INTRODUCTION

Many countries have experienced a shortage of medical products during the novel coronavirus 2019 (COVID-19) pandemic, which the World Health Organization (WHO) recognised on 11 March 2020. Since that time, the demand for protective items, such as face masks, has risen dramatically worldwide.
However, due to the limited supply, people were not able to obtain a sufficient number of items. Even hospitals were in danger of running out of masks. Furthermore, to ensure an adequate supply for domestic consumption, many countries imposed measures against the outflow of these items, including export bans. According to the World Trade Organization, China supplied 25% of the face masks exported to the world market in 2019, and together with Germany and the US, provided nearly half of the global supply. These three countries also had a large number of confirmed cases and consequently required a large number of masks. Thus, it proved challenging to import medical products from foreign countries.

This study empirically investigates what kinds of countries imported and exported medical products during the COVID-19 pandemic. As mentioned above, many countries that were in danger of running out of medical products restricted their exports. Nevertheless, many of those countries allowed exports to certain ‘special’ countries. For instance, owing to a longstanding or close relationship, they might help neighbouring countries. In addition, they might export to countries with similar political stances. Medical products might also be imported from countries with large expatriate populations. Old colonial ties or close economic ties, including regional trade agreements (RTAs), might facilitate the trade of medical products. In short, countries may prohibit exports in general but engage in trade with some countries when there are specific reasons to do so.

We examine the bilateral trade values of medical products among 35 reporting countries and 250 partner countries between January and August in both 2019 and 2020. We follow the World Trade Organization (WTO) classification of medical products, which includes four categories: medicines, medical supplies, medical equipment and personal protective products. We regress trade values of each category on the numbers of COVID-19 cases or deaths in exporting and importing countries. The estimated coefficients indicate the impacts of COVID-19 on trade in each category. Then, we introduce interaction terms together with various bilateral measures to identify the ‘special’ countries mentioned above. Following the literature on determinants of foreign aid, we examine four measures: the similarity index in United Nations voting record (political ties), the RTA dummy (economic ties), numbers of immigrants between exporting and importing countries (demographic ties) and geographical distance (geographical ties). By exploring the estimates in these interaction terms, we investigate what kinds of bilateral relationships increase trade.

Indeed, investigating health diplomacy in the COVID-19 era provides a rare opportunity for evaluating the roles of bilateral relations. Fazal (2020) examines SARS 2003, HINI 2009, MERS 2012 and Ebola 2014 and 2018 as health diplomacy cases during a pandemic period. Yet, these cases were not global and thus did not have enough variations to examine the role of country-pair characteristics in health diplomacy. Furthermore, during such a crisis, multilateral approaches such as using international organisations tend not to work well because there is less coordination and health diplomacy around COVID-19 has shown fragmentation (Fazal, 2020). Great powers like the United States and China and emerging countries like Turkey and Taiwan have played the role of donors of medical products. Furthermore, competition between the US and China and weak leadership of the WHO provided the conditions for bilateral health diplomacy.

Our findings can be summarised as follows. An increase in the number of COVID-19 cases or deaths in a country significantly decreases exports of medical products and increases imports.

1https://www.wto.org/english/news_e/news20_e/rese_03apr20_e.pdf.

2The definition of health diplomacy is a topic of debate (Feldbaum & Michaud, 2010). Health diplomacy is different from global health diplomacy. The main aim of global health diplomacy is to contribute to the improvement of global health, whereas that of health diplomacy is to increase or strengthen national interests by solving the health problems of other countries (Bliss, 2011). According to Bliss, China and Russia are pioneers of health diplomacy based on their humanitarian, strategic and ideological purposes.
However, any decrease in exports becomes smaller when exporting to countries with political, economic or geographical ties, whereas the increase of imports does not become larger when importing from such countries. In contrast, demographic ties play a role in the importation of medical products, especially personal protective products.

Our study relates to various strands of the literature, including a large number of studies on how and why countries grant foreign aid. Recent examples include Bermeo (2017) and Dreher et al. (2018). Although health diplomacy appears similar to foreign aid, in-kind aid may differ from monetary aid. Second, we contribute to the literature on the international trade–COVID-19 nexus. Some studies have empirically investigated the effects of COVID-19 on global value chains (Friedt & Zhang, 2020; Hayakawa & Mukunoki, 2021b; Kejzar & Velic, 2020; Meier & Pinto, 2020). These show that negative effects of COVID-19 on trade propagate across countries through supply chains. Some studies also discuss this trade–COVID-19 nexus in the context of medical products (Evenett, 2020; Gereffi, 2020). Furthermore, Evenett et al. (2021) developed a new data set on trade policy changes targeting medical and food products since the beginning of the COVID-19 pandemic. There are also several policy reports on China’s ‘mask diplomacy’. Examples include ADB (2020), Baldwin and Freeman (2020), Kahn and Prin (2020), Verma (2020), White (2020) and Wong (2020). However, these studies do not statistically investigate the effects of COVID-19 on the trade of medical products and how those effects differ according to bilateral linkages.

The studies closest to this paper are Fuchs et al. (2020) and Telias and Urdinez (2020). Both investigate exports of medical products from China and shed light on the roles of political and economic ties with foreign countries. We extend their analyses in three ways. First, we cover worldwide trade, including exports from China. Second, we examine not only economic and political linkages but also demographic linkages. Third, we investigate the role of these linkages in both exporting and importing.

The remainder of this study is organised as follows. Section 2 establishes our conceptual framework on trade in medical products during the pandemic by referring to the determinants of foreign aid policy. In Section 3, we present an overview of global trade in medical products. After explaining our empirical framework in Section 4, we report our estimation results in Section 5. Lastly, Section 6 concludes.

2 CONCEPTUAL FRAMEWORK

Given the global nature of the COVID-19 pandemic, every country needs medical products. During a pandemic, the act of supplying medical products can be considered a form of foreign aid (Hattori, 2001). Indeed, as in the case of foreign aid, the aim of health diplomacy is to strengthen national interests (Feldbaum & Michaud, 2010; Vanderwagen, 2006).

Foreign aid can be characterised by three main pillars: strategic relationships, humanitarian behaviour and economic assistance. The motivation behind strategic relationships is to obtain material benefits such as political and security gains. Humanitarian behaviour is aimed at increasing soft power. Although the motivation behind economic assistance is similar to that of humanitarian behaviour, the former also intends to develop recipient states as future trading partners. McKinley and Little (1977) studied US foreign aid programmes during the 1960s and concluded that strategic relationships were the central motivation of the programmes. They also examined the aid policies of the

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3 More specifically, McKinley and Little (1977) suggested five elements for comparative analysis: development interests, overseas economic interests, security interests, power-political interests and interest in political stability and democracy. Security interests, power political interests and interest in political stability and democracy are regarded as the motivation behind strategic relationships. Development interests are based on humanitarian behaviour. The aim of overseas economic interests is to form alliances with trading partners.
UK, France and Germany during the 1960s and argued that the UK and France prioritised strategic relationships (McKinley, 1979; McKinley & Little, 1978). These studies concluded that economic assistance and humanitarian action were not key drivers of donor countries’ motivation.

Schraeder et al. (1998) added three more factors, including cultural/historical similarities, ideological stance and geographical features. Although these models relate to the three traditional pillars, the motivations behind them are slightly different. For cultural similarities, decision makers take account of cultural ties based on historical legacies such as colonial traditions. For ideological ties, decision makers prioritise ideological similarities when selecting the destination of aid. Geographical features may be linked to strategic relationships because geographical proximity is an element of threat perception, which is directly connected to national security (Walt, 1987). Decision makers tend to tame neighbouring countries through either military power or foreign aid. In some cases (e.g. wars, civil wars, or disasters), the geographical position can be critical. Neighbouring states may need an emergent response to such cases for their security. In an analysis of four countries (the United States, Japan, France and Sweden) in the 1980s, Schraeder et al. (1998) found that all six elements affected the donor's motivation or the target of the aid. Nevertheless, they emphasised that humanitarian concerns were a relatively weak motivation, whereas economic relationships via trade play a vital role in all donor countries’ motivation.

Recent studies on foreign aid have introduced the idea of constructivism. Theories about international relations have included several kinds of identity, such as national identity (Wendt, 1999). Among them, national identity plays a decisive role in the sending and receiving of foreign aid. Shain and Barth (2003) emphasise the diaspora nexus between donor and recipient countries. The activities of Jewish and Armenian lobbies in the United States are typical examples of diaspora politics. They have four motivations, namely influencing (i) the whole kinship community, (ii) the future of their homeland, (iii) people or communities in their host country and (iv) influential organisations, such as American-Israel Public Affairs Committee (AIPAC) in the case of Jewish Americans (Shain & Barth, 2003). Diaspora politics have worked well in the arena of foreign aid.

Migrant communities also play a similar role. For example, Bermeo and Leblang (2015) found a positive relationship between aid allocation and the number of migrants from a recipient country to a donor country. One motivation for donor countries to provide aid might be to decrease migration from the recipient country. However, migrants (those with dual-citizenship) living in a host country are interested in developing their home country. To this end, migrants or migrant organisations may pressure the government of the host by joining forces with their home government. For example, they lobby the host government to provide aid (Prather, 2020).

In sum, previous studies supposed seven factors: strategic relationships, humanitarian relations, economic partners, cultural similarities, ideological similarities, geographical features and identity ties. Those studies concluded that humanitarian action is not a critical factor. Although ideology worked well during the Cold War era, it is no longer relevant. In addition, geographical proximity is critical to avoiding potential conflicts with neighbouring countries. Hence, strategic relationships, economic partners, cultural ties, identity networks and geographical features play critical roles in the allocation of foreign aid.

These five factors may also have significant effects on trade in medical products in the COVID-19 pandemic. Health diplomacy during a pandemic can be considered a form of foreign aid. Moreover, many countries introduced export prohibitions and restrictions in order to mitigate shortages and keep them for domestic use. For example, according to the WTO, 73 countries or territories introduced such restrictions on face and eye protection as of 22 April 2020. Also, Evenett et al. (2021) identified
120 export restricting measures for medical products as of April 2020. Therefore, governments and other decision makers have exerted some control over the trade. The abovementioned factors in foreign aid are expected to play a critical role in the trade of medical products.

3 | BACKGROUND

Here, we examine monthly trade values of medical products worldwide. We follow the four category classification of medical goods defined by the WTO: medicines, including immunological products, vaccines for human medicine and medicaments; medical supplies, which are consumables for hospital and laboratory use; medical equipment, which includes medical, surgical and laboratory sterilisers as well as medical and surgical instruments and apparatuses; and personal protective products (Personal), which includes hand soap and sanitiser, face masks and protective eyewear. A list of six-digit level codes in the Harmonized System (HS) 2017 is available on the WTO website.5

We obtained monthly data on trade values from the Global Trade Atlas maintained by the IHS Markit.6 In particular, we examine trade values of the 35 countries listed in the Global Trade Atlas.7 The potential number of trading partner countries is 250. We aggregate the trade values at the HS six-digit level according to the four categories described above. We first examine the monthly exports of the 35 countries in 2020 relative to those in 2019. We focus on exports because the data on imports may indicate the figures one or two months after production. This time lag is inevitable because import statistics record the date of arrival at ports in importing countries, and it takes time to ship goods from the port of an exporting country to the port of an importing country. This time lag may not matter much when using annual data but might affect the results of a month-by-month analysis such as ours (Hayakawa, 2020). Thus, when examining monthly trade values, we use only the trade data from export statistics.

Exports of the 35 countries to the rest of the world for each category of medical products are shown in Figure 1. The increase in exports of personal protective products is of particular note. They rose dramatically in April, peaked in May and then gradually decreased. In May, the magnitude of exports was 2.5 times larger than that in 2019. Even in August, it was still more than 50% greater. This is consistent with consumer demand. Face masks were needed for infection control not only at hospitals but also at offices. Although the growth of exports in other medical goods is moderate by comparison, it is greater than the value of one, indicating a larger magnitude than the level in 2019. This fact is surprising because other products (e.g. apparel, electronic machinery products and transport equipment) experienced a sharp drop in trade, particularly in April and May (Hayakawa & Mukunoki, 2021a). Thus, based on the rise in demand, the trade in medical goods increased despite the export restrictions imposed by many countries.

Next, we examine who exports or imports by exploring the sum of exports to or imports from other countries from January to August in 2020. To this end, we mix the trade values of export and import

5http://www.wcoomd.org/~/media/wco/public/global/pdf/topics/nomenclature/covid_19/hs-classification-reference_2_1-24_4_20_en.pdf?la=en. It should be noted that this list does not include intermediate products needed to produce these medical products because it is difficult to identify whether intermediate products are used for medical or non-medical products.

6https://connect.ihsmarkit.com/gta/home.

7AR, AT, AU, BE, BR, CA, CH, CI, CN, DE, DK, ES, FR, GB, GR, HK, ID, IE, IL, JP, KE, KR, LU, MX, MY, NL, PH, PT, RU, SE, SG, TH, TW, US, ZA.
statistics because this is not a month-by-month analysis. We create a more comprehensive data set on global trade by using mirror trade data. We use imports when both exports and imports are available. The top five exporters and importers are listed in Table 1. In terms of exports, Germany and the United States are key players in most product categories. However, China is a major exporter of personal protective products, accounting for 45% of the world's exports. Thus, the surge in exports of personal protective products shown in Figure 1 was realised mostly by China's exports. However, in terms of

### FIGURE 1

Monthly exports of medical goods in 2020 relative to those in 2019. *Source: Authors’ computation using the Global Trade Atlas* [Colour figure can be viewed at wileyonlinelibrary.com]

### TABLE 1

Top 5 exporters and importers between January and August in 2020 (%)

|            | Equipment | Supplies | Medicines | Personal |
|------------|-----------|----------|-----------|----------|
| Export     |           |          |           |          |
| 1st        | United States | 18      | United States | 19  | Germany | 15  | China     | 45  |
| 2nd        | Germany   | 15       | Germany   | 12      | Switzerland | 12  | Germany   | 9   |
| 3rd        | China     | 14       | China     | 11      | Ireland     | 12  | United States | 7  |
| 4th        | Mexico    | 7        | Ireland   | 5       | United States | 9  | Japan     | 4   |
| 5th        | Japan     | 6        | Netherlands | 5  | Belgium     | 6  | France    | 3   |
| Import     |           |          |           |          |
| 1st        | United States | 21      | United States | 16  | United States | 21  | United States | 12  |
| 2nd        | China     | 10       | Germany   | 10      | Germany     | 9   | Germany    | 11  |
| 3rd        | Germany   | 7        | Netherlands | 6  | Belgium     | 8   | France     | 8   |
| 4th        | Netherlands | 6        | China     | 5       | Switzerland | 6   | China      | 7   |
| 5th        | Japan     | 4        | France    | 5       | China       | 5   | UK         | 5   |

*Source: Authors’ computation using the Global Trade Atlas.*
imports, Germany and the United States are again key players in most medical products. The United States in particular ranked first in all four categories.

4 | EMPIRICAL FRAMEWORK

Our data set contains two time points. As shown in Table 1, we use both import and export statistics to maximise the number of country pairs in the data set. We again use data on trade values from the Global Trade Atlas. Thus, our data set covers the trade between 35 reporting countries and 250 trading partners. We again aggregate trade values at the HS six-digit level according to the four categories of medical products.

Our baseline model is as follows:

\[ \text{Trade}_{ijy} = \exp \left\{ \alpha_1 \text{COVID}_{iy} + \beta_1 \text{COVID}_{jy} + \delta_{ij} + \delta_{jf} \right\} \cdot \epsilon_{ijy} \]  

(1)

\[ \text{Trade}_{ijy} \] is the sum of export values from countries \( i \) to \( j \) during January–August in year \( y \). \( \text{COVID}_{iy} \) and \( \text{COVID}_{jy} \) are the COVID-19 burdens in exporting countries and importing countries respectively. We control for two kinds of fixed effects (\( \delta_{ij} \) and \( \delta_{jf} \)). The subscript ‘\( f \)’ indicates the trade flow included in the data (i.e. export statistics or import statistics). Given that our study time includes two points, \( \delta_{jf} \) has four combinations. \( \epsilon_{ijy} \) is a disturbance term. We estimate this equation for each category of medical products by the Poisson pseudo-maximum likelihood (PPML) method.

We measure COVID-19 burden as the sum of the number of confirmed cases or deaths from January to August. These data are obtained from the European Centre for Disease Prevention and Control\(^8\) and have been collected on a daily basis from reports issued by health authorities worldwide. The numbers are set to zero for 2019. We add a value of one to these numbers and then take their logs. Although these numbers represent those who contracted the virus, large numbers are also expected to have a substantial psychological impact on the uninfected, discouraging them from working or going out. Thus, we expect that this measure reflects the economic impacts of COVID-19. As a result, the coefficients for these numbers indicate the effects of COVID-19 on trade.

We introduce two kinds of fixed effects. \( \delta_{ij} \) represents country-pair fixed effects, which control for standard gravity variables such as geographical distance. Furthermore, due to the short time period (two years), this type of fixed effect may control for country characteristics that do not change much in such a short time (e.g. total population of importing and exporting countries). \( \delta_{jf} \) represents year-flow fixed effects. The year component of this controls for changes in the world income, whereas the trade flow component (\( f \)) controls for the difference in the trade value between the import and export statistics, that is, the difference between FOB base values and CIF base values.

Next, we extend our model by introducing the interaction terms of COVID-19 variables with variables on various bilateral linkages.

\[ \text{Trade}_{ijy} = \exp \left\{ \alpha_1 \text{COVID}_{iy} + \alpha_2 \text{COVID}_{jy} \cdot \text{Linkage}_{ij} + \beta_1 \text{COVID}_{jy} + \beta_2 \text{COVID}_{jy} \cdot \text{Linkage}_{ij} + \delta_{ij} + \delta_{jf} \right\} \cdot \epsilon_{ijy} \]  

(2)

In Section 2, we discussed the roles of political, economic, demographic and geographical linkages. \( \text{Linkage}_{ij} \) captures these four kinds of bilateral relationships \( i \) and \( j \).\(^9\) Furthermore, we examine their role in exporting and importing separately by interacting the linkage with the COVID variables

\(^8\)https://data.europa.eu/euodp/en/data/dataset/covid-19-coronavirus-data.

\(^9\)Later, we also examine the role of cultural or historical linkages.
of importers and exporters. Some types of linkages may be effective only in the context of exporting and vice versa.

Here, we use the following variables to measure the strength of each linkage. In the literature, strategic relationships have been measured by several indicators, including treaties between donor and recipient countries, friend or foe status with respect to applicable states or alliances, and United Nations General Assembly (UNGA) voting similarity (Alesina & Dollar, 2000). We use the voting similarity index in 2019, the data of which are obtained from Bailey et al. (2017). This indicates similarity of state preferences inferred from voting behaviour in the UNGA. For the economic linkage, while some studies examined the role of trade volumes in foreign aid (Lundsgaarde et al., 2010), we use a dummy variable that indicates the existence of RTAs between two countries. We obtain the RTA dummy variable from Egger and Larch (2008) and update it for 2020 by using the information on RTAs available on the WTO website. As an indicator of the demographic linkage, we use number of migrants. Stock data on bilateral migrants as of 2019 are obtained from the report International Migrant Stock 2019 issued by the United Nations. We measure geographical linkage by geographical distance, with data drawn from the CEPII website.

5 | EMPIRICAL RESULTS

In all estimations, we cluster the standard errors by country pairs. Estimation results for Equation (1) are shown in Table 2. We report those by medical product categories and COVID-19 measures. In all columns, the coefficient for the exporter’s COVID-19 is estimated to be negative, although the number of deaths is insignificant in terms of equipment trade. Thus, countries more severely impacted by COVID-19 decreased their exports of all medical products. The difference in magnitude across categories indicates that such a decrease is relatively large for personal protection products and small for medical equipment. In contrast, the coefficient for the importer’s COVID-19 is significant only in trade in personal protection products. Furthermore, the coefficient for the importer's COVID-19 is estimated to be positive, indicating that countries with a larger number of cases or deaths increase their imports of personal protection products. This result is as expected given that such countries need those products to prevent the further spread of infection.

Before estimating Equation (2), we estimate our model for monthly trade. To this end, we estimate the following equation:

\[
\text{Trade}_{ijym} = \exp \left\{ \text{COVID}_{y} \mathbf{D}' \alpha + \text{COVID}_{ym} \mathbf{D}' \beta + \delta_{ijy} + \delta_{ijm} + \delta_{ym} \right\} \cdot \epsilon_{ijym}
\]  

(3)

\(\text{Trade}_{ijym}\) is the export value from countries \(i\) to \(j\) in month \(m\) in year \(y\). To minimise the time lag between the production and arrival of goods at ports, we only use export statistics from reporting countries. For COVID variables, we use the sum of new cases and new deaths for each month.\(^{10}\) \(\mathbf{D}\) includes dummy variables that indicate the month. We control for three kinds of fixed effects. \(\delta_{ijy}\) controls for not only the standard gravity variables but also the effects of trade agreements as well as the annual average of multilateral resistance terms in each country, the annual average of the exporter’s factor prices and the annual average of the importer’s income. \(\delta_{ijm}\) is country-pair month fixed effects. This type of fixed effect controls for the seasonality of trade between the two countries (e.g. flu season). \(\delta_{ym}\) is the year-month fixed effects, which control for time-series changes in world income.

\(^{10}\)One notice is that the database reports 27 cases for China in 31 December 2019, which are added to the cases for China in January 2020.
The results are reported in Table 3. Compared with Table 2, we can see many significant coefficients, implying that the significance of COVID-19 differs greatly by month. On the import side, a significant increase in personal protective products starts in April, perhaps because most countries recognised the threat posed by COVID-19 in March. On the export side, except for medicines, we can see negatively significant coefficients for most months. However, the absolute magnitude seems smaller in the third quarter (i.e. July and August), indicating that the shortage of those medical products started to be less severe because of the gradual decrease in confirmed COVID-19 cases and deaths in Asia. In contrast, we do not find significant coefficients for exports of medicines in most months.

Table 4 reports results from estimating Equation (2). We interact with the similarity index in voting in the UNGA. The interaction terms for importers have significantly negative coefficients, except for trade in medicines. This implies countries tend to import those medical goods from countries with less similar state preferences. Thus, political linkages are not helpful when requesting medical aid. In contrast, the coefficient for the interaction term for exporters is significantly positive, especially for trade in personal protective products. Even if countries experience an increase in cases or deaths, they export personal protective products to countries with similar state preferences. Similar results can be found when introducing the interaction terms with the RTA dummy, as shown in Table 5. Countries are less likely to import medical products from RTA partners but more likely to export them to RTA partners. In sum, these results indicate that the decrease in exports of medical products caused by COVID-19 is smaller for exports to countries with political or economic ties. In other words, strategic and economic relationships play significant roles in the export of medical products but not in requesting medical aid.
| Importer COVID                      | Cases                      | Deaths                      |
|-------------------------------------|----------------------------|-----------------------------|
|                                    | Equipment                  | Supplies                    | Medicines                  | Personal | Equipment                  | Supplies                    | Medicines                  | Personal |
| 1 for January                       | −0.007                     | −0.007                      | −0.033***                  | 0.019     | −0.031***                  | −0.017                      | −0.061***                  | 0.021    |
| 1 for February                      | 0.012***                   | 0.003                       | 0.028***                  | 0.024     | 0.000                      | 0.016**                     | 0.059***                  | 0.052*   |
| 1 for March                         | 0.009                      | 0.012                       | 0.042***                  | −0.007    | 0.005                      | 0.000                       | 0.017                      | −0.017   |
| 1 for April                         | −0.019***                  | −0.023                      | −0.007                    | 0.051***  | −0.016**                   | −0.026**                    | −0.011                    | 0.024*   |
| 1 for May                           | −0.022                     | −0.001                      | 0.017                     | 0.066***  | −0.017                     | −0.005                      | 0.014                     | 0.055***  |
| 1 for June                          | 0.012                      | 0.012                       | −0.013                    | 0.058***  | 0.014**                    | 0.012                       | −0.014                    | 0.044***  |
| 1 for July                          | 0.011                      | −0.003                      | 0.003                     | 0.046***  | 0.014                      | 0.000                       | 0.003                     | 0.038***  |
| 1 for August                        | 0.001                      | 0.005                       | 0.005                     | 0.057***  | 0.002                      | 0.005                       | 0.004                     | 0.050***  |

| Exporter COVID                      |                          |                             |
|-------------------------------------|----------------------------|-----------------------------|
|                                    | Equipment                  | Supplies                    | Medicines                  | Personal | Equipment                  | Supplies                    | Medicines                  | Personal |
| 1 for January                       | −0.079***                  | −0.097***                   | −0.029*                   | −0.171*** | −0.135***                  | −0.153***                   | −0.095***                  | −0.276***  |
| 1 for February                      | −0.037***                  | −0.046***                   | 0.01                      | −0.092*** | −0.047***                  | −0.057***                   | −0.024                     | −0.118***  |
| 1 for March                         | −0.004                     | 0.001                       | −0.01                     | −0.018    | −0.013                     | −0.003                      | −0.036                     | −0.063***  |
| 1 for April                         | −0.035***                  | −0.011                      | 0.007                     | −0.087*** | −0.021**                   | −0.009                      | 0.015                      | −0.042***  |
| 1 for May                           | −0.063***                  | −0.033***                   | −0.003                    | −0.122*** | −0.053***                  | −0.026***                   | −0.009                    | −0.095***  |
| 1 for June                          | −0.037***                  | −0.050***                   | 0.017                     | −0.058*** | −0.027***                  | −0.044***                   | 0.024*                     | −0.043***  |
| 1 for July                          | −0.021*                    | −0.038***                   | 0.013                     | −0.048*** | −0.006                     | −0.033***                   | 0.01                      | −0.032**   |
| 1 for August                        | −0.023**                   | −0.039***                   | 0.007                     | −0.033*** | −0.017*                    | −0.029***                   | 0.005                     | −0.025     |
| Log                                 | −2.6.E+09                  | −3.5.E+09                   | −1.4.E+10                 | −3.3.E+09 | −2.6.E+09                  | −3.5.E+09                   | −1.4.E+10                 | −3.2.E+09 |
| Pseudolikelihood                    | Pseudo $R^2$               | Number of obs               |
|                                    | .9939                      | 59,352                      |
|                                    | .9938                      | 65,560                      |
|                                    | .9915                      | 52,226                      |
|                                    | .9943                      | 70,884                      |
|                                    | .9939                      | 59,318                      |
|                                    | .9938                      | 65,522                      |
|                                    | .9915                      | 52,206                      |
|                                    | .9945                      | 70,856                      |

**Notes:** This table reports the estimation results by the PPML method. ***, ** and *1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for country-pair fixed effects and trade flow-year fixed effects. ‘COVID’ indicates the number of confirmed cases (Cases) or deaths (Deaths).
Next, we interact with migrant stocks. The model becomes somewhat complicated because of the use of two unidirectional variables (i.e. trade and migration). With COVID variables, we interact two migration variables, namely the log of the number of migrants from an exporting country to an importing country (Emigration) and the log of the number of migrants from an importing country to an exporting country (Immigration). We name the migration variables based on the flow of trade and use the numbers as of 2019. We take their logs after adding the value of one because many country pairs have a zero-valued stock of bilateral migrants.

The estimation results are presented in Table 6. We can find significant results in interaction terms, especially for imports of personal protective products. In particular, the interaction term between the importer’s COVID and Emigration has significantly positive coefficients when using both the cases and deaths of COVID-19. This result implies that a country tends to import personal protective products from countries with large numbers of people immigrating to that country. In short, immigrants’ home countries send face masks. However, the negative result in the interaction term between

| TABLE 4 | Heterogenous impacts: Political linkages |
|-----------------|-----------------|-----------------|-----------------|
|                | Equipment | Supplies | Medicines | Personal |
| (i) Cases      |           |           |           |          |
| Importer COVID | 0.028*    | −0.011    | −0.004    | 0.071**  |
|                | [0.016]   | [0.010]   | [0.009]   | [0.032]  |
| Agreement      | −0.017    | −0.015*   | −0.013    | −0.098***|
|                | [0.016]   | [0.009]   | [0.015]   | [0.029]  |
| Exporter COVID | −0.017**  | −0.034*** | −0.028*** | −0.124***|
|                | [0.009]   | [0.006]   | [0.009]   | [0.022]  |
| Agreement      | 0.01      | 0.008     | 0.017     | 0.050*   |
|                | [0.015]   | [0.009]   | [0.014]   | [0.025]  |
| Log pseudolikelihood | −2.3E+09 | −3.1E+09 | −8.1E+09 | −8.0E+09 |
| Pseudo R-squared | .9955    | .9948     | .9963     | .9864    |
| Number of obs. | 12,914  | 13,702    | 11,414    | 15,376   |
| (ii) Deaths    |           |           |           |          |
| Importer COVID | 0.026**   | −0.005    | −0.005    | 0.089*** |
|                | [0.012]   | [0.009]   | [0.008]   | [0.029]  |
| Agreement      | −0.027*** | −0.017*   | −0.009    | −0.120***|
|                | [0.010]   | [0.008]   | [0.012]   | [0.028]  |
| Exporter COVID | −0.008    | −0.027*** | −0.023**  | −0.084***|
|                | [0.008]   | [0.005]   | [0.009]   | [0.021]  |
| Agreement      | 0.018**   | 0.01      | 0.016     | 0.056**  |
|                | [0.009]   | [0.007]   | [0.011]   | [0.023]  |
| Log pseudolikelihood | −2.3E+09 | −3.1E+09 | −8.1E+09 | −8.1E+09 |
| Pseudo R-squared | .9955    | .9948     | .9963     | .9861    |
| Number of obs. | 12,914  | 13,702    | 11,414    | 15,376   |

Notes: This table reports the estimation results by the PPML method. ***, ** and *1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for country-pair fixed effects and trade flow-year fixed effects. ‘COVID’ indicates the number of confirmed cases (Cases) or deaths (Deaths).
the exporter’s deaths and Immigration is inconsistent with this result because both interaction terms capture the same flows in trade and migration. Nevertheless, in contrast to the results of political or economic ties, identity and demographic ties affect the import of essential goods.

Table 7 shows the results when introducing the interaction terms with the log of geographical distance between two countries, and we report significant coefficients for the interaction terms for trade in most products. Those results indicate that when COVID-19 hits a country hard, that country does not necessarily import medical products from neighbouring countries. This might be because neighbouring countries also want medical products when they experience a substantial increase in COVID-19 infections. However, the decrease of exports is smaller when exporting to neighbours. This result is similar to the cases of political and economic linkages presented in Tables 4 and 5. However, it is not limited to personal protective products but is found in most categories. Thus, geographical proximity plays a greater role in the export of medical products than other types of linkages, including political and economic relations. This might also indicate that geographical connections are related
|                  | Cases                     |                          | Deaths                    |                          |
|------------------|---------------------------|--------------------------|---------------------------|--------------------------|
|                  | Equipment | Supplies | Medicines | Personal | Equipment | Supplies | Medicines | Personal |
| Importer COVID   | 0.002     | 0.007    | 0.017     | 0.025     | 0.003     | -0.006   | 0.009     | 0.019    |
|                  | [0.009]   | [0.011]  | [0.011]   | [0.017]   | [0.009]   | [0.010]  | [0.014]   | [0.019]  |
| ln (1 + Immigration) | 0.000    | -0.002   | -0.003*   | -0.008*** | 0.001     | -0.001   | -0.001    | -0.007*** |
|                  | [0.001]   | [0.001]  | [0.001]   | [0.002]   | [0.001]   | [0.001]  | [0.002]   | [0.002]  |
| Exporter COVID   | -0.002    | -0.041***| -0.040*** | 0.015     | 0.012     | -0.023*  | -0.017    | 0.048*** |
|                  | [0.012]   | [0.002]  | [0.001]   | [0.003]   | [0.010]   | [0.012]  | [0.015]   | [0.017]  |
| ln (1 + Immigration) | -0.001   | 0.000    | 0.002     | -0.001    | -0.003*** | -0.002*  | -0.001    | -0.005*** |
|                  | [0.001]   | [0.001]  | [0.001]   | [0.002]   | [0.001]   | [0.001]  | [0.002]   | [0.002]  |
| ln (1 + Emigration) | 0.001    | 0.002    | 0.000     | -0.002    | 0.002**   | 0.003**  | 0.001     | 0.000    |
|                  | [0.001]   | [0.002]  | [0.001]   | [0.003]   | [0.001]   | [0.001]  | [0.001]   | [0.002]  |
| Log pseudolikelihood | -2.3.E+09| -3.2.E+09| -8.4.E+09| -5.5.E+09| -2.3.E+09| -3.2.E+09| -8.5.E+09| -5.4.E+09|
| Pseudo R-squared | .9957     | .9949    | .9963     | .9912     | .9957     | .9949    | .9962     | .9915    |
| Number of obs.   | 14,800    | 15,580   | 12,564    | 17,764    | 14,800    | 15,580   | 12,564    | 17,764    |

Notes: This table reports the estimation results by the PPML method. ***, ** and *1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for country-pair fixed effects and trade flow-year fixed effects. ‘COVID’ indicates the number of confirmed cases (Cases) or deaths (Deaths).
Lastly, we conduct two more analyses. First, to investigate the role of cultural or historical linkages, we introduce the interaction terms with the dummy for past colonial ties, the data of which are obtained from the CEPII website, as in the case of geographical distance. The estimation results are presented in Table A2 in the Appendix. Most coefficients were estimated to be non-significant. We can see significant results mainly for trade in medical supplies in the case of deaths, which indicates that countries import those products from countries with past colonial ties but are less likely to export to such countries. Second, as found in Table 1, China is a key player in the trade of medical products. Thus, in Tables A3–A6, we estimate our models by excluding China. Although the significance becomes weaker in the interaction term with RTAs, the other results do not change much.

| Table 7 | Heterogenous impacts: Geographical linkages |
|---------|--------------------------------------------|
| | Equipment | Supplies | Medicines | Personal |
| (i) Cases | | | | |
| Importer COVID | $-0.052$  | $-0.140^{***}$  | $-0.114^{**}$  | $-0.299^{***}$  |
| [0.056]  | [0.051]  | [0.048]  | [0.071]  |
| ln Distance | $0.008$  | $0.015^{***}$ | $0.012^{**}$  | $0.040^{***}$  |
| [0.006]  | [0.005]  | [0.006]  | [0.009]  |
| Exporter COVID | $0.034$  | $0.065$  | $0.079$  | $0.1$  |
| [0.046]  | [0.041]  | [0.049]  | [0.066]  |
| ln Distance | $-0.006$  | $-0.011^{**}$ | $-0.012^{**}$ | $-0.018^{**}$ |
| [0.005]  | [0.005]  | [0.006]  | [0.008]  |
| Log pseudolikelihood | $-2.5.E+09$  | $-3.3.E+09$  | $-8.4.E+09$  | $-7.8.E+09$  |
| Pseudo $R^2$-squared | $0.9954$  | $0.9946$  | $0.9963$  | $0.9876$  |
| Number of obs. | $14,800$  | $15,580$  | $12,564$  | $17,764$  |
| (ii) Deaths | | | | |
| Importer COVID | $-0.058$  | $-0.107^{***}$ | $-0.082^{*}$ | $-0.283^{***}$ |
| [0.042]  | [0.039]  | [0.046]  | [0.063]  |
| ln Distance | $0.009^{*}$  | $0.011^{***}$ | $0.009$  | $0.039^{***}$ |
| [0.005]  | [0.004]  | [0.005]  | [0.008]  |
| Exporter COVID | $0.046$  | $0.046$  | $0.062$  | $0.055$  |
| [0.038]  | [0.032]  | [0.045]  | [0.054]  |
| ln Distance | $-0.006$  | $-0.008^{**}$ | $-0.009^{*}$ | $-0.009$  |
| [0.004]  | [0.004]  | [0.005]  | [0.007]  |
| Log pseudolikelihood | $-2.5.E+09$  | $-3.4.E+09$  | $-8.4.E+09$  | $-7.9.E+09$  |
| Pseudo $R^2$-squared | $0.9953$  | $0.9945$  | $0.9962$  | $0.9875$  |
| Number of obs. | $14,800$  | $15,580$  | $12,564$  | $17,764$  |

Notes: This table reports the estimation results by the PPML method. $^{***}$, $^{**}$ and $^{*}$1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for country-pair fixed effects and trade flow-year fixed effects. ‘COVID’ indicates the number of confirmed cases (Cases) or deaths (Deaths).
CONCLUDING REMARKS

This study empirically investigated what kinds of countries imported and exported medical products during the COVID-19 pandemic. To that end, we examined the bilateral trade values of medical products among 35 reporting countries and 250 partner countries between January and August in both 2019 and 2020. Our findings can be summarised as follows. An increase in COVID-19 burden led to decreases in exports of medical products. However, such a decrease is smaller when exporting to countries with political ties or economic ties or to neighbouring countries. In contrast, demographic ties are critical in the import of medical products, especially personal protective products such as face masks. In sum, our analyses may indicate that medical products are likely to be exported based on political or economic incentives during the pandemic, whereas identity or demographic ties play a key role in the import of such products.

These findings also contribute to the debate on foreign aid, including health diplomacy in international relations. Traditionally, strategic relationships and economic relations have been the most influential factors in foreign aid. However, our findings indicate that the decision makers of donor states and migrants’ homelands also influence the demographic ties based on identity and geographical proximity during crises. During a global pandemic, it is crucial for decision makers to explain to their people the need to prioritise domestic politics and national security because the public will demand that the crisis be addressed in their own country first. Clarifying their policy stance legitimises sending essential goods such as medical products to other countries that are home to diaspora and migrant populations. Also, given that COVID-19 is a life-threatening disease, emigrants may engage more actively in demanding that medical products be sent to their home country. In addition, caring for neighbouring countries is the first step towards preventing possible external threats, such as the entry of infected people. COVID-19 may accelerate foreign policy’s subordination to domestic politics.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from IHS Markit. Restrictions apply to the availability of these data, which were used under license for this study.

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### APPENDIX A

#### TABLE A1  Basic statistics

|                         | Obs.     | Mean    | Std. dev. | Min  | Max  |
|-------------------------|----------|---------|-----------|------|------|
| Importer COVID          | 17,764   | 4.831   | 5.354     | 0    | 15.607 |
| Agreement               | 15,376   | 1.538   | 3.718     | 0    | 15.607 |
| RTA                     | 17,764   | 1.821   | 4.025     | 0    | 15.607 |
| ln (1 + Immigration)    | 17,764   | 20.851  | 40.611    | 0    | 253.719 |
| ln (1 + Emigration)     | 17,764   | 21.020  | 39.033    | 0    | 223.430 |
| ln Distance             | 17,764   | 41.926  | 46.864    | 0    | 151.808 |
| Colony                  | 17,764   | 0.125   | 1.037     | 0    | 12.118 |
| Exporter COVID          | 17,764   | 5.047   | 5.498     | 0    | 15.607 |
| Agreement               | 15,376   | 1.576   | 3.786     | 0    | 15.607 |
| RTA                     | 17,764   | 1.901   | 4.149     | 0    | 15.607 |
| ln (1 + Immigration)    | 17,764   | 20.434  | 39.060    | 0    | 223.430 |
| ln (1 + Emigration)     | 17,764   | 22.452  | 41.564    | 0    | 253.719 |
| ln Distance             | 17,764   | 43.813  | 48.152    | 0    | 151.708 |
| Colony                  | 17,764   | 0.142   | 1.129     | 0    | 12.118 |

*Note:* In this table, we compute the basic statistics for explanatory variables by using the observations for personal protective products.
|                | Equipment | Supplies | Medicines | Personal |
|----------------|-----------|----------|-----------|----------|
| **(i) Cases**  |           |          |           |          |
| Importer COVID  | 0.016     | −0.012   | −0.007    | 0.053**  |
|                | [0.012]   | [0.010]  | [0.007]   | [0.023]  |
| Colony         | −0.020*   | 0.015    | −0.017    | −0.028   |
|                | [0.010]   | [0.011]  | [0.029]   | [0.028]  |
| Exporter COVID | −0.015**  | −0.031***| −0.025*** | −0.051***|
|                | [0.007]   | [0.005]  | [0.009]   | [0.013]  |
| Colony         | 0.015     | −0.013   | 0.017     | −0.001   |
|                | [0.009]   | [0.009]  | [0.023]   | [0.023]  |
| Log pseudolikelihood | −2.5.E+09 | −3.4.E+09 | −8.5.E+09 | −1.0.E+10 |
| Pseudo R-squared | .9953       | .9945    | .9962     | .9838    |
| Number of obs. | 14,800    | 15,580   | 12,564    | 17,764   |
| **(ii) Deaths**|           |          |           |          |
| Importer COVID  | 0.016     | −0.011   | −0.009    | 0.055**  |
|                | [0.010]   | [0.009]  | [0.006]   | [0.024]  |
| Colony         | −0.01     | 0.025**  | −0.014    | −0.024   |
|                | [0.015]   | [0.011]  | [0.029]   | [0.028]  |
| Exporter COVID | −0.004    | −0.026***| −0.018**  | −0.034***|
|                | [0.008]   | [0.005]  | [0.009]   | [0.012]  |
| Colony         | 0.002     | −0.022** | 0.013     | −0.016   |
|                | [0.012]   | [0.009]  | [0.021]   | [0.022]  |
| Log pseudolikelihood | −2.5.E+09 | −3.5.E+09 | −8.5.E+09 | −1.0.E+10 |
| Pseudo R-squared | .9953       | .9944    | .9962     | .9837    |
| Number of obs. | 14,800    | 15,580   | 12,564    | 17,764   |

**Notes:** This table reports the estimation results by the PPML method. ***, ** and *1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for country-pair fixed effects and trade flow-year fixed effects. ‘COVID’ indicates the number of confirmed cases (Cases) or deaths (Deaths).
### Table A3: Heterogenous impacts by political linkages: Excluding China

|                | Equipment | Supplies | Medicines | Personal |
|----------------|-----------|----------|-----------|----------|
| Importer COVID |           |          |           |          |
|                | 0.028*    | −0.011   | −0.004    | 0.017*   |
|                | [0.016]   | [0.008]  | [0.010]   | [0.010]  |
| Agreement      |           |          |           |          |
|                | −0.028**  | −0.011   | −0.015    | −0.037***|
|                | [0.012]   | [0.008]  | [0.015]   | [0.011]  |
| Exporter COVID |           |          |           |          |
|                | −0.004    | −0.023***| −0.030*** | −0.045***|
|                | [0.009]   | [0.005]  | [0.009]   | [0.012]  |
| Agreement      |           |          |           |          |
|                | 0.023**   | 0.008    | 0.019     | 0.033*** |
|                | [0.011]   | [0.008]  | [0.015]   | [0.010]  |
| Log pseudolikelihood | −1.3.E+09 | −2.1.E+09 | −7.6.E+09 | −1.3.E+09 |
| Pseudo $R^2$  | .9966     | .996     | .9963     | .9954    |
| Number of obs. | 12,332    | 13,102   | 10,930    | 14,684   |

Notes: This table reports the estimation results by the PPML method. ***, ** and *1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for country-pair fixed effects and trade flow-year fixed effects. ‘COVID’ indicates the number of confirmed cases (Cases) or deaths (Deaths).

### Table A4: Heterogenous impacts by economic linkages: Excluding China

|                | Equipment | Supplies | Medicines | Personal |
|----------------|-----------|----------|-----------|----------|
| Importer COVID |           |          |           |          |
|                | 0.016*    | −0.006   | −0.004    | 0.003    |
|                | [0.009]   | [0.006]  | [0.007]   | [0.007]  |
| RTA            |           |          |           |          |
|                | 0.01      | −0.012   | −0.019*   | −0.015   |
|                | [0.015]   | [0.010]  | [0.011]   | [0.011]  |
| Exporter COVID |           |          |           |          |
|                | −0.002    | −0.029***| −0.033*** | −0.039***|
|                | [0.010]   | [0.006]  | [0.008]   | [0.007]  |
| RTA            |           |          |           |          |
|                | −0.008    | 0.007    | 0.020*    | 0.012    |
|                | [0.011]   | [0.009]  | [0.011]   | [0.010]  |
| Log pseudolikelihood | −1.5.E+09 | −2.3.E+09 | −7.9.E+09 | −1.5.E+09 |
| Pseudo $R^2$  | .9964     | .9958    | .9963     | .9951    |
| Number of obs. | 14,160    | 14,930   | 12,042    | 17,002   |

Notes: This table reports the estimation results by the PPML method. ***, ** and *1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for country-pair fixed effects and trade flow-year fixed effects. ‘COVID’ indicates the number of confirmed cases (Cases) or deaths (Deaths).
### TABLE A5  Heterogenous impacts by demographic linkages: Excluding China

|                  | Equipment | Supplies  | Medicines | Personal |
|------------------|-----------|-----------|-----------|----------|
| Importer COVID   | −0.006    | 0.018*    | 0.015     | −0.018** |
|                  | [0.010]   | [0.010]   | [0.012]   | [0.007]  |
| ln (1 + Immigration) | 0.000     | −0.002*** | −0.002    | −0.001   |
|                  | [0.001]   | [0.001]   | [0.002]   | [0.001]  |
| ln (1 + Emigration) | 0.001     | −0.001    | −0.001    | 0.003*   |
|                  | [0.001]   | [0.001]   | [0.001]   | [0.001]  |
| Exporter COVID   | −0.008    | −0.048*** | −0.042*** | −0.033***|
|                  | [0.009]   | [0.012]   | [0.015]   | [0.008]  |
| ln (1 + Immigration) | 0.000     | 0.002**   | 0.001     | 0.000    |
|                  | [0.001]   | [0.001]   | [0.001]   | [0.001]  |
| ln (1 + Emigration) | 0.000     | 0.001     | 0.001     | −0.001   |
|                  | [0.001]   | [0.001]   | [0.001]   | [0.001]  |
|                   | Log pseudolikelihood | −1.4.E+09 | −2.3.E+09 | −7.9.E+09 | −1.5.E+09 |
|                   |           | [0.009]   | [0.012]   | [0.015]   | [0.008]  |
|                   | Pseudo R-squared | .9966     | .9958     | .9963     | .9952    |
| Number of obs.   | 14,160    | 14,930    | 12,042    | 17,002   |

Notes: This table reports the estimation results by the PPML method. ***, ** and *1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for country-pair fixed effects and trade flow-year fixed effects. ‘COVID’ indicates the number of confirmed cases (Cases) or deaths (Deaths).

### TABLE A6  Heterogenous impacts by geographical linkages: Excluding China

|                  | Equipment | Supplies | Medicines | Personal |
|------------------|-----------|----------|-----------|----------|
| Importer COVID   | 0.032     | −0.075** | −0.112**  | −0.130***|
|                  | [0.049]   | [0.038]  | [0.049]   | [0.042]  |
| ln Distance      | −0.001    | 0.008*   | 0.012**   | 0.015*** |
|                  | [0.005]   | [0.004]  | [0.006]   | [0.005]  |
| Exporter COVID   | −0.011    | 0.03     | 0.073     | 0.084**  |
|                  | [0.035]   | [0.031]  | [0.051]   | [0.037]  |
| ln Distance      | 0.001     | −0.006*  | −0.012**  | −0.014***|
|                  | [0.004]   | [0.004]  | [0.006]   | [0.005]  |
|                   | Log pseudolikelihood | −1.5.E+09 | −2.3.E+09 | −7.9.E+09 | −1.5.E+09 |
|                   |           | [0.009]   | [0.012]   | [0.015]   | [0.008]  |
|                   | Pseudo R-squared | .9964     | .9958     | .9963     | .9952    |
| Number of obs.   | 14,160    | 14,930    | 12,042    | 17,002   |

Notes: This table reports the estimation results by the PPML method. ***, ** and *1%, 5% and 10% levels of statistical significance respectively. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for country-pair fixed effects and trade flow-year fixed effects. ‘COVID’ indicates the number of confirmed cases (Cases) or deaths (Deaths).