy-pair fixed effects and trade flow-year fixed effects. 'COVID-19' indicates the number of confirmed cases.

Source: Authors' calculations.

Table 8b: Effect of Regional Trade Agreements on Trade in Essential Medical Goods Due to COVID-19 Deaths

Variables	PPE	Test kits	Vaccines	Ingredients	Vaccine primary packaging	Vaccine Storage and Distribution	Vaccine Administration
Exporter economy COVID-19	-0.100***	-0.014	-0.013	-0.037***	-0.069***	-0.061***	-0.03**
	[0.015]	[0.016]	[0.033]	[0.001]	[0.012]	[0.015]	[0.011]
RTA	0.140***	0.610***	0.130**	0.088***	0.12***	0.087***	0.047**
	[0.023]	[0.023]	[0.054]	[0.027]	[0.024]	[0.024]	[0.022]
Importer economy COVID-19	0.035**	0.010	-0.044	-0.004	-0.063***	-0.038***	-0.053***
	[0.015]	[0.016]	[0.0437]	[0.009]	[0.011]	[0.014]	[0.014]
RTA	0.033	0.020	-0.03	0.009	0.100***	0.097***	0.122***
	[0.023]	[0.023]	[0.05]	[0.030]	[0.022]	[0.022]	[0.025]
Log pseudo likelihood	-3.25E+11	-2.32E+11	-1.89E+10	-3.71E+10	-1.94E+10	-1.90E+10	-3.83E+10
Pseudo R^2	0.5086	0.6037	0.6875	0.4232	0.6096	0.4575	0.6359
Observations	115,473	57,327	14,064	86,400	28,800	86,400	28,800

COVID-19 = coronavirus disease, PPE = personal protective equipment, RTA = regional trade agreement.

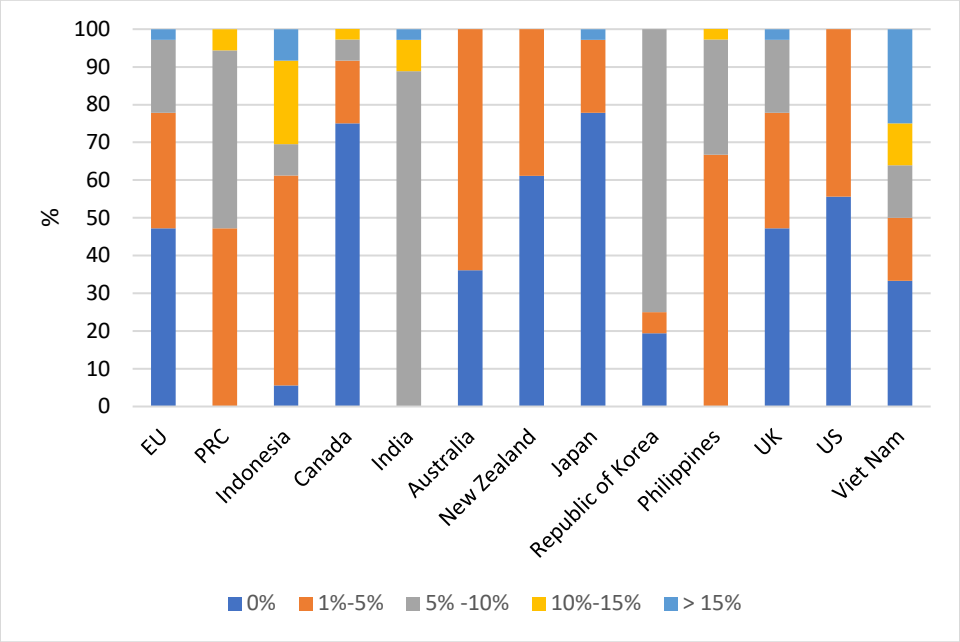
Notes: Estimation results shown by the Poisson pseudo-maximum likelihood method. ***, ** and *denote 1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in square brackets are those clustered by pairs of economies. In all specifications, we control for economy-pair fixed effects and trade flow-year fixed effects. 'COVID-19' indicates the number of confirmed deaths.

Source: Authors' calculations.

B. Role of Tariff Barriers

Some of the above results can be explained by the tariff structure that exists on these goods. The product level analysis presents a wide disparity among developed and developing economies when it comes to tariff barriers and their range over the medical products. Summarizing the data, Figure 1 presents the share of essential medical goods in 2019 and 2020 by most-favored nation (MFN) ad-valorem tariff range. While the US, Japan, Australia, and New Zealand all had tariffs on these product categories within the range of 1%–5%, those for the PRC were evenly distributed across the 1%–5% and 5%–10% ranges.

Figure 1: Most-Favored Nation Ad-Valorem Tariff Range of Essential Medical Goods by Economy, 2020



PRC = People's Republic of China, EU = European Union, UK = United Kingdom, US = United States.

Source: Authors' calculations.

Viet Nam, a key player in Asia and the Pacific in global PPE products trade, had the most restrictive tariff structure on two-thirds of these products, with nearly a quarter of them (9 products) attracting tariffs of 15% or more. Indonesia was the next most restrictive economy in terms of tariff barriers, with 22% (8 products), attracting peak tariffs of 10%–15%, and 8% (3 products) attracting an average most-favored nation tariff *ad-valorem* equivalent of 15% or more. India, a key player in the global vaccine production supply chain, also ranked among restrictive tariff regimes in Asia and the Pacific, attracting 5%–10% average import tariffs on almost 89% of these product categories, with peak tariffs of 15% or more on at least 3 products, particularly vaccine ingredients such as sorbitol.

The data for preferential tariffs charged under bilateral and regional preferential trade agreements under the product level analysis suggest that while some specific trading partners enjoyed tariff-free trade of essential medical goods, tariff barriers still exist preferentially between developed and developing economies, even in presence of enforced preferential trade agreements. Tariffs are largely eliminated for intra-EU and intra-ASEAN trade, between the US

and its preferential trade agreement partners in Asia and the Pacific; the PRC; Hong Kong, China; and Taipei,China; and zero across several product categories among ASEAN–Australia–New Zealand Free Trade Area (AANZFTA) and Comprehensive and Progressive Trans-Pacific Partnership (CPTPP) members. However, exceptions remain for specific products among essential medical goods, in PPE products as well as in the vaccine value chains (Tables 9 and 10). For example, one key vaccine ingredient, Sorbitol, continues to attract high tariffs even in the presence of RTAs among Asia and the Pacific economies, which may explain why ingredients trade by the importing economy is not impacted significantly, even in presence of RTAs (Tables 8a and 8b). A narrow margin of tariff preference in RTAs for some vaccine supply chain products can also explain why a strong and significant positive impact of RTAs on the exporting economy is not observed across the board of all seven medical categories. While Asia and the Pacific economies may have benefitted in PPE products from being part of existing RTAs in the region, there is evidence that vaccine global value chain trade may have been undermined the lower end of the value chain for importing economies due to the lack of regional economic cooperation between developed and developing economies, with the exception of APEC (which does not include the EU or India, two important economies in global trade involving these essential medical goods).

Table 9: Average Most-Favored Nation Tariffs on Essential Medical Goods in 2019–2020 by Selected Economies (%)

Product Group	EU	CAN	AUS	NZL	JPN	ROK	CHE	UK	US	PRC	INO	IND	PHI	VIE
Testing kits	0	0	3	4	0	6	0	0	0	5	6	10	2	0
Ingredients	4	0	2	1	2	6	0	4	1	5	5	9	2	2
PPE	4	4	4	3	2	7	3	4	3	7	11	10	7	12
Primary packaging	4	2	4	3	0	7	4	4	2	12	9	11	4	13
Secondary packaging: Storage and distribution	1	1	4	1	0	3	4	1	1	6	8	10	6	14
Secondary packaging: Vaccine administration	0	0	0	0	0	8	0	0	0	6	13	8	1	0
Vaccine for human medicines	0	0	0	0	0	0	0	0	0	3	3	10	1	0

AUS = Australia, CAN = Canada, CHE = Switzerland, EU = European Union, IND = India, INO = Indonesia, JPN = Japan, NZL = New Zealand, PPE = personal protective equipment, PRC = People's Republic of China, ROK = Republic of Korea, PHI = Philippines, UK = United Kingdom, US = United States, VIE = Viet Nam.

Source: Authors' compilation from the United Nations Conference on Trade and Development. TRAINS Online. https://trainsonline.unctad.org/home.

Table 10: Selected Product Specific Preferential Tariffs on Essential Medical Goods by Importing Economy and Regional and Bilateral Regional Trade Agreements in 2020

Product	Japan (CPTPP)	India (Japan)	Japan (ASEAN)	PRC (New Zealand)	Indonesia (ROK)	Viet Nam (India)
Sorbitol (vaccine ingredient)	12	20	17	8	0	0
Cold boxes	0	15	0	0	12	7
Vials	0	10	0	14	0	7
Hand soaps	0	10	4	7	6	14
Hand sanitizers	0	8	4	7	6	2
Textile face masks (630790)	5*	10	0	6	17	5

ASEAN = Association of Southeast Asia Nation, CPTPP = Comprehensive and Progressive Trans-Pacific Partnership, PRC = People's Republic of China.

*indicates that tariff applies for imports from Viet Nam only among Comprehensive and Progressive Trans-Pacific Partnership members.

Source: Authors' compilation from the United Nations Conference on Trade and Development. TRAINS Online. https://trainsonline.unctad.org/home.

It is also important to note that besides, trade barriers, non-tariff barriers in terms of export restrictions, product standards and regulations, testing requirements, and the likes add on to the trade costs which would also be important to reduce or eliminate among these economies to enhance access for critical medical goods to developing economies (Gopalakrishnan, Vickers, and Ali 2020).

C. Role of Trade Facilitation Measure

As noted, international trade for these goods faces barriers not only in tariffs but also through customs inefficiency caused by inadequate border infrastructure, regulations, and digitalization of trade processes.

The trade facilitation score, published by the UN Global Survey on Digital and Sustainable Trade Facilitation 2021, demonstrates that all economies do not rank high in the initiatives. At first glance, it shows that while leading economies involved in two-way trade of COVID-19 essential goods rank high, economies that are part of one-way trade and less developed need to catch up further (Table 11). Clearly, the latter are more vulnerable to external shocks such as seen during the pandemic. This highlights the role RTAs play in embedding trade facilitation in the Asia and the Pacific region. This is because most of them, including AEC, RCEP, CPTPP, and APEC, get their participating members to commit to transparent, harmonized, and streamlined border procedures. The agreements also include commitments to customs automation and digitalization, both of which should facilitate trade interdependencies of these developing economies, among themselves as well as with advanced economies.

Table 11: Trade Facilitation Score for Economies Involved in Trade for COVID-19 Essential Medical Goods

Country	Overall Trade Facilitation Score	Country	Overall Trade Facilitation Score
United States	…	Canada	88.17
New Zealand	96.77	Thailand	87.10
Australia	96.77	Malaysia	86.02
Singapore	95.70	Philippines	86.02
Belgium	94.62	Indonesia	84.95
Netherlands	94.62	United Kingdom	82.80
Republic of Korea	94.62	Italy	81.72
Japan	93.55	Brunei Darussalam	78.49
People's Republic of China	91.40	Cambodia	78.49
Mexico	91.40	France	76.34
Switzerland	90.32	Poland	72.04
India	90.32	Viet Nam	66.67
Germany	88.17	Lao PDR	63.44

. . . = not available, COVID-19 = coronavirus disease, Lao PDR = Lao People's Democratic Republic.

Source: Authors' compilation from the United Nations. UN Global Survey on Digital and Sustainable Trade Facilitation. https://www.untfsurvey.org/economy.

VII. CONCLUSION AND POLICY RECOMMENDATIONS

Our paper has analyzed the extent of trade interdependencies in seven key product categories of essential medical goods, incorporating vaccines and their global value chain products trade for the first time in the empirical literature. Focusing on the contribution of developing Asia, the empirical analysis is extended to understand whether this trade suffered due to COVID-19, and whether existing regional cooperation initiatives, involving trade facilitation measures, were able to mitigate adverse impacts.

Three key findings arise. First, trade is integral to Asian economies' access to these goods. Smooth cross-border movement of goods is crucial to the post-pandemic recovery of the region's economies. Currently, much of the production and trade of essential COVID-19 medical goods is concentrated among a few developed economies and a handful of developing economies, i.e., high- and middle-income ones. Majority of Southeast Asian developing economies are yet to catch up. They are highly dependent on imports and lack manufacturing capacity to produce them locally, leaving them vulnerable to COVID-19 infections and to challenges in economic recovery. While trade becomes important for these economies for domestic accessibility, additional challenges are faced from supply chain shocks, including lack of availability, trade restrictions, distribution bottlenecks, and customs inefficiencies.

Second, trade interdependencies are observed to be higher in PPE products and in lower end of the vaccine value chain (involving primary packaging, storage, distribution, administration). This is true for Asian economies such as Malaysia, Singapore, Thailand, India, Japan, Viet Nam, and the ROK. Europe and other advanced economies play a larger role in upper value chain trade of vaccine production, ingredients, and in COVID-19 diagnostic testing kits. This showcases mutual complementarity in the vaccine value chain, where both developed and developing economies would benefit from closer economic cooperation in facilitating access to this.

Third, regional economic cooperation through RTAs have played a crucial role in reversing or at least mitigating adverse impact of COVID-19 on cross-border flows of these goods. The impact is significant for PPE products in magnitude and weakest for vaccine ingredients. As COVID-19 has progressed, economies have had to rely more on trade in PPE products, test kits, and vaccine storage distribution in the value chain. Economies with RTAs were more likely to have mitigated the initial adverse impact of the pandemic on exports of vaccine supply chain products and test kits, and were more likely to also import those essential medical products from RTA partners involved in primary and secondary packaging and distribution stages of the vaccine value chain. Tariff barriers remain fairly low in developed and developing economies, but, exceptions, even in preferential trade agreement tariffs remain for specific products, in PPE products, and in the vaccine value chain, such as Sorbitol, a key vaccine ingredient. Implementation of trade facilitation measures, as committed to WTO Trade Facilitation Agreement and UN-ESCAP Digital trade, shows scope for improvement, particularly for less developed Asian economies.

Drawing on from the above, our paper makes the following key policy recommendations.

1. Many developing economies in Asia feature relatively low in top 20 ranks, depending on imports and having limited capacity to produce. Governments should identify multiple source economies for imports of these goods and enhance investment in their production to diversify risks. They could also look for bilateral or regional cooperation to institutionalize ties with bigger Asian economies, thus reducing the possibility of supply chain shocks emanating from the developed economies. In this regard, RTAs such as the AEC, ASEAN+1 Free Trade Agreements, and the RCEP are important. Even bilateral regional cooperation among Asian economies increases opportunities for trade and improves access to these goods.
2. Cross-continental trade agreements are crucial because much of the trade for vaccine manufacturing, ingredients, and packaging materials for distribution and administration are happening among developed and developing economies. APEC measures and the CPTPP have a strong role to play in building strategic relationships between developing Asia and the US and Europe. Availability of vaccines and timely testing of cases will help this region’s economies to recover from the pandemic. Governments should work together to lower or eliminate trade barriers, including tariff, customs inefficiency, and other infrastructure, that are essential for strengthening the value chain of vaccine manufacturing.
3. Governments need to keep supply chains open and increase economic cooperation and prioritize trade facilitation, lowering trade barriers, simplifying border procedures, and enhancing provision of hard and soft infrastructure to improve access to essential medical goods across borders. This reiterates the importance of the WTO Trade Facilitation Agreement and paperless trade for cross border movement of essential medical goods, as accessibility to these will facilitate economic recovery in 2022 and beyond.

REFERENCES

ADB. 2020. *Supply Chain Maps for Pandemic-Fighting Products*. Manila: Asian Development Bank.

Arriola, C., P. Kowalski, and F. van Tongeren. 2021. “The Impact of COVID-19 on the Directions and Structure of International Trade.” OECD Trade Policy Papers No. 252. Organisation for Economic Co-operation and Development, Paris.

Baldwin, R., and R. Freeman. 2020. “Trade Conflict in the Age of Covid-19.” *VoxEU.org*, May 22.

Brown, C. 2020. “PRC Should Export More Medical Gear to Battle COVID-19.” *Trade and Investment Watch.* Peterson Institute of International Economics.

ESCAP and ADB. 2021. *Asia-Pacific Trade Facilitation Report 2021: Supply Chains of Critical Goods amid the COVID-19 Pandemic- Disruptions, Recovery and Resilience*. Bangkok and Manila: Economic and Social Commission for Asia and the Pacific and Asian Development Bank.

Evenett, S. 2020. Chinese Whispers: COVID-19, Global Supply Chains in Essential Goods, and Public Policy. *Journal of International Business Policy 3*: 408–29.

Evenett, S., M. Fiorini, J. Fritz, B. Hoekman, P. Lukaszuk, N. Rocha, M. Ruta, F. Santi, and A. Shingal. 2022. Trade Policy Responses to the COVID-19 Pandemic Crisis: Evidence from A New Data Set." *The World Economy* 45 (2): 342–64.

Fontagné, L., and M. Freudenberg. 1997. “Intra-Industry Trade: Methodological Issues Reconsidered.” CEPII Document De Travail No. 97-01 . Centre d'Études Prospectives et d'Informations Internationales, Paris.

Gereffi, G. 2020. “What Does the COVID-19 Pandemic Teach Us About Global Value Chains? The Case of Medical Supplies.” *Journal of International Business Policy* 3 (3): 287–301.

Gopalakrishnan, B. N., B. Vickers, and S. Ali. 2020. “Analysing the Effects of the COVID-19 Pandemic on Medical Supply Chains in Commonwealth Countries.” International Trade Working Paper 2020/09. Commonwealth Secretariat, London.

Grubel, H. G., and P. J. Lloyd.1975. *Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products*. Vol. 12. London: Macmillan.

Hayakawa, K., and K. Imai. 2022. "Who Sends Me Face Masks? Evidence for the Impacts of COVID-19 on International Trade in Medical Goods." *The World Economy* 45 (2): 365–85.

Hayakawa, K., and H. Mukunoki. 2021. “The Impact of COVID-19 on International Trade: Evidence from the First Shock." *Journal of the Japanese and International Economies* 60: 101135.

Jámbor, A. 2015. “Country- and Industry-Specific Determinants of Intra-Industry Trade in Agri-Food Products in the Visegrad Countries.” *Studies in Agricultural Economics* 117 (2): 93–101.

OECD. 2020a. *Trade Interdependencies in COVID-19 Goods.* Paris: Organisation for Economic Co-operation and Development. 5 May 5.

_____. 2020b. *The Face Mask Global Value Chain in the COVID-19 Outbreak: Evidence and Policy Lessons.* Paris: Organisation for Economic Co-operation and Development.

_____. 2021. "Using Trade to Fight COVID-19: Manufacturing and Distributing Vaccines." OECD Policy Responses to Coronavirus (COVID-19). Paris: Organisation for Economic Co-operation and Development.

Park, C-Y., K. Kim, S. Roth, S. Beck, J. W. Kang, M. C. Tayag, and M. Griffin. 2020. "Global Shortage of Personal Protective Equipment Amid COVID-19: Supply Chains, Bottlenecks, and Policy Implications." ADB Briefs No. 130. Asian Development Bank, Manila.

Santos Silva, J.M.C., and S. Tenreyro. 2011. "Further Simulation Evidence on The Performance of the Poisson Pseudo-Maximum Likelihood Estimator." *Economics Letters* 112 (2): 220–22.

_____. 2006. "The Log of Gravity." *The Review of Economics and Statistics* 88 (4): 641–58.

WTO. 2020. "Trade Set to Plunge as COVID-19 Pandemic Upends Global Economy." Press release. April 8. World Trade Organization, Geneva.

_____. 2021a. "World Trade Primed for Strong but Uneven Recovery after COVID-19 Pandemic Shock." Press release. March 31. World Trade Organization, Geneva.

_____. 2021b. Trade in Medical Goods in the Context of Tackling COVID-19: Developments in 2020. Information Notice. June 30. World Trade Organization, Geneva.

_____. 2022. Regional Trade Agreements Database. https://rtais.wto.org/UI/About.aspx.

Yotov, Y. V., R. Piermartini, and M. Larch. 2016. *An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model*. Geneva: World Trade Organization.

Trade Interdependencies in COVID-19-Related Essential Medical Goods

Role of Trade Facilitation and Cooperation for the Asian Economies

International trade is an integral part of accessing coronavirus disease (COVID-19) essential medical goods for Asian economies. This working paper finds that their nature of trade dependence varies. Furthermore, economies that are party to regional trade agreements (RTAs) containing trade facilitation measures can mitigate the adverse impact on trade in essential medical goods. This emphasizes the role of governments in preparing Asian economies to be more resilient to future shocks through participation in RTAs and implementation of trade facilitation measures.

About the Asian Development Bank

ADB is committed to achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific, while sustaining its efforts to eradicate extreme poverty. Established in 1966, it is owned by 68 members —49 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

ADB

ASIAN DEVELOPMENT BANK
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org