

Revealed Symmetric Comparative Advantage of Global Medical Product Exports

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Abstract

This study investigates the comparative advantages of medical product exportation among the leading exporters. We extend the traditional Balassa index by applying a revealed symmetric comparative advantage (RSCA) index that corrects the asymmetry in measuring exports' comparative advantages or disadvantages. This study includes four groups of medical export products: medicines, medical supplies, medical equipment and technology, and personal protective equipment (PPE). We analyze data from the top 24 exporters in the world, which account for more than 80% of the export value spanning from 2015 to 2019. The findings indicate that high-income countries, specifically Switzerland, Japan, and Denmark, have a leading comparative advantage in medicines, medical supplies, and medical equipment and technology; however, China, Hong Kong, and the Czech Republic are among the leading producers of PPE. These findings provide a foundation for policy formulation to develop sustainable healthcare capacities.

Keywords: Comparative Advantage, Medical Products, RSCA, Export, Competitiveness.

Introduction

The global provision of medical supplies is dominated by developed countries because of superior capacities for research and development. In addition to increased monopolies among the developed countries (Semin et al, 2007). Recently, developing countries such as China and India have shifted focus to producing medical products for global export. The COVID-19 pandemic significantly highlighted the prominence of the need for medical products in international trade. According to the United Nations (UN), exports of COVID-19 medical products from China, the European Union, and the United States (US) surged from approximately US\$25 billion to US\$45 billion per month between January and May 2020. Personal protective equipment (PPE) had the most substantial increase, with the share rising from 13.7% in 2019 to 17.4% in 2020. PPE also exhibited the highest growth in trade, with a 47.2% increase in 2020 compared with just 1.5% in 2019. In terms of value, PPE trade expanded by US\$130.6 billion in 2020, largely due to an over 80% increase in face mask trade. The World Trade Organization (WTO, 2021) reported that the total trade value of face masks alone reached US\$277.7 billion in 2020.

Network analysis conducted by Bai et al (2022), revealed that the medical device trade market is export-oriented, and some countries have a strong influence because of large trading partnerships and countries that produce medical products increased export restrictions to ensure sufficient local supply during the pandemic. This scenario put pressure on importing countries, resulting in supply shortages and higher prices. According to a WTO report (2021), by October 2020, almost 390 measures had been adopted by exporting countries, ranging from export controls to import facilitation, leaving vulnerable countries at high risk regarding the implementation of pandemic-related health measures and increased uncertainty in the global medical trade (Evenett, 2020).

The Ricardian and Heckscher–Ohlin models of international trade emphasize the importance of identifying a country's comparative advantages based on resources, technology, and specialization in exporting related goods. The purpose of this study is not to examine the determinants of trade. Instead, we investigate which countries possess comparative advantages in the production of medical products and successfully penetrate the export market. This study extends the work of Zera et al (2022), which analyzed comparative advantage using the Balassa index. The traditional revealed comparative advantage (RCA) index is limited by its asymmetry, which ranges from zero to infinity and must be adjusted to achieve symmetry to address this issue. Dalum et al. (1998) proposed the revealed symmetric comparative advantage (RSCA) index, which corrects asymmetry in measuring comparative advantage and disadvantages of exports (Rossato et al., 2018).

This study calculates countries' comparative advantages in medical product exports and illustrates it employing a dynamic perspective between 2015 to 2019. Data during COVID-19 is excluded to avoid bias since we observe abnormal trends during that time. The study of comparative and competitive advantages in the export of medical products significantly contributes to ensuring a steady global supply chain, especially during health crises. For producer countries, this understanding helps governments in formulating trade policies that

further enhance competitive advantages by investing in research and development (R&D) and providing subsidies to these critical sectors.

Figure 1 illustrates the proportion of medical product exports from 2015 to 2019. Medicine exports contribute the highest compared with other types of medical products. In addition, Figure 2 presents the value of medical product exports, which surged from USD 508 billion in 2014 to USD 932 billion in 2018. According to the WTO (2020), this figure further escalated to USD 995 billion in 2019, representing approximately 6% of total product exports. Over the years, pharmaceuticals have consistently remained the largest category of traded medical products. Table 1 reveals that the top 10 exporters of medical products in 2019 were predominantly high-income countries, except for China. Together, high-income nations accounted for roughly 74% of global medical exports in 2019.

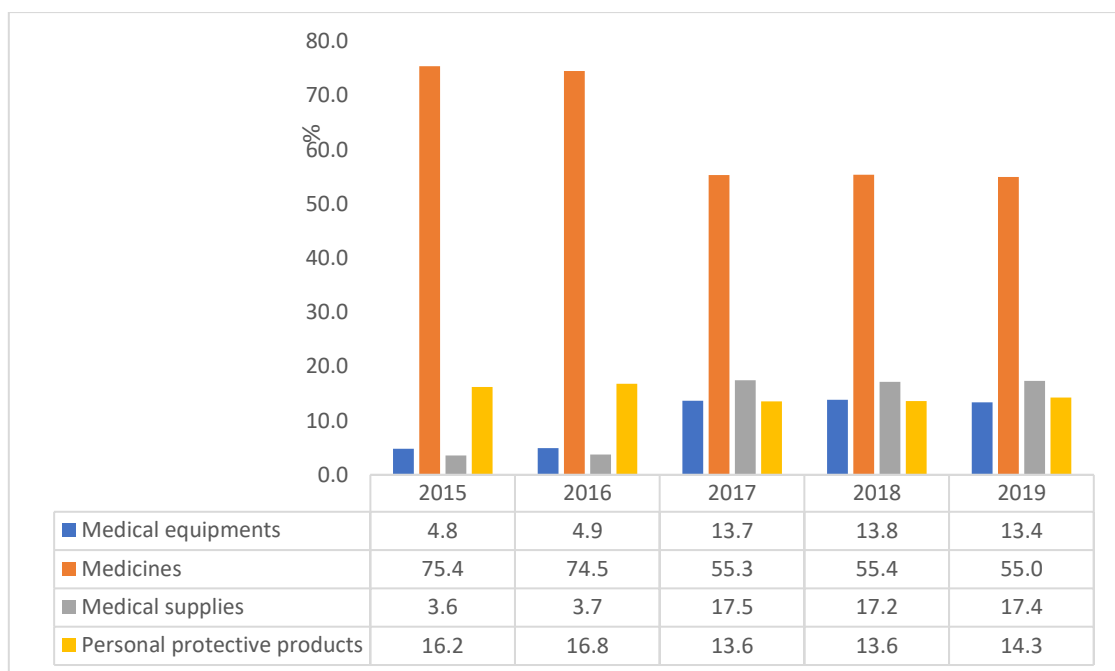


Figure 1: Proportion of Medical Products in Total Export

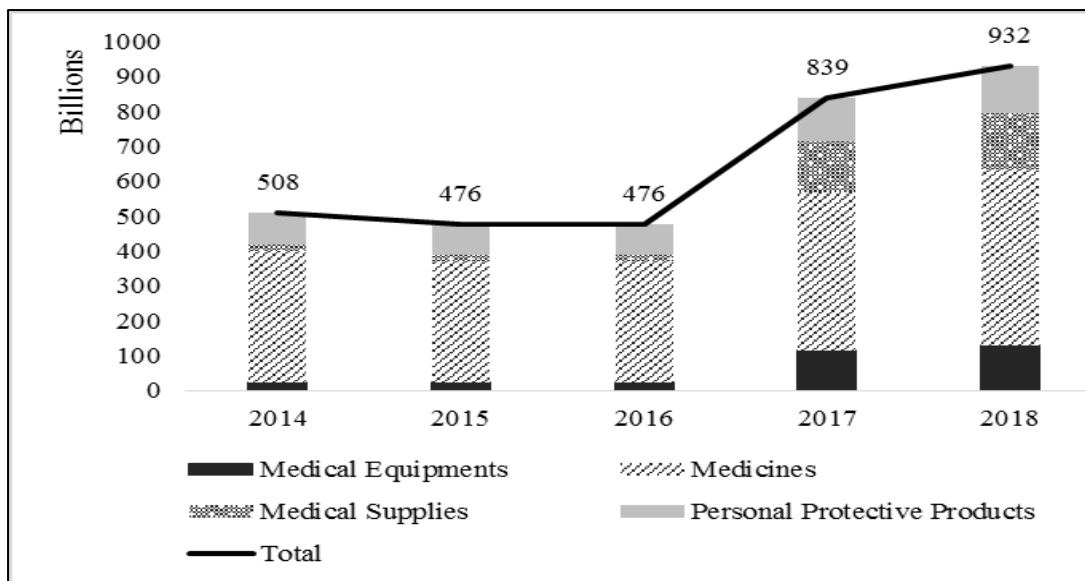


Figure 2: Export of Medical Product Value

Table 1

Top Ten Medical Product Exporters (2019)

Country	Medical Product Exports (US\$ Billion)	Share of Global Medical Exports (%)
Germany	136.2	14
US	116.6	12
Switzerland	89.9	9
Netherlands	73.1	7
Belgium	65.8	7
Ireland	65.3	7
China	51.6	5
France	49.9	5
Italy	42.9	4
United Kingdom	38.2	4
TOTAL	729.5	74

Source: World Trade Organization

Methodology

This study uses the RSCA index proposed by Laursen (2015), who argued that this approach provides the most accurate measure of comparative advantage, which was also applied by Shohibul (2013). The RSCA can be defined as follows:

$$RSCA_{ij}^k = \frac{RCA - 1}{RCA + 1} \tag{1}$$

where RCA is the RCA index introduced by Balassa (1965), which can be calculated as follows:

$$RCA_{ij} = \frac{X_{ij}/X_{ik}}{X_{wj}/X_{wk}} \tag{2}$$

where X denotes export value, subscript i denotes the country under study, and j denotes exported products. In this study, j refers to one of the four groups of medical products. Subscript k denotes all traded products except j and w , which represent all other countries excluding country i .

After calculating the RCA, the RSCA index can be measured, ranging from -1 to 1 , where an RSCA above zero indicates that country i has a comparative advantage in product j . In contrast, if the RSCA is less than zero, the country i exhibits no comparative advantage in product j . In this study, X refers to the export value of medical product j , where $j = 1, \dots, 4$ from country i , where $i = 1, \dots, 24$, and k denotes other medical product groups, while w refers to all other countries excluding i .

Data

The data in this study are sourced from the UN Commodity Trade Statistics Database (COMTRADE). The sample includes the 24 primary exporters of medical products that are presented in the Appendix, and medical products are defined using the Harmonized System 2017 (HS2017) code. The 92 products identified are categorized into four groups, aligning with classifications established by the WTO. The categories include medicines, medical supplies, medical equipment and technology, and PPE, and export data span from 2015 to 2019.

Results and Discussion

As described above, this study divides the analysis and discussion of comparative advantage based on the RSCA index into the four groups of medical products.

Tables 2a and 2b present the RSCA results for medicines. Switzerland demonstrates the strongest comparative advantage in producing and exporting medicines, followed by India, Belgium, Ireland, and Italy. For Switzerland, the RSCA index is positive and close to 1 for the average year (2015–2019), establishing it as a leading pharmaceutical exporter. Achilladelis and Antonakis (2001) asserted that a significant factor contributing to this advantage is innovation in the industry. Notably, Switzerland's RSCA index for medicines exhibits a declining trend, dropping from 0.82 in 2015 to 0.72 in 2019 (see Table 1 in the Appendix). India, Belgium, and Ireland also have average RSCA indices above 0.4.

Figure 2b presents a dynamic analysis of the RSCA for medicines. Countries in Quadrant 1 that had a comparative advantage in 2015 maintained their performance in 2019. Switzerland and India continue to hold comparative advantage, and despite having a high comparative advantage in 2015, Ireland and Belgium experienced slight declines by 2019; however, they still maintained a positive comparative advantage.

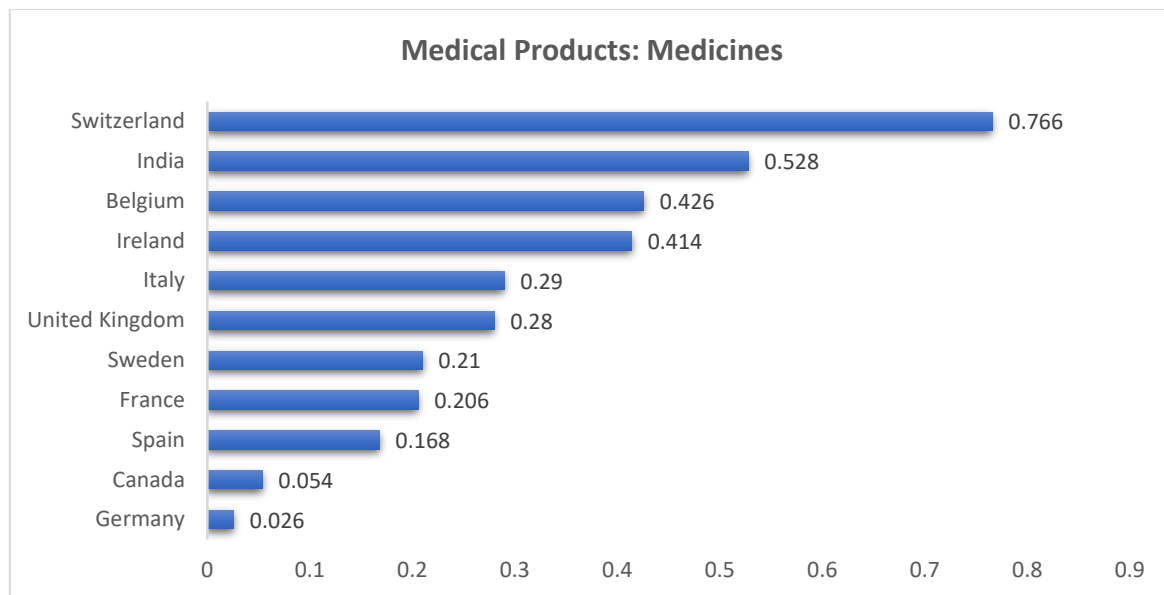


Fig 2a: Average RSCA for Medicines (2015–2019)

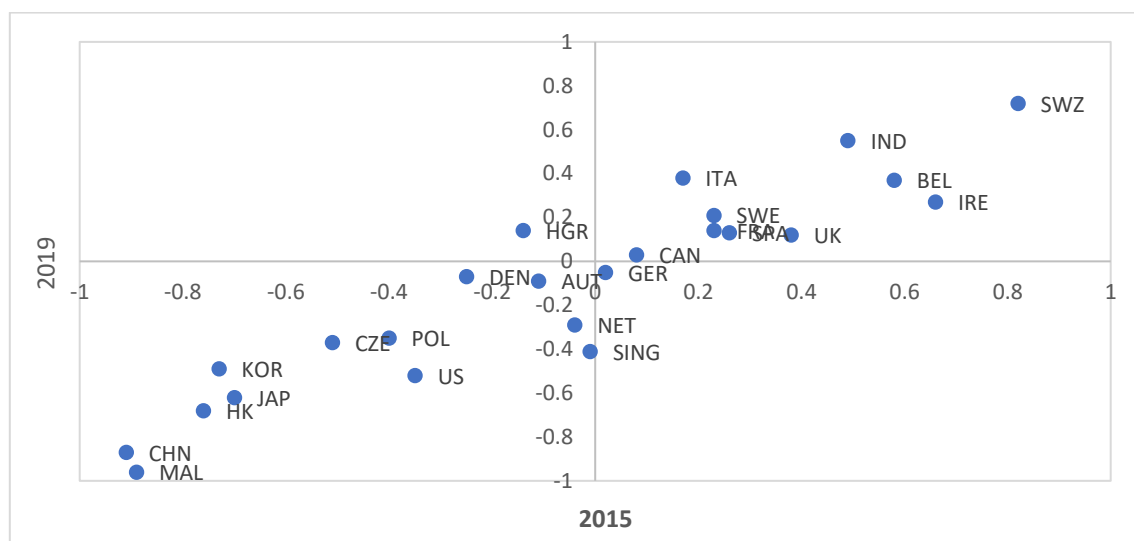


Fig 2b: Dynamic Analysis of RSCA for Medicines, Comparing 2015 and 2019

The second category of exported medical products examined is medical equipment and technology, which includes a wide range of devices and tools used for patient diagnosis, monitoring, treatment, and care such as X-ray machines, MRI scanners, ultrasound machines, oscilloscopes, and oscillographs. The results are illustrated in Figures 3a and 3b, revealing that nine countries exhibit a comparative advantage in medical equipment and technology (Japan, South Korea, Hong Kong, the US, Malaysia, the Netherlands, China, Singapore, and Germany). On average, Japan demonstrates the strongest comparative advantage, with a mean RSCA of 0.636. Despite maintaining this comparative advantage between 2015 and 2019, Japan exhibits a decreasing trend, with its RSCA declining from 0.83 in 2015 to 0.5 in 2019. In contrast, Singapore’s RSCA index increased from 0.15 in 2015 to 0.49 in 2019 (Figure 3b). Other countries with a positive RSCA also have negative trends.

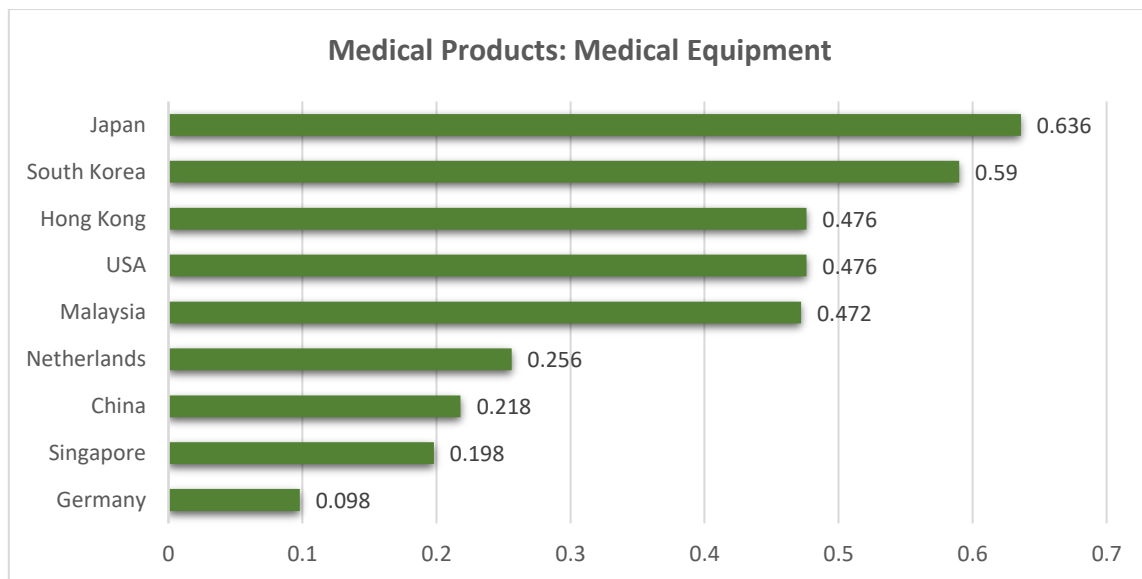


Fig 3a: Average RSCA for Medical Equipment and Technology (2015–2019)

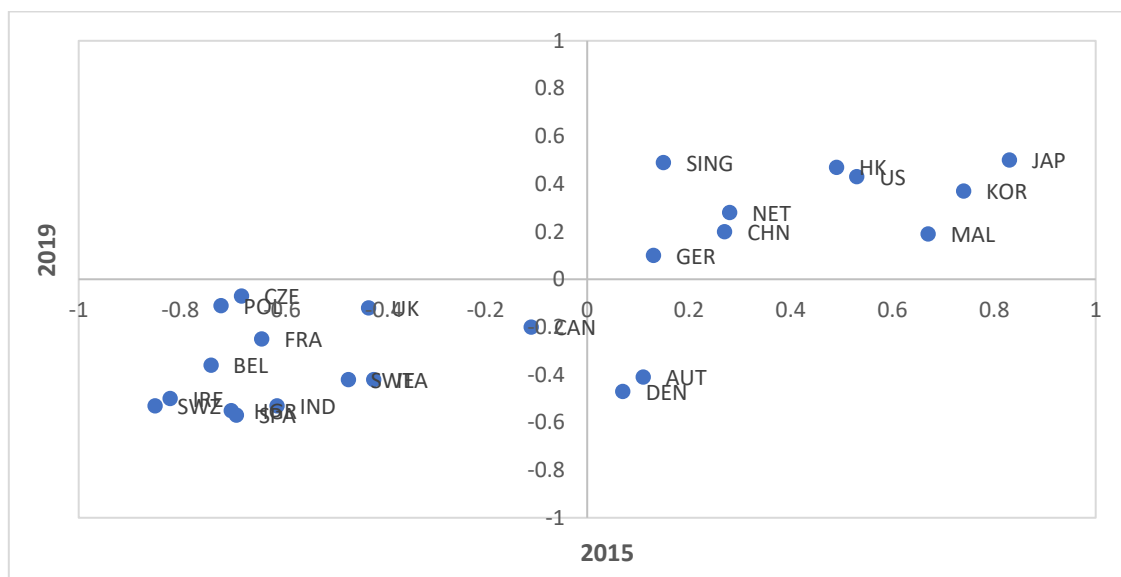


Fig 3b: Dynamic Analysis of the RSCA for Medical Equipment and Technology, Comparing 2015 and 2019

Figure 4a examines countries’ comparative advantages in medical supplies, revealing that several countries have a comparative advantage based on the average RSCA index. These countries include Denmark, the US, the Netherlands, China, Ireland, Hungary, Austria, Singapore, South Korea, Sweden, and Spain. Medical supplies encompass a wide range of products used in healthcare settings for various purposes, including diagnostics, treatment, and patient care such as syringes and needles, medical gloves, swabs, thermometers, and many other products.

Denmark had an RSCA index of 0.63 in 2015, which decreased to 0.34 in 2019. In contrast, Malaysia’s RSCA index was negative in 2015; however, it reached 0.77 in 2019. In 2019, Malaysia’s exports were dominated by rubber-based medical products such as gloves, medical instruments, surgical instruments, and catheters. As the world’s leading supplier of

medical gloves and supplies, Malaysia supplied over 50% of global demand (MREPC, 2019), which is largely attributable to the country’s rich rubber resources.

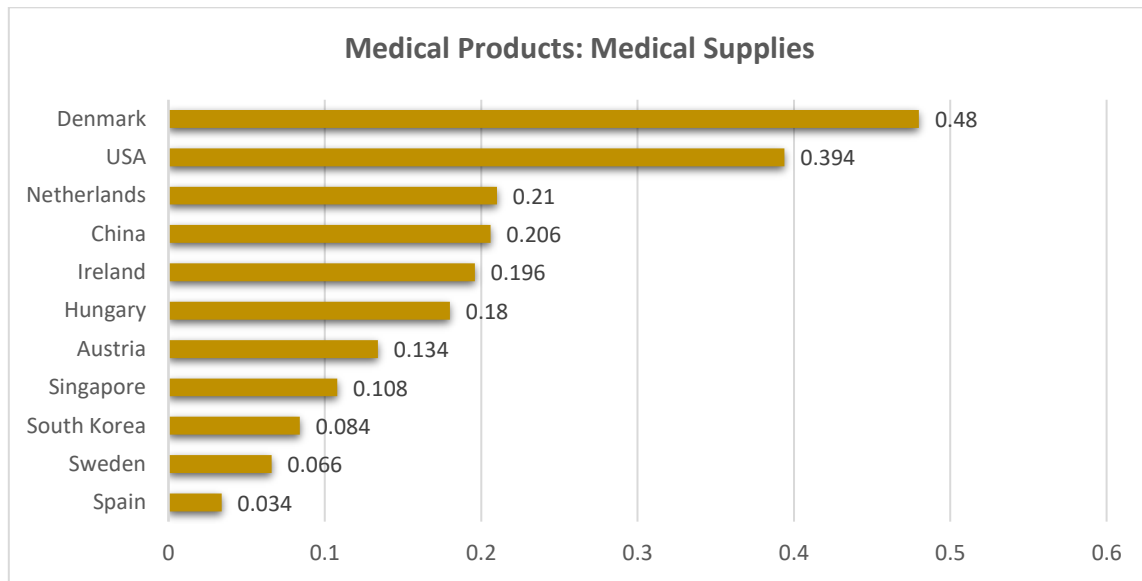


Fig 4a: Average RSCA for Medical Supplies (2015–2019)

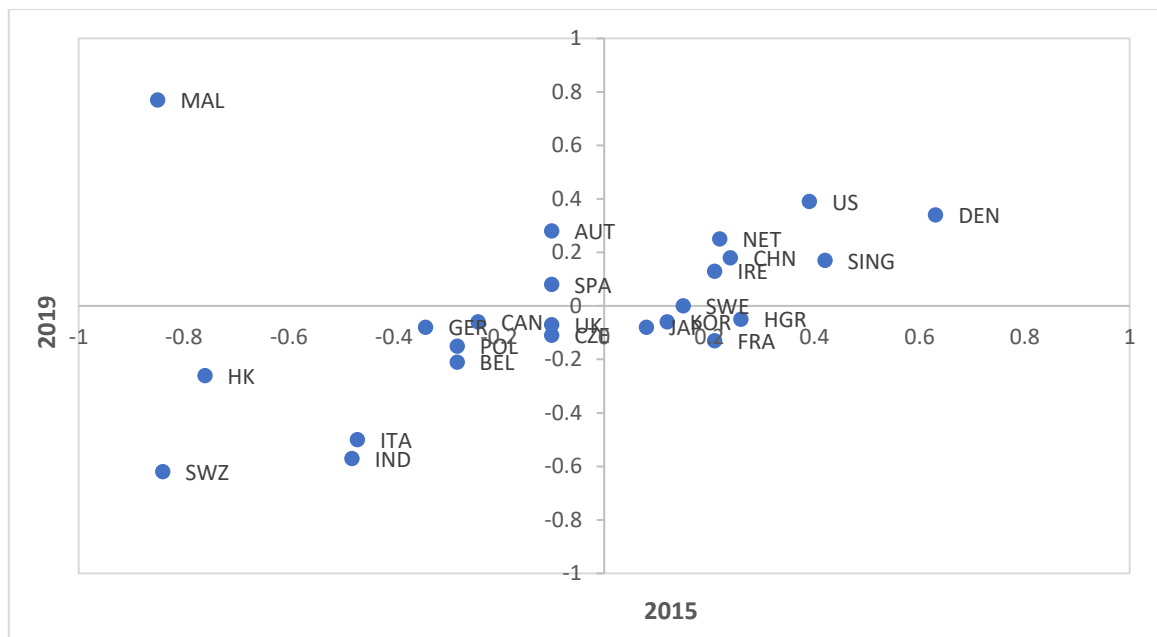


Fig 4b: Dynamic Analysis of RSCA for Medical Supplies, Comparing 2015 and 2019

Figure 5a illustrates the countries with comparative advantage on PPE based on the average RSCA index from 2015 to 2019. China has the highest RSCA index (0.82), followed by Hong Kong (0.69), Czechia (0.62), Poland (0.56), Malaysia (0.546), and South Korea (0.51). Based on dynamic analysis, as illustrated in Figure 5b, these countries maintain performance in 2019 when compared with 2015. Notably, China has demonstrated a remarkable trend, maintaining its top comparative advantage rank in producing and exporting PPE.

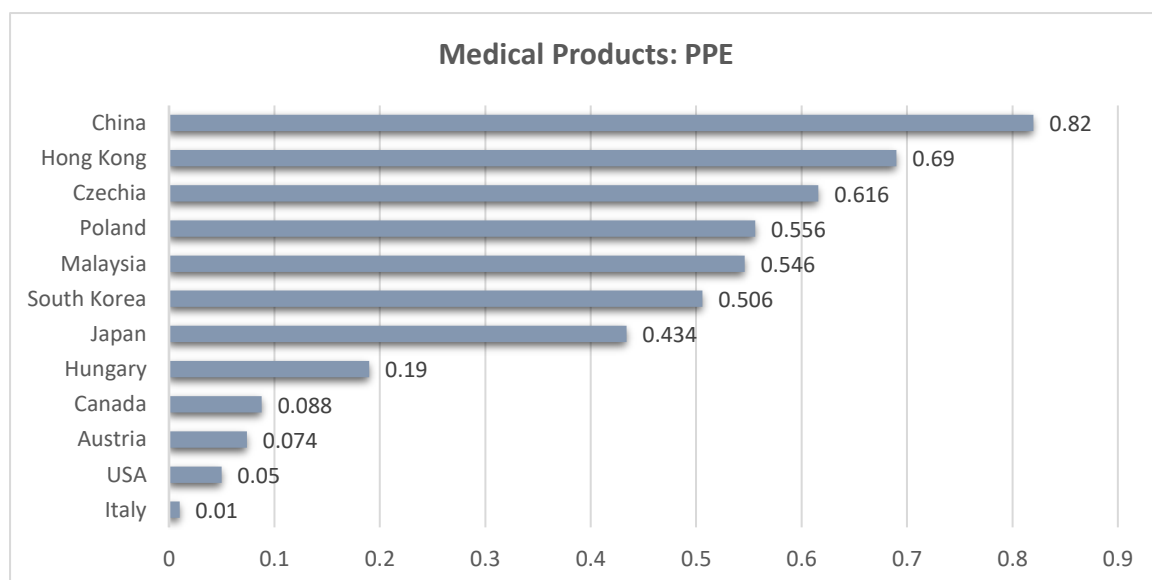


Fig 5a: Average RSCA for PPE (2015–2019)

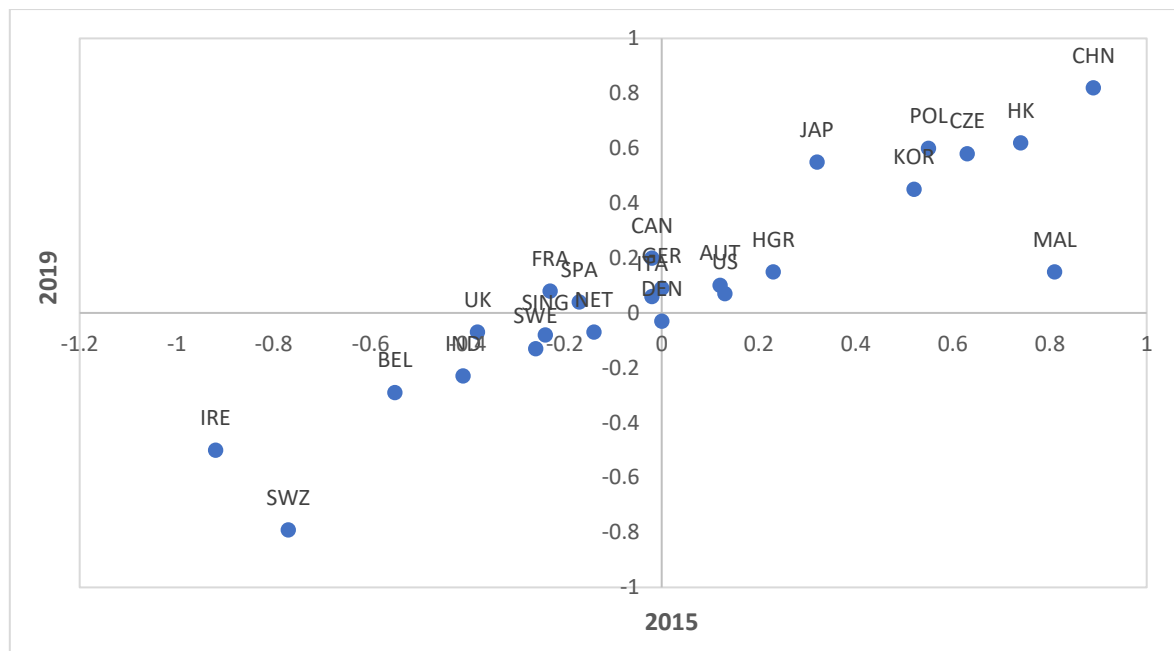


Fig 5b: Dynamic analysis of RSCA for Personal Protective Equipment (PPE) comparing 2015 and 2019

Conclusion

Medical product availability gained worldwide attention when COVID-19 spread globally, highlighting the critical importance of stable access to essential items. Producer countries that manufacture and distribute medical products have the advantage of ensuring sufficient supplies for local markets, which allows them to meet domestic demand more effectively and respond swiftly to health emergencies; however, importing countries that rely on a limited number of medical product suppliers face significant challenges during health crises due to supply shortages. These shortages can arise from increased global demand, production, supply chain disruptions, and export restrictions imposed by producer countries prioritizing internal demand, which leaves importing nations vulnerable and struggling to secure essential medical supplies for their populations.

This study uses the RSCA index to correct asymmetry in measuring comparative advantages or disadvantages in exports, measuring the strength of countries in production and global export of medical products. The results reveal that developed countries such as Switzerland (medicines), Japan (medical equipment and technology), and Denmark (medical supplies) have high comparative advantages; however, China dominates PPE exports, with consistently high scores between 2015 and 2019. This study also illustrates countries' dynamic positioning comparative advantages between 2015 and 2019. The results demonstrate that many developing countries such as India (Medicines, China, and Malaysia (medical equipment and technology, medical supplies, and PPE) have a strong comparative advantage.

The findings of this study have critical implications for policymakers, indicating they should focus on products where their countries have a comparative advantage to drive market expansion and economic growth. By identifying and promoting these key products, policymakers can enhance countries' competitive edge in the global market, attract investment, and stimulate innovation in the medical sector. This strategic focus can advance

increased production capacity, job creation, and a more resilient supply chain for essential medical goods. Additionally, importing countries should proactively prepare for potential unexpected changes in global health crises by diversifying market access by establishing trade relationships with a broader range of supplier countries, investing in local production capabilities, and creating strategic reserves of essential medical products. Such measures can ensure that importing countries have sufficient and stable supplies of medical products during emergencies, reducing vulnerabilities to global supply chain disruptions and enhancing their ability to respond effectively to health crises. By implementing these strategies, countries can strengthen their healthcare systems, improve public health outcomes, and maintain economic stability when faced with future global health challenges.

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Appendix

No	Country	Income group	Medical Products	RSCA Index					2015-19 (Average)
				2015	2016	2017	2018	2019	
1	Germany	High-income	Medicines	0.02	0.02	0.05	0.09	-0.05	0.026
			Medical Supplies	-0.34	-0.33	-0.11	-0.16	-0.08	-0.204
			Medical Equipment	0.13	0.12	0.09	0.05	0.1	0.098
			PPE	0	0	-0.05	-0.07	0.09	-0.006
2	USA	High-income	Medicines	-0.35	-0.39	-0.49	-0.48	-0.52	-0.446
			Medical Supplies	0.39	0.46	0.36	0.37	0.39	0.394
			Medical Equipment	0.53	0.54	0.45	0.43	0.43	0.476
			PPE	0.13	0.14	-0.04	-0.05	0.07	0.05
3	Switzerland	High-income	Medicines	0.82	0.83	0.73	0.73	0.72	0.766
			Medical Supplies	-0.84	-0.84	-0.6	-0.61	-0.62	-0.702
			Medical Equipment	-0.85	-0.78	-0.49	-0.51	-0.53	-0.632
			PPE	-0.77	-0.8	-0.8	-0.8	-0.79	-0.792
4	Belgium	High-income	Medicines	0.58	0.56	0.27	0.35	0.37	0.426
			Medical Supplies	-0.28	-0.29	-0.06	-0.13	-0.21	-0.194
			Medical Equipment	-0.74	-0.73	-0.22	-0.34	-0.36	-0.478
			PPE	-0.55	-0.52	-0.37	-0.35	-0.29	-0.416
5	Ireland	High-income	Medicines	0.66	0.58	0.21	0.35	0.27	0.414
			Medical Supplies	0.21	0.36	0.2	0.08	0.13	0.196
			Medical Equipment	-0.82	-0.81	-0.41	-0.51	-0.5	-0.61
			PPE	-0.92	-0.91	-0.51	-0.56	-0.5	-0.68
6	Netherlands	High-income	Medicines	-0.04	-0.05	-0.12	-0.25	-0.29	-0.15
			Medical Supplies	0.22	0.17	0.17	0.24	0.25	0.21
			Medical Equipment	0.28	0.29	0.16	0.27	0.28	0.256
			PPE	-0.14	-0.11	-0.18	-0.15	-0.07	-0.13
7	France	High-income	Medicines	0.23	0.26	0.21	0.19	0.14	0.206

			Medical Supplies	0.21	0.08	-	-	-	-0.02
			Medical Equipment	-	-0.6	-	-	-	-0.402
			PPE	-	-	-	-	0.08	-0.09
				0.23	0.23	0.04	0.03		
8	Italy	High-income	Medicines	0.17	0.17	0.37	0.36	0.38	0.29
			Medical Supplies	-	-	-	-0.5	-0.5	-0.494
			Medical Equipment	0.47	0.49	0.51			
			PPE	-	-	0	0.03	0.06	0.01
				0.42	0.41	0.34	0.36	0.42	-0.39
				0.02	0.02				
9	United Kingdom	High-income	Medicines	0.38	0.34	0.31	0.25	0.12	0.28
			Medical Supplies	-0.1	-	-	-	-	-0.096
			Medical Equipment	0.43	0.42	0.27	0.21	0.12	-0.29
			PPE	-	-	-	-0.2	-	-0.258
				0.38	0.36	0.28	0.07		
10	Japan	High-income	Medicines	-0.7	-	-	-	-	-0.656
			Medical Supplies	0.08	0.06	-0.1	0.11	0.08	-0.03
			Medical Equipment	0.83	0.8	0.54	0.51	0.5	0.636
			PPE	0.32	0.31	0.5	0.49	0.55	0.434
11	Singapore	High-income	Medicines	-	-	0.32	-0.3	-	-0.094
			Medical Supplies	0.42	0.35	-0.5	0.1	0.17	0.108
			Medical Equipment	0.15	0.22	-	0.45	0.49	0.198
			PPE	-	-	0.07	-	-	-0.116
				0.01	0.07			0.41	
				0.24	0.15	0.07	0.18	0.08	
12	Spain	High-income	Medicines	0.26	0.26	0.08	0.11	0.13	0.168
			Medical Supplies	-0.1	-	0.19	0.14	0.08	0.034
			Medical Equipment	-	-	-	-	-	-0.596
			PPE	0.69	0.67	0.53	0.52	0.57	
				0.17	0.15	0.05	0.03	0.04	-0.072
13	Austria	High-income	Medicines	-	-	-	-	-	-0.084
			Medical Supplies	-0.1	-	0.29	0.31	0.28	0.134
			Medical Equipment	0.11	0.04	-	-	-	-0.204
			PPE	0.12	0.08	0.04	0.03	0.1	0.074
				0.11	0.05	0.08	0.09	0.09	
14	Sweden	High-income	Medicines	0.23	0.22	0.19	0.2	0.21	0.21

			Medical Supplies	0.15	0.15	0	0.03	0	0.066
			Medical Equipment	-	-	-	-	-	-0.39
			PPE	-	-	-	-0.2	-	-0.202
				0.26	0.24	0.18	0.35	0.42	
15	Canada	High-income	Medicines	0.08	0.11	-0.02	0.07	0.03	0.054
			Medical Supplies	-	-	-	-	-	-0.154
			Medical Equipment	-	-	-0.1	-	-0.2	-0.148
			PPE	-	-	0.18	0.12	0.2	0.088
				0.02	0.04				
16	Denmark	High-income	Medicines	-	-	-	-	-	-0.152
			Medical Supplies	0.63	0.62	0.43	0.38	0.34	0.48
			Medical Equipment	0.07	0.01	-	-	-	-0.26
			PPE	0	0	-	-	-	-0.056
				0.25	0.24	0.13	0.07	0.07	
				0.07	0.01	0.45	0.46	0.47	
				0	0	0.14	0.11	0.03	
17	South Korea	High-income	Medicines	-	-	-	-	-	-0.646
			Medical Supplies	0.12	0.2	0.23	0.07	0.06	0.084
			Medical Equipment	0.74	0.72	0.71	0.41	0.37	0.59
			PPE	0.52	0.54	0.57	0.45	0.45	0.506
				0.73	0.73	0.76	0.52	0.49	
18	Poland	High-income	Medicines	-0.4	-	-	-	-	-0.37
			Medical Supplies	-	-	-	-	-	-0.144
			Medical Equipment	-	-	-	-	-	-0.428
			PPE	0.55	0.56	0.6	0.47	0.6	0.556
				0.28	0.09	0.04	0.16	0.15	
				0.72	0.61	0.52	0.18	0.11	
				0.55	0.56	0.6	0.47	0.6	
19	Hungary	High-income	Medicines	-	-	-	-	-	-0.038
			Medical Supplies	0.26	0.33	0.45	0.09	0.05	0.18
			Medical Equipment	-0.7	-	-	-	-	-0.624
			PPE	0.23	0.19	0.2	0.18	0.15	0.19
				0.14	0.13	0.19	0.13	0.14	
				0.26	0.33	0.45	0.09	0.05	
				-0.7	0.69	0.66	0.52	0.55	
				0.23	0.19	0.2	0.18	0.15	
20	Hong Kong	High-income	Medicines	-	-	-	-	-	-0.716
			Medical Supplies	-	-	-	-	-	-0.544
			Medical Equipment	0.49	0.49	0.52	0.41	0.47	0.476
			PPE	0.74	0.73	0.73	0.63	0.62	0.69
				0.76	0.74	0.75	0.65	0.68	
				0.76	0.74	0.72	0.24	0.26	
				0.49	0.49	0.52	0.41	0.47	
				0.74	0.73	0.73	0.63	0.62	
21	Czechia	High-income	Medicines	-	-	-	-	-	-0.454
				0.51	0.51	0.51	0.37	0.37	

			Medical Supplies	-0.1	-	-	-0.1	-	-0.132
			Medical Equipment	-	-	-	-	-	-0.438
			PPE	0.63	0.64	0.64	0.59	0.58	0.616
22	China	Middle-income	Medicines	-	-	-	-	-	-0.876
			Medical Supplies	0.24	0.21	0.2	0.2	0.18	0.206
			Medical Equipment	0.27	0.27	0.18	0.17	0.2	0.218
			PPE	0.89	0.88	0.76	0.75	0.82	0.82
23	India	Middle-income	Medicines	0.49	0.48	0.55	0.57	0.55	0.528
			Medical Supplies	-	-	-	-	-	-0.54
			Medical Equipment	-	-	-	-	-	-0.586
			PPE	-	-	-	-	-	-0.3
				0.41	0.36	0.21	0.29	0.23	
24	Malaysia	Middle-income	Medicines	-	-	-0.9	-	-	-0.924
			Medical Supplies	0.85	0.87	0.87	0.78	0.77	-0.208
			Medical Equipment	0.67	0.69	0.66	0.15	0.19	0.472
			PPE	0.81	0.81	0.81	0.15	0.15	0.546