

Study on the Regulatory Effects of National Relations on Medical Product Trade in the Context of the COVID-19 Pandemic

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Abstract

This empirical study examines the import of medical products from China by 158 importing countries from January 2020 to September 2022 in the context of the COVID-19 pandemic. The research considers three aspects of the pandemic's impact on bilateral trade: the situations in the importing country, exporting country, and other trade partner countries. Furthermore, the medical product exports during the pandemic are viewed as a form of foreign aid. By introducing two moderating variables, namely political relations and economic relations, this study explores the regulatory effects of national relations on medical product trade under the backdrop of the pandemic. The results indicate that positive economic cooperation relationships enhance the positive effects of the pandemic on China's key medical product exports. Countries with effective regional trade agreements with China receive more assistance in terms of key medical products. Additionally, the "political distance" between two countries also has a positive regulatory effect. Countries farther away from China in terms of political alignment import more medical products from China during the pandemic. In other words, China tends to export medical products to countries with significant political differences, especially during the pandemic.

Keywords

COVID-19; Foreign Aid; National Relations; Medical Products Trade.

1. Introduction

At the end of 2019, an unprecedented scale of the COVID-19 pandemic broke out, causing significant negative impacts on the global economy and human health, while also impeding the process of trade liberalization worldwide. However, the pandemic has also stimulated the growth of medical product trade. As a crucial means of international cooperation in combating the pandemic, research on medical product trade during this period holds significant practical significance.

In the early stages of the global pandemic outbreak, the daily increase in new COVID-19 infections rose exponentially, severely impacting the global commodity supply chains. Several economies experienced disruptions in their production and trade, leading to shortages of essential goods, particularly medical supplies, in many countries. As the world's largest exporter of goods, China faced significant challenges in the production and export of medical products during the first two months of 2020. However, due to robust macroeconomic control measures implemented by the Chinese government, medical product production was ensured, allowing domestic capacity to swiftly recover from the pandemic's impact. According to a report by the State Council of China, by April 2020, the daily output of personal protective equipment had increased to 90 times the level in January 2020. Consequently, China exported a substantial amount of medical products, especially personal protective items such as masks and protective suits, to other countries worldwide to prevent the spread of the virus. As the

global pandemic entered a plateau phase, with the evolution and mutation of the novel coronavirus, a new and complex situation emerged. Medical product supply remained insufficient globally, and the number of virus infections continued to rise. However, most economies had recovered from the initial unpreparedness of the virus outbreak. They implemented measures such as isolation, export restrictions, and other limitations to control the pandemic and ensure the supply of essential products. The impact of the COVID-19 pandemic on global commodity supply chains diminished, and international trade activities gained resilience against public health crisis risks. Throughout the entire COVID-19 pandemic period, the crisis had a tremendous impact on global commodity trade, hindering the progress of trade liberalization. According to WTO statistics, in 2020, global merchandise trade volume decreased by 7.3% compared to the previous year. However, concurrently, amidst the overall negative growth trend in trade, global medical product trade showed a remarkable growth trajectory. The average growth rate of the medical product industry exceeded 14% in 2020 and 2021. Its share in the total merchandise trade volume increased from 5.3% before the pandemic to 6.6% in 2020 and 5.9% in 2021. This indicates the vital role played by medical product trade during the pandemic. Not only is it a crucial means for the world to combat the pandemic, but it also serves as a cornerstone for stable development in international trade in the post-pandemic era.

2. Literature Review

2.1. Literature on the Trade Impact of the Pandemic

When examining the long-term and short-term effects of the pandemic, it is observed that there is a considerable amount of literature focusing on the short-term impact due to the relatively short period since the outbreak, which is yet to conclude. Liang Xiangdong et al.[1] (2022) assessed the impact of the COVID-19 pandemic on China's outward export trade structure using breakpoint regression methods based on monthly export trade data between China and its major trading partners reported by the General Administration of Customs of China. The results indicated a significant optimization of China's export trade structure with major trading partners in the short term under the influence of the COVID-19 pandemic. This temporary optimization of China's outward export trade structure might be attributed to the reduction in effective labor supply due to a series of measures, such as restricting travel and controlling the movement of people, taken domestically in response to the virus spread. Liu Hongduo et al.[2] (2021) studied the trade inhibitory effects of the pandemic from January to June 2020 using monthly panel data. They explored the mechanisms behind the pandemic's impact on trade and estimated the trade effects of COVID-19 from the perspective of tariff equivalent conversion. The researchers creatively used genetic distance as an instrumental variable to address endogeneity issues. Specifically, they set China as the reference and employed the cross-product term of the genetic distance between other sample economies and the reference (China) with the cumulative death toll of COVID-19 (in logarithmic form) in each month during the sample period. On one hand, genetic distance possesses strong exogeneity, satisfying the exclusion restriction condition for instrumental variables to a certain extent. On the other hand, genetic inheritance is relatively stable. Hence, the ancient genetic relationship between other sample economies and the reference (China) is likely to persist, affecting the similarity in physiological genetic factors between other sample economies and the reference. This relationship is closely related to the occurrence of the pandemic in economies outside the reference (China) but does not impact current cross-border trade activities through other channels, making it an ingenious approach. Maliszewska et al.[3] (2020) and Li and Lin[4] (2021) simulated and evaluated the operational status of international trade under the impact of the COVID-19 pandemic using empirical methods. They found that under different recovery

scenarios, global trade declined by approximately 8% to 20%, with significant negative impacts on economies such as the European Union, the United States, and China. However, research on the short-term effects of the pandemic is challenging due to limited accessibility to relevant data [5](Francke and Korevaar, 2021).

Literature examining the long-term effects of the pandemic often extrapolates based on historical public health crises. For instance, Ambrus et al. [6](2020) pointed out that sudden pandemics might have long-term effects. By exploring the impact of the 19th-century cholera outbreak in London, they found that the differences in housing prices between the original epidemic area and other areas continued to widen, profoundly affecting the local residents' wealth distribution. Hu Xiaodan et al.[7] (2022) constructed a "quasi-experiment" based on the 2003 SARS epidemic, empirically investigating the impact of pandemic shocks on the import of intermediate goods by Chinese manufacturing firms at the micro-level, providing valuable insights for the study of the long-term effects of the COVID-19 pandemic. Albanesi and Kim[8] (2021) also recognized the long-term impact of sudden pandemics. Due to the COVID-19 pandemic, female laborers in the United States not only faced a higher risk of job loss in the short term but also experienced continuous human capital depreciation after leaving the labor market, leading to further "motherhood penalties." Additionally, employment stickiness was detrimental to the sustained increase in the labor force participation rate of women.

2.2. Studies on the Impact of the Pandemic on Medical Product Trade

Due to limited data availability and the complexity of the underlying mechanisms, literature related to the impact of the pandemic on pharmaceutical trade, both domestically and internationally, is relatively scarce. Existing literature can be broadly categorized into four types.

The first category explores the short-term impact of the pandemic on the scale of medical product imports and exports. Researchers typically introduce pandemic-related variables into traditional gravity models and employ monthly data for regression analysis. For example, Pu et al.[9] (2022) measured the intensity of the COVID-19 pandemic using monthly data on new COVID-19 infections and examined its positive impact on medical product imports from China to various countries. The second type of literature investigates the impact of the pandemic on the value chain of medical products. For instance, Soyigit[10] (2022) employed complex network analysis to examine the global trade structure of medical masks and ventilators. The study revealed the complex network properties and core-periphery structure of this trade, exposing the vulnerability of the ventilator trade network. Current global value chains are susceptible to supply shocks. Mehrotra et al.[11] (2020) developed a stochastic optimization model for allocating and sharing critical resources during the pandemic. They applied this model to study the distribution of ventilator stocks among different states by the Federal Emergency Management Agency in the United States. The study found that a central coordinating body could regulate the allocation of scarce critical resources, thereby enhancing system efficiency. The third category of literature focuses on the marginal impact of political, economic, and demographic connections between countries on medical product trade. Similar international political stances, close economic ties, and population movements facilitate medical product trade. For example, Fuchs [12](2020) examined the factors influencing China's medical product exports in the initial two months of the pandemic. Political connections between importing countries and China were measured based on international political stances, international donations, sister province partnerships, and adherence to the "One China" principle. The study explored the impact of political connections on medical product exports. The fourth category of literature investigates changes in medical product trade policies and their resulting effects under the backdrop of the COVID-19 pandemic. Due to the scarcity of medical products during the initial outbreak, many countries implemented trade policies to

restrict or promote imports, ensuring adequate domestic supply. Evenett et al. [13](2021) constructed a dataset documenting countries' medical product trade policies in response to health crises. The dataset revealed a rapid increase in trade policies promoting imports in February and March 2020 as infection cases rose. The observed heterogeneity raised questions about the impact of these policies on the prices of critical products and the influence of regional trade agreements on trade policy usage. Grassia et al. [14](2022) employed a shock diffusion model in the international trade network to simulate the effects of different restriction measures. The study found that export restrictions, while benefiting the implementing country in the short term, damaged overall trade efficiency and welfare in the trade network.

However, the development of this pandemic has been rapid and persistent, and new situations continue to emerge. The cloud of this public health crisis still looms over humanity, necessitating continuous attention and research from scholars.

3. Analysis of the Current Situation of Medical Product Trade Under the COVID-19 Pandemic

3.1. Pandemic Development Trends

3.1.1. Global Pandemic Trends

Since the initial outbreak in late 2019, the COVID-19 pandemic has posed significant challenges due to the emergence of various virus variants, leading to a turbulent and fluctuating global pandemic situation. International society has progressed from initial chaos to collaborative efforts against the pandemic, followed by the development and promotion of vaccines, ultimately moving toward global cooperation and economic recovery. The development trends of the pandemic can be summarized as follows:

(1) Initial Outbreak (December 2019 to January 2020): This phase marked the initial outbreak of the pandemic, characterized by a rapid increase in the number of cases within a short period. The epidemic was mainly concentrated in Hubei Province, especially in Wuhan city.

(2) Global Pandemic (February 2020 to October 2020): COVID-19 began to spread globally, leading to a surge in cases in various countries. Governments around the world implemented various preventive and control measures, such as city lockdowns and international travel restrictions.

(3) Relatively Stable Period with Occasional Resurgences (November 2020 to September 2022): With the implementation of control measures and a better understanding of the virus, the number of cases became relatively stable. However, occasional resurgences still occurred.

(4) Initiation of Vaccination Efforts (January 2021 to Early 2022): With the successful development and deployment of COVID-19 vaccines, mass vaccination campaigns commenced worldwide. This contributed to controlling the further spread of the pandemic to some extent.

(5) Emergence of Variants (Second Half of 2021): As the virus continued to circulate, new variants such as Delta and Omicron emerged, posing new challenges to pandemic control efforts.

(6) Pandemic Under Control (Early 2023 to Present): With the completion of widespread COVID-19 vaccination and improvements in pandemic prevention and control measures, the global pandemic has been largely brought under control. There have been only a few new cases reported, and the symptoms have been relatively mild.

The detailed trends of daily new infection cases, new infection-related deaths, and new COVID-induced hospitalizations from January 2020 to October 2022 are illustrated in Figure 1.

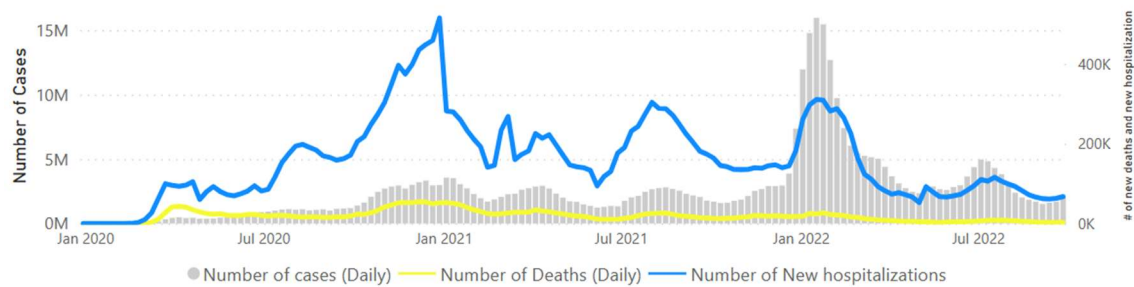


Figure 1. Overview of the Global Pandemic from January 2021 to October 2022 (Source: World Health Organization)

3.1.2. Trends in Domestic COVID-19 Development in China

China, despite being the first country to detect the COVID-19 virus, was also one of the quickest nations to control the spread of the pandemic. The achievements made in combating the COVID-19 pandemic have been widely recognized worldwide. Due to the strict and rapid preventive measures implemented by China, along with the establishment of an effective disease testing and reporting system, the country's robust public health response capabilities minimized the impact of the pandemic on public health. As shown in Figure 2, covering the period from January 2020 to October 2022 and based on the daily new infection cases, new infection-related deaths, and new COVID-induced hospitalizations reported to the World Health Organization, it is evident that China effectively managed the pandemic during 2020 and 2021, maintaining a low and stable intensity level.

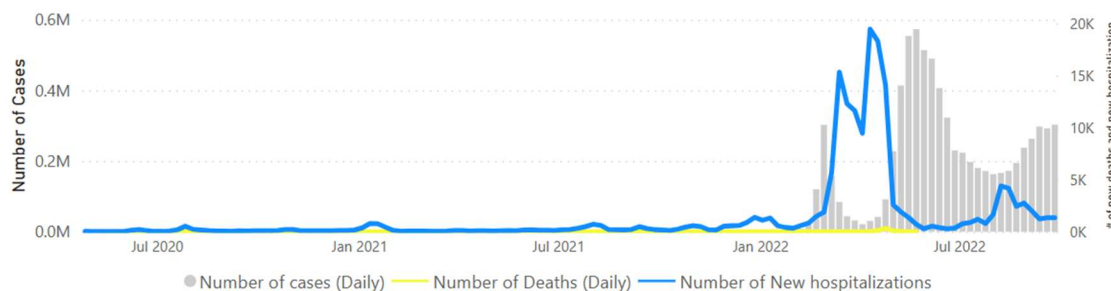


Figure 2. Overview of Domestic COVID-19 Situation from January 2021 to October 2022 (Source: World Health Organization)

The development of the COVID-19 pandemic in China can be roughly divided into the following stages:

- (1) Initial Outbreak Stage (December 2019 - January 2020): During this period, the number of infection cases rapidly increased, leading the Chinese government to announce the lockdown of Wuhan and surrounding cities on January 23, 2020.
- (2) National Prevention and Control Stage (February 2020 - March 2020): The pandemic quickly spread to various parts of China. Strict containment measures, including lockdowns of public places, travel restrictions, and mandatory mask-wearing, were implemented nationwide.
- (3) Stable Period of the Pandemic (April 2020 - December 2020): The spread of COVID-19 in China was effectively controlled during this period, with the rate of new cases significantly slowing down. Life and economic activities began to gradually resume.
- (4) Mass Vaccination Stage (January 2021 - October 2022): With the approval and distribution of COVID-19 vaccines, China initiated a large-scale vaccination campaign, offering free vaccinations to the entire population. This accelerated the pandemic control efforts and prevented potential resurgences.

(5) Variant Response Stage (Mid-2021 - Early 2023): Since the emergence of global variants such as Delta and Omicron, China optimized its vaccine distribution strategy. The country maintained a high level of alertness, implementing scientifically rigorous localized containment measures to safeguard the health and safety of the people.

(6) Comprehensive Reopening Stage (December 2022 - Present): With the gradual completion of the vaccination campaign and the reduced impact of the virus on human health, China has loosened containment measures. To optimize pandemic prevention and control policies and promote economic recovery, the country has progressively lifted restrictions. The pandemic is now under basic control.

3.2. World Medical Product Trade Amidst the Pandemic

3.2.1. Substantial Growth in Medical Product Trade

The spread of the COVID-19 pandemic had a significant negative impact on global merchandise trade, with a 7.3% year-on-year decrease in world goods trade volume in 2020. However, amidst this downturn, the trade in medical products continued to expand from 2019 to 2021, with an average growth rate of 11.1% over the three-year period. The most notable surge occurred in the first year of the pandemic in 2020, with a growth rate of 16.4%. The growth rate slowed slightly in 2021 to 12.5%. In 2019, medical product trade accounted for 5.3% of the world's total trade volume. The pandemic elevated the importance of medical products, increasing their share to 6.6% in 2020. In 2021, even as global trade volumes began to recover, the medical goods sector's share remained higher than pre-pandemic levels, at 5.9%.

Table 1. The trade volume and growth rates of various medical products from 2019 to 2021

Product categories	Total import and export trade volume (in million US dollars)			Annual growth rate (%)		
	2019	2020	2021	2019/2018	2020/2019	2021/2020
ALL	2027832	2359851	2653747	4.7	16.4	12.5
Medicines	1118569	1230104	1480125	5.6	10.0	20.3
Medical Consumables	345066	409598	485929	4.7	18.7	18.6
Medical Equipment	286010	308629	329234	5.0	7.9	6.7
Personal Protective Equipment	278187	411521	283398	1.3	47.9	-12.9

Data Source: World Trade Organization Secretariat.

With the evolving global pandemic situation, the growth and shares of four categories of medical products fluctuated, reflecting the varying significance of these products at different stages (see Table 1). In the early stages of the widespread transmission of the novel coronavirus in 2020, personal protective equipment (PPE) trade experienced the fastest growth, reaching 48%. Medical consumables trade also had a significant growth rate of 18.7% that year, ranking second. During this period, due to the lack of clear prevention or treatment methods for COVID-19 and the virus's high contagiousness, the most critical products were those that restricted virus spread and detected the virus, leading to the highest growth rates in these two categories. In 2021, vaccines targeting the novel coronavirus were introduced to the market. Vaccine-producing countries began exporting and assisting other nations with vaccines.

Medical and pharmaceutical products, including vaccines, replaced personal protective equipment as the fastest-growing category, with a growth rate of 20.3%. At the onset of the pandemic, the immense rigid demand and supply shortages led to inflated prices and trade volumes for personal protective equipment, especially masks. However, many importing countries began localizing production in 2021, leading to a 12.9% decrease in the trade volume of these products during this period. Additionally, medical equipment, being a durable good, had limited new demand as many countries had already procured these devices in the previous stage, resulting in a relatively low growth rate in the trade volume of medical equipment.

3.2.2. Changes in the Global Medical Product Trade Pattern

According to WTO Data, the pandemic shifted the trade centers of certain medical products from Europe and the United States to Asia. Asia's share in global medical product exports increased from 15.8% in 2019 to 21.4% in 2020, dropping to 19.3% in 2021. Its export growth primarily concentrated on medical consumables and personal protective equipment (PPE). Concerning the latter, Asia's share in global exports was slightly over one-third in 2019, at 34.7%. However, by 2020, Asia accounted for more than half of the world's PPE exports. In contrast, Europe's share in PPE declined by 11 percentage points but recovered in 2021. The growth in Asia's PPE exports was predominantly driven by the increased export of masks. In 2020, Asia's share in mask exports surged by 22 percentage points, rising from 39.7% in 2019 to 61.7% in 2020.

Europe still dominates in pharmaceutical production and exports, accounting for at least 80% of the world's total exports in 2019 and 2020. This share slightly decreased to 77.7% in 2021. Simultaneously, Asia's share in the pharmaceutical market increased from 7.7% in 2019 to 10.9% in 2020. Regions outside Asia, Europe, and North America have very low participation in global medical product trade, with an average export share of 2.4% during 2019-2021. Specifically, the share of other regions was 2.6% in 2019, but it further dropped to 2.3% in 2021. In fact, these regions, including Africa, Latin America, Central America, the Middle East, the Commonwealth of Independent States, and other parts of the world, never surpassed a trade share of 5% in any medical product category.

4. Empirical Analysis

4.1. Model Construction

4.1.1. Baseline Regression Model

After removing samples with excessive zero trade values and significant missing data, a dataset consisting of 158 countries, observed over 33 months, and totaling 5214 observations was obtained. Following the approach of Liu X et al. [15] (2022), this study controls for the negative effects of the epidemic on the supply side in importing countries and other trading partner countries, as well as the positive effects on the demand side. Additionally, a variable controlling for the impact of the epidemic in the exporting country (China) was added. Based on an extension of the traditional gravity model, the baseline model is constructed as follows:

$$\begin{aligned} Trade_{ijt} = & \beta_0 + \beta_1 Covid_{it} + \beta_2 Stringency_{it} + \beta_3 Covid_{jt} \\ & + \beta_4 Covid_{-tpc_{it}} + \beta_5 Stringency_{-tpc_{it}} + \delta_i + \delta_t + \varpi_{it} \end{aligned} \quad (1)$$

Where i represents the importing country, t represents the month, and j represents China as the exporting country. $Trade_{ijt}$ is the dependent variable, representing the value of medical product imports from China to country i in month t . The key explanatory variables are $Covid_{it}$ and $Stringency_{it}$, representing the occurrence of the epidemic and government containment measures in the importing country during month t . These two variables are endogenous to each

other; the growth in the number of infections may lead to stricter government controls, but stringent lockdowns can also control the epidemic's development. Including both variables in the model aims to explore their independent effects on domestic demand and supply. $Covid_{jt}$ represents the domestic epidemic situation in China and is used to measure the positive effect of the epidemic on domestic demand. Unlike in the importing countries, here, government containment measures are not simultaneously controlled to avoid multicollinearity. $Covid_tpc_{it}$ represents the average severity of the epidemic in the importing country i (excluding China) and $Stringency_tpc_{it}$ represents the average strictness of containment measures in other trading partner countries. δ_i represents country fixed effects, controlling for differences among countries with relatively stable characteristics (such as population size, aging population, and geographic distance). δ_t represents time fixed effects, controlling at the monthly level to eliminate seasonal effects and variations in global economic welfare. ω_{ijt} represents the error term.

4.1.2. Moderation Effect Model

Following the approach taken by Hayakawa [16](2022), we introduce a variable representing the relationship between countries and interact it with the core explanatory variable, $Covid_{it}$. This interaction aims to examine the moderating effects of political and economic relationships between two countries on the importation of medical products from China.

$$\begin{aligned} Trade_{ijt} = & \beta_0 + \beta_1 Covid_{it} + \beta_2 Covid_{it} \times Linkage_{ijt} + \beta_3 Stringency_{it} \\ & + \beta_4 Covid_{jt} + \beta_5 Covid_tpc_{it} + \beta_6 Stringency_tpc_{it} + \delta_i + \delta_t + \omega_{ijt} \end{aligned} \quad (2)$$

The variable $Linkage_{ijt}$ represents the political and economic relationship between the importing country and China, measured by the similarity of political stances and the depth of regional economic cooperation. Since trade and diplomatic relationships in the same year can influence each other mutually, and trade disputes might lead to deterioration in diplomatic relations, the data on diplomatic relationships are lagged by one year. This lagging approach is also more realistic. The indicators used in this study to measure diplomatic relationships, such as the United Nations voting similarity and regional trade agreement data, often exhibit a certain lag when reflecting changes in diplomatic relationships.

Finally, all data are logarithmically transformed, and standard errors are clustered at the country level, employing heteroscedasticity-robust standard errors.

4.2. Variable Construction and Data Sources

In accordance with the established econometric model, the selected variables and their data sources are explained as follows:

4.2.1. Core Explanatory Variables

The severity of the pandemic and the strictness of containment measures are used to control the positive effects on the demand side and the negative effects on the supply side, respectively. To measure the intensity of the pandemic in a country each month, the number of new confirmed COVID-19 cases in that month is utilized. However, due to significant differences in population sizes among countries, nations with larger populations tend to report more new cases. To ensure comparability across countries, the number of new cases in each country is divided by its population, creating a standardized measure: new confirmed cases per million people. To gauge the strictness of government containment measures during the pandemic, the Government Stringency Index is employed. This index records nine restrictive measures implemented by governments for pandemic prevention: school closures, workplace closures, cancellation of public events, restrictions on public gatherings, closure of public transport, stay-

at-home requirements, public information campaigns, restrictions on internal movements, and international travel controls. The average score of these nine measures is calculated to obtain the Government Stringency Index.

In this study, the data for the two core explanatory variables were sourced from the Oxford COVID-19 Government Response Tracker, a dataset systematically collecting daily updates on new infection and death cases, as well as public policy information regarding government responses to the pandemic since its outbreak. This dataset was compiled by Hale[17] (2021) and colleagues. To measure the severity of the pandemic in both importing and exporting countries, the dataset's new confirmed cases data were utilized. The strictness of government containment measures was represented by the dataset's Stringency Index. A higher Stringency Index indicates more extensive government restrictions on domestic economic activities, such as workplace and school closures, which consequently limit the domestic supply capacity of products. These indicators, originally available on a daily basis, were aggregated and transformed into monthly data for analysis. Additionally, population data for calculating new confirmed cases per million people for each country were obtained from the World Development Indicators (WDI) website, maintained by the World Bank.

4.2.2. Dependent Variables

The monthly export data of medical products from China to other countries were sourced from the official website of the General Administration of Customs of the People's Republic of China. The data covers the period from January 2020 to September 2022. Using China's Free On Board (FOB) export data instead of various countries' Cost, Insurance, and Freight (CIF) data minimizes the time lags caused by transit and customs procedures, offering a more immediate reflection of the pandemic's impact. The World Trade Organization (WTO) classifies medical products into four categories: Pharmaceuticals (including immunological products, human vaccines, and drugs), Medical Consumables (items used in hospitals and laboratories), Medical Devices (including medical, surgical, and laboratory disinfectors, as well as medical and surgical instruments and devices), and Personal Protective Equipment (such as hand sanitizers, disinfectants, masks, and protective eyewear). Building upon this classification and considering the differences in technological levels, this study further refined the categories into Critical Medical Products (labor-intensive products), Medicine (knowledge-intensive products), and Equipment (capital-intensive products). This modified classification approach enables the consideration of China's product distribution characteristics.

Critical Medical Products: This category includes Personal Protective Equipment and Medical Consumables under the WTO's classification of medical products. It comprises medical masks, disposable protective suits, test kits, vaccines, disinfectant alcohol, respirators, and similar items. **Medicine:** Encompasses all products classified under the 30th category in the Harmonized System, relating to pharmaceuticals. **Equipment:** Includes products classified under the Medical Devices category in the WTO's classification.

4.2.3. Variables Describing the Pandemic Situation in Other Trading Partner Countries

In the basic regression model, the study also considers the pandemic and stringency levels in the trading partner countries of the importing nations to control for changes in multilateral trade costs. Following the approach of previous literature (X Liu, 2022)[15], the method to construct the indicators for the severity of the pandemic and stringency in multilateral trade costs is as follows:

$$Covid_tpc_{imt} = \frac{\sum_{j=1}^N Trade_{ijm,2019} Covid_{jt}}{\sum_{j=1}^N Trade_{ijm,2019}} \quad (3)$$

$$Stringency_tpc_{imt} = \frac{\sum_{j=1}^N Trade_{ijm,2019}Stringency_{jt}}{\sum_{j=1}^N Trade_{ijm,2019}} \tag{4}$$

Where the weight term Trade_{ijm,2019} represents the trade value of product category m between importing country i and all trading partner countries except China for the entire year of 2019. However, for critical medical products, which were not specifically classified in 2019, the weights for this category are set equal to those of pharmaceuticals. The rationale behind this choice is that before the onset of the pandemic, these products were primarily categorized under pharmaceuticals.

4.2.4. Moderating Variables

In this study, the variable used to measure political relationships is the similarity in political stances among countries. This is quantified using the Political Distance dataset provided by Bailey [18](2017). This dataset employs the IRT model and estimates the political distance based on each country's voting preferences in the United Nations General Assembly sessions every year. A larger numerical value indicates a greater political distance. This indicator has been widely utilized to measure bilateral political relationships[19][20] (Allen, 2020; Rommel and Schaudt, 2020).

The variable used to measure economic relationships in this study is the depth of regional economic cooperation, represented by whether each country has an active regional trade agreement (RTA) with China at the current time. The presence of a regional trade agreement can reduce bilateral trade barriers and lower tariffs, promoting trade between countries. Data on the existence of regional trade agreements in the current period were sourced from the official website of the World Trade Organization (WTO). In the panel data, this information is represented using binary variables: 1 indicates the presence of an agreement, and 0 indicates its absence.

4.3. Empirical Results Analysis

4.3.1. Baseline Regression Results

Table 2. Baseline Regression Results

	Critical		Medicine		Equipments	
	M1	M2	M1	M2	M1	M2
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Incovid_i</i>	0.044*** (0.008)	0.034*** (0.008)	0.068*** (0.018)	0.056*** (0.018)	0.03*** (0.012)	0.03** (0.012)
<i>Instringency_i</i>	0.118*** (0.026)	0.082*** (0.024)	0.265** (0.102)	0.214** (0.104)	0.204*** (0.06)	0.155*** (0.06)
<i>Incovid_j</i>		-0.426*** (0.12)		-0.925*** (0.225)		-0.389* (0.209)
<i>Incovid_tpc</i>		0.07** (.034)		0.101 (0.082)		-0.052 (0.082)
<i>Instringency_tpc</i>		0.55*** (0.216)		0.773** (0.332)		0.656* (0.384)
<i>FE</i>	√	√	√	√	√	√
<i>Month dummies</i>	√	√	√	√	√	√
Observations	5214	5214	5214	5214	5214	5214
R-squared	0.355	0.367	0.171	0.176	0.135	0.141
<i>Standard errors are in parentheses</i>						
*** <i>p</i> <0.01, ** <i>p</i> <0.05, * <i>p</i> <0.1						

The regression results of Equation (1) are presented in Table 2, reported by medical product category.

The table reports regression results for critical medical products, pharmaceuticals, and medical equipment, incorporating the import country's pandemic variables and other pandemic-related variables into the model in two steps (M1 and M2). All categories control for country fixed effects and monthly fixed effects.

The coefficients of the core explanatory variables, Covidit and Stringencyit, are significantly positive across all three product categories. This indicates that the COVID-19 pandemic in the importing countries significantly stimulates imports of medical products from China. The pandemic impacts both supply and demand in the importing countries, leading to a substantial increase in import demand. The severity of the pandemic in exporting country China, represented by Covidjt, is significantly negative across all three product categories, indicating that the severity of the domestic pandemic in China has a negative impact on medical product exports.

The coefficient of the multilateral trade resistance variable, Stringency_ptcit, is significantly positive for all three product categories, confirming the inhibitory effect of the exporting country's pandemic and the trade diversion effect in multilateral trade. However, Covid_ptcit does not have a significant coefficient for pharmaceuticals and medical equipment. There are two main reasons for this. First, pharmaceuticals and most medical equipment (such as respirators) are knowledge-intensive and capital-intensive goods, with high technological content. China's competitiveness in medical equipment compared to developed countries in Europe and the United States is relatively low, leading importing countries to prefer importing from other nations. Second, medical equipment is a durable good, and after the previous round of purchases, there is limited demand for new acquisitions. Therefore, even if the exports from trade partner countries are affected by the pandemic, imports from China may not necessarily substitute for them.

4.3.2. Moderation Effect Regression Results

Equation (2) incorporates the moderation variables into the model to explore the moderating effects of political and economic relationships on China's medical product exports. The estimation results, categorized by product types, are presented in Table 5-4. Columns (1), (3), and (5) report the regression results with the introduction of the "political relationships" variable, while columns (2), (4), and (6) report the regression results with the introduction of the "economic relationships" variable.

In the categories of critical medical products and pharmaceuticals, the coefficients of the political distance interaction terms are significant at least at the 10% level, indicating that exports of critical medical products and pharmaceuticals have stronger political implications compared to medical equipment exports. Moreover, the direction of the interaction term coefficients is consistent with that of the core explanatory variables, indicating that political distance enhances the promoting effect of the pandemic on medical product imports. In other words, the more dissimilar the political stance of the importing country is to that of China, the more the pandemic stimulates the import of critical medical products and pharmaceuticals from China. This suggests that throughout the entire pandemic period, China's exports of critical medical products and pharmaceuticals tend to be directed towards countries with a greater distance in terms of their United Nations voting patterns. This contrasts with the common practice in other countries during the initial outbreak period, as indicated by Hayakawa's (2021) findings, where medical product trade was negatively affected by the pandemic, particularly among politically closely linked countries.

Regarding the introduced interaction terms between economic relationships and the core explanatory variables, significant coefficients were only found in the critical medical products

category, and they were consistent with the coefficients of the core explanatory variables. This implies that the existence of regional trade agreements strengthens the positive effect of the pandemic on the import of critical medical products, indicating that China's exports of critical medical products tend to be directed towards countries with deeper regional economic cooperation during the pandemic. However, in the pharmaceuticals and medical equipment categories, the coefficients of the interaction terms between regional trade agreements and importing countries' pandemic variables were not significant. This suggests that the existing regional economic relationships did not have a significant impact, at least statistically, on the pandemic-induced shocks to trade in pharmaceuticals and medical equipment. This is mainly because, prior to the pandemic, China's exports of competitive products were labor-intensive items like personal protective equipment. In contrast, for pharmaceuticals and medical equipment, the major exporting countries were in Europe and North America, with China having a relatively small market share. Therefore, the pre-pandemic trade links did not have a stimulating effect on the export of these two product categories.

In summary, the following conclusions can be drawn: (1) Political alignment does not necessarily promote China's medical product exports. On the contrary, medical product exports, as a form of international aid during the pandemic, indicate the Chinese government's efforts to improve international relations; (2) Previous economic connections only played a promotional role in the export of critical medical products, while no moderating effect was found in the exports of the other two product categories.

Table 3. Moderation effect regression results

	Critical		Medicine		Medicine	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Incovid_i</i>	0.106***	0.029***	0.253***	0.056***	0.149**	0.027*
	(0.319)	(0.009)	(0.074)	(0.217)	(0.068)	(0.015)
<i>Instringency_i</i>	-0.012	0.088***	0.041	0.22	0.084	0.159**
	(0.039)	(0.024)	(0.113)	(0.105)	(0.064)	(0.062)
<i>Incovid_j</i>	-0.353***	-0.419***	-0.743***	-0.917***	-0.287	-0.383*
	(0.119)	(0.12)	(0.211)	(0.224)	(0.184)	(0.21)
<i>Incovid_tpc</i>	0.075*	0.072*	0.106	0.101	-0.051	-0.051
	(0.04)	(0.04)	(0.082)	(0.082)	(0.081)	(0.081)
<i>Lnstringency_tpc</i>	0.511**	0.551**	0.68**	0.76**	0.614*	0.65*
	(0.218)	(0.216)	(0.321)	(0.331)	(0.367)	(0.385)
<i>Incovid_i*lnpodist</i>	-0.074**		-0.204***		-0.123	
	(0.03)		(0.074)		(0.068)	
<i>Incovid_i*RTA</i>		0.02*		-0.003		0.011
		(0.011)		(0.025)		(0.015)
FE	√	√	√	√	√	√
Month dummies	√	√	√	√	√	√
202001-202209	√	√	√	√	√	√
Observations	5214	5214	5214	5214	5214	5214
R-squared	0.369	0.367	0.179	0.176	0.144	0.141

5. Conclusion and Policy Recommendations

5.1. Conclusion

This study empirically examined the import of medical products from China by 158 importing countries from January 2020 to September 2022. The analysis considered three aspects of the pandemic's impact on bilateral trade: importing countries, exporting countries (China), and other trading partner countries. The product categorization was refined based on factor intensity, dividing products into labor-intensive critical medical products, knowledge-intensive pharmaceuticals, and capital-intensive medical equipment. This rigorous and scientific categorization allowed for a comprehensive observation of various aspects of the impact of the pandemic on medical product imports and exports, leading to nuanced conclusions.

In this study, medical product exports during the pandemic were considered a form of foreign aid. By introducing two moderating variables, political relations and economic relations, the study explored the moderating effects of diplomatic relations on medical product trade during the pandemic. The empirical results showed that economic cooperation relationships favored strengthening the positive effects of the pandemic on China's exports of critical medical products. Countries with effective regional trade agreements with China received more assistance in the form of critical medical products. Additionally, the "political distance" between countries and China also had a positive moderating effect. Countries farther from China politically imported more medical products from China due to the pandemic. In other words, during the pandemic, China tended to export medical products to countries with significantly different political stances. This finding contrasts with many scholars' conclusions, suggesting that the Chinese government appears to use foreign aid, specifically medical product trade, to improve international relations.

5.2. Policy Recommendations

The statistical data reveal the significant fluctuations in global medical product trade during the various stages of the COVID-19 pandemic. The empirical results also indicate the substantial impact of the pandemic's development on the transnational flow of medical products. This indirectly reflects the inadequate domestic production capacity of medical products in various countries, highlighting the fragility of domestic supply chains. During the pandemic, the top ten medical product-exporting countries supplied approximately 70% of the world's import demand. Governments worldwide should enhance their domestic production capabilities for critical medical products, such as personal protective equipment (PPE) and antiviral medications. This enhancement requires not only increasing the quantity but also ensuring quality control, diversification of product types, and robustness of the production and supply chain from raw materials to finished products. Specific measures include:

- Optimize Supply Chain Management:** Implement modern supply chain management concepts and technologies, such as big data and artificial intelligence, to monitor and predict medical product supply chains in real time, enabling rapid responses to various changes.
- Establish Diverse Supply Systems:** Create alternative suppliers and production bases to reduce dependence on specific suppliers or regions. Quick switching mechanisms should be in place to ensure supply stability in the event of interruptions.
- Strengthen Cooperation and Coordination:** Enhance collaboration between upstream and downstream enterprises, improving the overall efficiency of the supply chain.
- Promote Technological Innovation and Independent Research:** Enhance research and development capabilities for core technologies, reducing reliance on external technologies.

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