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Mask Wars:

China's Exports of Medical Goods in Times of COVID-19

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Abstract

The COVID-19 outbreak has cut China's supply of and raised the world's demand for face masks, disinfectants, ventilators, and other critical medical goods. This article studies the economic and political factors that are associated with China's exports of medical equipment during the first two months of the global pandemic. Regression results show that—controlled for demand factors—countries with stronger past economic ties with China import more critical medical goods from China at both the national level and the level of Chinese provinces. Friendly political relations, such as the twinning of provinces, appear to work as a substitute for pre-existing economic ties at the provincial level. These findings imply that, to secure access to medical equipment in crises, countries are well advised to either diversify their sources or to develop closer relations with Beijing and China's provinces.

JEL Codes: F14, F59, H12, H77, H84, P33

Keywords: COVID-19, crisis management, medical equipment, face masks, strategic exports, disaster aid

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> "America first" will not help us to cope with this crisis. [...] The protective materials available here are currently only sufficient for a few days. [...] I therefore ask the People's Republic of China for support.
>
> *Stephan Pusch, Administrator of Heinsberg District, Germany, in an open letter to China's President Xi Jinping, March 23, 2020 (own translation)*

1 Introduction

With the outbreak of the coronavirus disease (COVID-19) hitting the worldwide scale in March 2020, the demand for critical medical equipment has skyrocketed and outstripped the global supply of these goods by far. The global health crisis has transformed simple medical products, such as face masks, gowns, and disinfectants, into very scarce goods.[1] Countries, companies, hospitals, and individuals started competing for these goods—with sometimes questionable means. For example, newspapers reported on April 4th that the United States had "confiscated" masks intended for the German capital Berlin at Bangkok Airport and diverted them to the United States. In response to these events, the Interior Minister of Berlin, Andreas Geisel, spoke of an "act of modern piracy" and demanded that "even in times of global crisis there should be no wild west methods" (The Guardian 2020a). This was everything but an isolated incident. The French Interior Minister Christophe Castaner called the situation within France a *guerre de masques*—a mask war between the local authorities and the state (Le Monde 2020).

China plays the central role in these "mask wars." The emerging economy is the world's largest supplier of such medical equipment. According to UN Comtrade (2020) statistics, 44% of the world's exports of face masks originated from China in 2018, whereas the next largest exporters, Germany (7%) and the United States (6%), play a comparatively minor role. However, while global demand for vital medical equipment from China surged during the outbreak of the pandemic in March 2020, their supply was low due to the shutdown of the Chinese economy. In fact, China itself ran short of medical equipment and was dependent

[1] In the week of March 15th, the global search interest in the topic "masks" outnumbered the interest in otherwise popular topics like "food" and "soccer," according to Google Trends.

on imports in February 2020, when the virus was still mainly within Chinese borders.[2] The European Commission limited its own exports of medical gear in mid-March, which was interpreted as a reaction to uncertainty about Europe's access to medical supplies from China (Bown 2020). This all resulted in fierce competition between countries over *Chinese* medical goods (Evenett 2020).[3]

This article analyzes the drivers of Chinese exports of face masks and other medical equipment in March and April 2020. These are the first two months in which the COVID-19 outbreak was considered a "global pandemic,"[4] and thus global competition over Chinese medical supplies was particularly fierce. The basic gravity model of international trade suggests that China sells more to countries that are economically larger and geographically closer. Moreover, the willingness to pay should depend on the severity of the coronavirus outbreak in a given country. Controlling for these demand factors, we focus on two less obvious drivers of China's medical exports: pre-existing economic ties and political relations.

First, given the reliance of the Chinese economy on trade, we expect that exports of crucial goods build on pre-existing commercial ties, with new trade ties showing a network character (Chaney 2014). In the Chinese context, Liu et al. (2001) observe a "virtuous circle" between trade and foreign direct investment (FDI) in the sense that economic ties in one of the two trigger links in the other. Similarly, Morgan and Zheng (2019) find that past Chinese aid promotes FDI today. We expect a similar effect of pre-existing economic ties when it comes to obtaining China's medical equipment during the pandemic.

Second, we expect that political relations shape China's export pattern of critical medical goods. Beijing has a track record of using trade to pursue its foreign-policy goals (Du et al. 2017, Fuchs 2018). We therefore analyze the extent to which China's exports of such vital goods are linked to the state of political relations with its trade partner countries, both at the national level and the level of Chinese provinces.

The role of political ties in China's exports is likely to be stronger for donations than for

[2]China's production of face masks had been cut by half to ten million per day in early February 2020. A spokeswoman from China's Ministry of Foreign Affairs summarized the situation as follows: "What China urgently needs at present are medical masks, protective suits and safety goggles" (BBC 2020).

[3]For example, The Guardian (2020b) reported on April 3rd that "US buyers waving wads of cash [had] managed to wrest control of a consignment of masks as it was about to be dispatched from China to one of the worst-hit coronavirus areas of France."

[4]The World Health Organization declared a global pandemic on March 11, 2020.
See statement of Director-General Tedros Adhanom Ghebreyesus at https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020 (accessed June 16, 2020).

commercial exports. Previous research shows, for example, that countries who have a close voting alignment with China in the United Nations receive significantly more aid, while countries that recognize the government in Taipei, rather than the one in Beijing, are largely excluded from any aid receipt (Dreher and Fuchs 2015, Dreher et al. 2018). Concerns loom large that Chinese aid spurs corruption and promotes authoritarian norms (Isaksson and Kotsadam 2018, Gehring et al. 2019). China's ambiguous role as an aid donor and as an aid recipient has been particularly prominent during the COVID-19 crisis. While asking for discretion from donors such as the European Union when medical supplies were sent to Hubei Province in January 2020, China successfully turned its own giving in March into a media campaign (Popescu 2020).

To test our predictions, this article analyzes China's export pattern of critical medical goods using monthly dyadic trade data from the General Administration of Customs of the People's Replublic of China (GACC 2020), published at the level of pairs of Chinese provinces and partner countries. Specifically, we test whether previous economic linkages through trade and investment, as well as political relations (including aid and donations to China in the early phases of the medical crisis and sister linkages of provinces) are associated with the export pattern.

Our results show significant positive correlations between past trade ties and the value of exported medical equipment at the country level. With the exception of aid and donations, exports of medical equipment, do not appear to follow political factors at the national level. Since this non-finding could be the result of aggregation and omitted-variable biases, we carry out dyadic regressions that exploit variation between province-country pairs only, while controlling for country and province fixed effects. Country fixed effects fully capture demand factors, such as the degree of affectedness by the COVID-19 pandemic. Province fixed effects fully capture supply factors, such as the production capacities of the medical industry in Chinese provinces. This allows us to move closer to a causal interpretation of our results. In the dyadic setting, we observe that countries can source more than double the amount of donations from sister provinces than they would obtain otherwise. Moreover, China reciprocates past aid receipts through significantly larger exports of medical equipment. Interactions with economic linkages further suggest that political ties can compensate a lack of past economic ties.

Our paper builds on previous research in economics and political science that discusses the extent to which political relations matter for international commerce (Hirschman 1945, Baldwin 1985). In a seminal contribution, Pollins (1989) develops a public-choice model in

which importers reward political friends through trade increases and punish adversaries through trade reductions. A subsequent stream of research documents that diplomatic relations, as operationalized by embassies and state visits, can foster bilateral trade (Nitsch 2007, Rose 2007).[5] While interlinked supply chains as well as bilateral and multilateral trade agreements could prevent governments from politicizing trade due to sunk costs (Davis and Meunier 2011), the persistent government control over economic activities may explain why Chinese trade still follows the flag (Davis et al. 2019). Consumer reactions to the state of bilateral relations are another mechanism through which politics affects commerce (Pandya and Venkatesan 2016).

Recent empirical evidence indeed suggests that Chinese trade has remained politicized in the aftermath of bilateral tensions. Political tensions caused by governments receiving the Dalai Lama lead to a reduction of their countries' exports to China (Fuchs and Klann 2013), which appears to mainly operate through state-owned enterprises (Lin et al. 2019). Various episodes of Sino-Japanese tensions also led to substantial declines in Chinese imports from Japan (Fisman et al. 2014, Heilmann 2016).

This paper distinguishes itself from the bulk of the literature in that it studies the role of politics in *export* decisions in the face of an unprecedented global surge in demand for medical goods.[6] There are reasons to expect that exports would be less likely to be politicized than imports, as export restrictions are considered to be costlier from the sender's perspective. Nevertheless, given the extent to which the Chinese state controls the production of medical equipment, we expect to observe a politicization of its export decisions. Tellingly, China's state-owned enterprises, including PetroChina and Sinopec, entered the mask business in February 2020 and jointly produced up to 38.5 metric tons of mask components per day (Lo 2020).

The major innovation of our paper is that we analyze the effects of contemporaneous international political relations on trade at the provincial level. Previous decentralization efforts (e.g., Jin et al. 2005) strengthen the expectation that subnational economic and political ties play a substantial role for trade. While Che et al. (2015) also analyze political factors in Chinese trade at the provincial level, they focus on political tensions rooted in history. They find that Chinese provinces that suffered more casualties during the Japanese Invasion from 1937 to 1945 trade less with Japan "today" (in 2001). Our paper in contrast focuses on contemporaneous

[5] See Moons and van Bergeijk (2017) for a meta analysis on the trade effects of economic diplomacy.

[6] In comparison to the large literature on the politicization of import decisions, relatively few studies exist that study political influences on export decisions. Exceptions include work on weapon embargoes and export restrictions on strategic technologies (e.g., Crozet and Hinz 2020, DellaVigna and La Ferrara 2010).

political relations and investigates friendly relations, such as donations and sister linkages of provinces at the provincial level. Moreover, our empirical design outperforms cross-country regressions and moves us closer to a causal interpretation of estimation results.

We proceed as follows. In Section 2, we analyze the cross-country pattern of China's exports of medical equipment to the rest of the world during the first two months of the COVID-19 pandemic. Section 3 moves to the provincial level and investigates the dyadic drivers of exports. We give our conclusions in Section 4.

2 Cross-country patterns of Chinese medical exports

2.1 Descriptive evidence

To study China's export patterns of medical equipment during the first months of the global COVID-19 pandemic, we rely on official monthly dyadic export data for all commodities for pairs of Chinese provinces and trade partner countries (GACC 2020). We identify 80 medical commodities (at the 6-digit level of the Harmonized System, HS6) that were classified as "critical" by the World Customs Organization and the World Health Organisation in regards to the pandemic (WCO/WHO 2020). For descriptive purposes, as well as for further robustness checks, we also rely on an alternative list of 11 medical products. These products are measured at the 8-digit level (HS8) and were deemed essential by the Chinese government for COVID-19 treatment and control.[7] Our main dependent variable measures *Total medical exports* from China during March and April 2020 (aggregating over 80 HS6 product categories). We further decompose these trade flows into *Commercial medical exports* and *Donation medical exports*, and also consider selected medical equipment, *Masks* and *Ventilators*, separately (measured at HS8 level).

As a result of the COVID-19 pandemic, China's exports of disinfectants and masks both increased by more than 1,000% and exports of ventilators almost tripled from March and April 2019 to March and April 2020 (see also Figure C.1 in the Online Appendix). Table D.1 in the Online Appendix lists 11 essential medical products (according to Chinese definitions) together with their aggregate value, quantity, average price, the most important exporting province, and the top three importing countries. Surgical masks top the list of essential medical equipment in terms of total export value, followed by surgical shoe covers and surgical gowns. Infrared

[7] See Online Appendix A for more detailed information on all variables used as well as coding procedures and data sources.

thermometers and ventilators are the two top traded items amongst the more complex medical equipment. From the 11 essential products, ventilators are by far the most expensive (with average unit prices of about US$ 2,500), reflecting their relatively larger complexity. For all 11 products, the United States is the most important importer, typically followed by Germany or Japan. In our product-specific regressions, we especially focus on surgical masks (as the most exported product) as well as ventilators (as the most complex and highest unit value product among the top-traded pieces of medical equipment), both of which received special and widespread global attention. The huge predominance of masks among the key supplies and the strong government interference led to frequent references to a new "mask diplomacy," whereas ventilator shortages were a major policy issue at the beginning of the pandemic (Hornung 2020).

Among total medical exports, commercial trade constitutes the major bulk (with 99%), whereas donations (with 1%) are of a minor economic importance, but of a much larger symbolic value. Donations of medical products in March and April 2020 increased by more than 400% relative to the same period in 2019, while commercial exports of medical products nearly doubled in the same reference period (see again Figure C.1 in the Online Appendix). The two world maps in Figure 1 show that there is virtually no country that did not import critical medical goods from China in March and April of 2020. Medical donations were also widely spread globally. On aggregate, the top commercial importers, as in the case of selected products, include the largest economies and are strongly dominated by the United States, followed by Japan and Germany. By contrast, the list of countries who receive the greatest amount of medical donations is led by Ethiopia, Italy, the United States, Hungary, South Korea, and Luxembourg. It thus includes smaller and/or economically less advanced countries. Some countries on the list of aid beneficiaries were especially affected by an earlier outbreak (like Italy or Luxembourg). For other top beneficiaries (like Ethiopia or Hungary), this new "mask diplomacy " must have followed other political and economic motives that go beyond a simple targeting of the largest humanitarian needs (Hornung 2020).

2.2 Econometric model and variables

We first run simple regression models at the cross-country level to analyze descriptively which trading partner country characteristics are more closely associated with the volume of Chinese exports of medical equipment at the beginning of the pandemic. We estimate the following

regression equation:

$$Y_j = \alpha + \beta X_j + \epsilon_j, \tag{1}$$

where Y_j denotes the inverse hyperbolic sine of the value of Chinese medical exports to partner country j in March and April 2020, X_j is a vector of explanatory variables introduced below, and ϵ_j is an error term.[8] We run separate regressions for total exports, commercial exports, and donations, and report results also for masks and ventilators.

The vector X_j includes four sets of explanatory variables, capturing bilateral economic ties, bilateral political ties, proxies for the demand for medical equipment, and typical gravity controls. We expect that both past economic and political ties make it more likely that medical equipment is sourced from China. We capture the importance of past economic ties for the sourcing of medical equipment by controlling for past trade and investment linkages. We measure past trade in the form of medical exports (decomposed into commercial exports and donations) as well as non-medical exports during the same months of the previous year (March and April 2019). While past medical exports capture the existence of direct trade linkages within the same sector, non-medical exports account for more generic trade ties. Focusing on the same months of the year helps to deal with seasonality-induced variations in trade flows. We measure investment linkages by the average annual value of *Inward FDI* flows by partner countries in China from 2015 to 2017 (MOFCOM 2019).

We measure four dimensions of bilateral political ties. *UN voting distance* captures past political (mis-)alignment between partner countries and China (Bailey et al. 2017). This measure exploits differences in voting behavior between China and its trade partners within the United Nations General Assembly (UNGA) between 2017 and 2019 and has been widely used to capture bilateral political relationships (see e.g., Allen et al. 2020, Rommel and Schaudt 2020). *Recognition of Taiwan* indicates whether a country recognizes the government in Taipei on Taiwan rather than the one in Beijing. Since China considers such diplomatic ties a breach of its so-called "One-China policy," we expect this proxy to capture a relevant indicator of a strenuous political relationship with China (e.g., Johnston et al. 2015).

As a further proxy of the quality of bilateral diplomatic ties, *Donations to China in Jan.-*

[8] All monetary values are measured in US$. We compute all log transformations by applying an inverse hyperbolic sine transformation, which is defined as $\sinh^{-1}(x) = \ln(x + \sqrt{x^2 + 1})$, is continuous through zero, and is well approximated for larger values by a log transformation.

Feb. of 2020 capture the total value of all donations made by partner countries at the peak of the Chinese health crisis. Within the first two months of 2020, the United States had exported the most aid to China (US$ 19.3 million), followed by South Korea and Japan. Altogether 112 countries donated goods to China, including many instances of South-South cooperation. Countries donated mostly medical equipment (96% of total donation imports), but our measure also includes other donations, like that of 30,000 sheep by Mongolia (Damdinsuren and Namjildorj 2020). We expect that such donations may have been systematically followed up by reciprocal diplomatic gestures. For instance, the New York Times (2020) cites an official from the Ministry of Commerce in Beijing stating: "In the previous stage of prevention and control, many countries have offered to help us, and we are willing to offer affected countries our share of help while we can."

The fourth dimension of political ties, *Sister linkages*, identifies countries that maintain at least one sister relationship to a Chinese province (Liu and Hu 2018). More than half of all countries fall into this category (51%). Sister province relations have evolved from other areas such as education towards trade (Mascitelli and Chung 2008) as, for example, in the case of the German State Schleswig-Holstein and Zhejiang Province (Liu and Hu 2018). This way, sister linkages measure broader political relationships, which extend to personal bonds and communication channels through liaison offices and among firms. Those may increase the exchange of medical equipment beyond an existing trade relationship. Anecdotal evidence suggests that sister relations have been helpful to attract Chinese medical equipment during the COVID-19 pandemic: Many Chinese provinces sent masks or other medical equipment to their respective sister entity, such as Fujian province to the US state Oregon, or Hunan province to the UK county of Lincolnshire (People's Daily 2020, The Lincolnite 2020).

In terms of demand factors, *COVID-19 infection rates* control for the urgent need of medical equipment by measuring the spread of the pandemic in each importing country by the end of April 2020 (Wahltinez 2020). We recognize, however, that this variable is likely to suffer from substantial measurement error as testing and reporting practices vary greatly across countries (Bommer and Vollmer 2020, Stock 2020). We control for *Government effectiveness* as it may have also affected early demand for medical products by determining the extent to which governments were capable to take early response measures in face of a global health crisis (Kaufmann et al. 2011). Finally, we control for the typical variables that enter a gravity model of trade, such as logged partner-country GDP and population size (Azevedo 2011, World Bank

2020), as well as geographic distance and contiguity (Mayer and Zignago 2011).

2.3 Results

Table 1 reports the cross-country regression results. Column 1 refers to all medical exports in March and April of 2020, combining 80 medical products according to the HS6 classification by the WCO/WHO. Columns 2 and 3 split total exports into commercial exports and donations. The last two columns repeat the same regressions for masks and ventilators.

Results generally confirm that past economic ties matter for sourcing medical equipment in the face of the pandemic. Commercial exports seem to build not only on past ties of medical exports, but also depend positively on other prior non-medical export links. In column 2, the estimated elasticity of new medical trade w.r.t. previous non-medical exports (0.5%) is larger than w.r.t. previous medical exports (0.2%). This finding is very much in line with the anecdotal evidence that has been widely reported about various Chinese businesses with global links switching into the medical equipment trade (Financial Times 2020).

Donations follow a somewhat different logic (see column 3). Instead of following past commercial ties, they build on past donation trade links, which points towards a more sustained foreign aid relationship from China. By contrast, generic non-medical trade links do not seem to matter for donations. When analyzing the exports of the two signature goods only, we observe again that countries which have had past trade relations with China source significantly more goods from China in the times of supply shortages as well. Product-specific trade ties matter for procuring ventilators (column 4) and total commercial medical goods trade matters for masks (column 3). Our alternative measure of economic linkages, past FDI flows to China, is not consistently related to medical exports at the cross-country level, and is even marginally negatively correlated with the export of masks.

The reliance of medical commercial exports on past trade ties contrasts the political variables, none of which seem to be relevant for explaining where commercial medical exports go on aggregate. China appears to be exporting medical equipment to "friends" and "foes" alike. By contrast, political factors matter crucially though for donations. Countries with sister linkages to Chinese provinces receive substantially more donations of medical equipment, whereas countries that recognize Taiwan do not receive any donations from China at all (which results in very large coefficients in column 3). Among the political variables, it is only the ideal point distance in UNGA voting that is not significantly linked to Chinese donations after the outbreak of the

global pandemic.

Turning to demand factors, we observe that more Chinese exports of medical equipment go into countries with higher COVID-19 infection rates. Despite the substantial scope for measurement error in infection rates, the estimated coefficient is positive and statistically significant at the one-percent level for total, commercial, and mask trade. It is remarkable that Chinese donations of medical equipment do not appear to respond to the severity of the pandemic. Political calculus appears to dominate here. Finally, trading partners' government effectiveness is not linked to overall Chinese medical exports, but more effective governments have been sourcing more masks over March and April 2020 from China.[9]

Further product-specific results on masks and ventilators in Table D.5 in the Online Appendix show that most of the observed effects are driven by variation in quantities, whereas there is little correlation of bilateral economic and political relations with average prices. The only highly significant factor explaining mask prices is the partner country's COVID-19 infection rate. It thus appears that countries with extremely high demand were willing to pay a substantial surcharge for masks at the height of the first global outbreak. This indication of price discrimination yields some support to the anecdotal evidence on a "bidding war" for masks.

Summing up our cross-country results, we find that past trade ties are associated with larger commercial exports of critical medical goods during the early months of the pandemic. Political ties appear to play a role for donations only. However, the absence of evidence for a role of politics in China's medical exports may be driven by an aggregation bias. This is why we now investigate the regional political economy of China's exports, focusing on Chinese provinces.

3 The regional sourcing of Chinese medical exports

3.1 Descriptive evidence

So far we treated China as an aggregate. However, the production of medical equipment is widely spread across China. Figure 2 shows the geographical distribution of the regional sourcing of medical exports within China, again split into commercial exports and donation exports. While Beijing and the coastal regions in the Southeast dominate as exporters of medical equipment, all Chinese provinces export at least some medical equipment, including both commercial trade and

[9] Disaggregating results into March and April in Tables D.3 and D.4 in the Online Appendix reveals that needs and government effectiveness particularly play a role in April, when infections peaked in high-income countries.

donation exports. The largest commercial exporter in March and April 2020 was Guangdong Province (20%), whereas Beijing provided the largest share of medical donations (34%). At the beginning of the crisis, the regional sourcing of medical equipment became more widely spread as compared to one year before. The Herfindahl-Hirschman Index of exporter market concentration across Chinese provinces went down from 0.16 to 0.12 in the case of masks, and from 0.31 to 0.16 in the case of ventilators. This suggests that the pandemic led to a significant creation of new trade links. The substantial sub-national variation in bilateral trade linkages allows us to study the importance of past economic and political ties at the level of Chinese provinces.

3.2 Econometric models and variables

We investigate the sourcing of medical equipment exports within China by estimating the following dyadic trade model:

$$Y_{ij} = \delta_1 E_{ij} + \delta_2 P_{ij} + \theta_i + \rho_j + \epsilon_{ij}, \tag{2}$$

where Y_{ij} denotes the inverse hyperbolic sine of the the value of medical equipment exported from Chinese province i to partner country j, E_{ij} and P_{ij} denote dyadic explanatory variables introduced below, and θ_i and ρ_j are fixed effects for Chinese provinces and trade partner countries, respectively.[10]

The major advantage of this model over the previous cross-country regression is that we can now control for unobserved province-of-origin and destination-country factors. Province fixed effects, θ_i, account for the average differences across Chinese provinces in their supply of medical equipment to the rest of the world and their average trade openness. They thus absorb cross-province variation in the location of medical industries within China and in general market access. They also capture variation in the extent to which Chinese provinces were affected by the pandemic themselves, which may have also reduced their ability or willingness to export critical medical goods. Country fixed effects, ρ_j, capture variation in the total level of medical equipment bought from China by each partner country j. They thus fully capture differences in demand across China's trade partners, as well as all other political and economic determinants that drive aggregate trade relations between China and each country (e.g., geographic distance

[10]Table D.6 in the Online Appendix provides descriptive statistics for all variables used in the dyadic analysis.

and trade agreements). This stricter specification allows us to focus on the within-country sourcing of exports and, by that, to move closer to a causal interpretation of our coefficients.[11] As we now focus on the variation across province-country pairs, we can isolate the effects of past bilateral linkages on the regional sourcing of China's medical exports.

Our vectors of measures of bilateral economic relations, E_{ij}, and political relations, P_{ij}, build on the economic and political proxies that we used in the cross-country analysis and that also have a dyadic component that varies across province-country pairs. We measure bilateral economic ties, E_{ij}, by the inverse hyperbolic sine of past medical and non-medical export values during the same months (March and April) of the previous year, from China's province i to country j. We again distinguish between commercial exports, donations, and non-medical exports. As a further proxy for economic linkages between trading partners and Chinese provinces, we employ the inverse hyperbolic sine of the average annual value of FDI inflows over the years 2015 to 2017, originating from partner country j and targeting province i.

We capture bilateral political ties, P_{ij}, with two variables. First, we use the (transformed) value of donations from each partner country j to province i in January and February 2020. Second, we include a binary variable that takes the value of one if a province i has a sister linkage with country j. In line with our earlier reasoning, we expect that foreign donations trigger reciprocal behavior, whereas sister linkages capture a wide range of dyadic ties built from the past, and both ease the sourcing of medical equipment from the provinces that were receiving those donations.

3.3 Results

The results show that economic ties do not only matter for medical exports at the national level, but also for the sourcing within China. As can be seen from Table 2, all types of medical exports are significantly related to past medical commercial exports and hence build on past commercial ties.[12] In the case of masks and ventilators, past product-specific bilateral trade is among the strongest determinants of dyadic exports, indicating that established commercial

[11] While the cross-sectional setup does not allow us to control for constant province-country-pair characteristics, using previous year's exports as an explanatory variable captures many of those factors. Further robustness tests to capture cultural ties based on dyadic tourism data and country-specific Google search interest in Chinese provinces leave our results unchanged (not reported).

[12] Whereas aggregates in Table 2 refer to the 80 HS6 products listed as critical medical goods by the WCO/WHO, Table D.7 in the Online Appendix reruns the same regressions based on the 11 HS8 products that were selected by China Customs as essential, with qualitatively comparable results.

ties also matter in crisis situations. The additional significance of past commercial medical exports also shows that not only direct but also indirect commercial linkages play a role, and, in the case of masks, the elasticities of past mask and past commercial exports are relatively close to each other (0.28 and 0.21).[13] By contrast, for the sourcing of the much more specialized ventilators, the more generic commercial medical exports matter substantially less than past exports of ventilators (with an elasticity of 0.03 vs. 0.50). While not related to our aggregate export measures, non-medical export ties are even negatively linked to bilateral exports of masks and ventilators.[14] Exports of these special products seem to follow different dyadic routes as their exports in 2019 were also negatively related to contemporaneous non-medical exports (not shown). Donations are building on past donation linkages, whereas past medical donations by Chinese provinces do not result in more commercial exports during the pandemic. Unlike in the aggregate cross-country setting, inward FDI also turns out positive and highly significant. Countries that invested in Chinese provinces in the past sourced significantly more medical supplies from these provinces during the first months of the pandemic in all forms.

In contrast to our results at the aggregate level, we find that political linkages also matter for the sourcing of commercial trade flows. First, Chinese provinces tend to reciprocate donations that they received just two months before, although with relatively low elasticities. A one-percent larger receipt of donations by a province increases total exports of medical equipment from this province by only 0.03 percent. The estimated elasticity is—with an increase of 0.09 percent—larger for donations, but still small. Second, donations of medical equipment are significantly (and substantially) larger to sister countries of Chinese provinces than to countries without such close political ties. Quantitatively, the financial value of donations is more than twice as large (2.66-fold when evaluated at the mean of all other variables) for countries that are connected to the exporting province through a sister relationship. If we analyze the first month of the global pandemic only, the sister-province effect extends to commercial exports in addition to aid and donations (see Tables D.9 and D.10 in the Online Appendix for monthly results).

One mechanism through which past economic and political ties foster exports of medical

[13]The results for commercial ties are robust to the application of a Poisson Pseudo-Maximum-Likelihood estimation (Silva and Tenreyro 2006), which accounts in Table D.8 in the Online Appendix for the larger fraction of zeros in the dyadic setting.

[14]The same negative correlation appears when regressing mask and ventilator exports in 2019 on non-medical exports in 2019. This indicates that selected medical exports are differently spread across countries than generic non-medical export ties would predict.

equipment during the pandemic is related to the creation of new trade linkages. Table D.11 in the Online Appendix focuses on the extensive margin of trade. It restricts the sample to province-country pairs with no previous medical (or product) trade in March and April 2019 and regresses an indicator of new medical trade linkages in March and April 2020 on the same dyadic covariates. Within this subsample, 16% of province-country pairs formed a new medical trade link at the beginning of the pandemic. Columns 1 and 2 for total and commercial medical exports support the notion that more general economic linkages (non-medical exports and inward FDI) matter for the establishment of new trade relations. Both sister linkages and donations to China in early 2020 play a strong role for both donations and masks exports according to columns 3 and 4. In short, in addition to past commercial linkages, political ties matter and facilitate the establishment of new trade ties.

Finally, we explore whether countries were able to compensate for the weakness of their past economic ties with certain provinces with stronger political ties. We rely on a set of interactions by varying the measure of past economic ties (using bilateral medical exports in March and April of 2019 as well as past dyadic inward FDI) and interacting these economic linkages with dyadic political factors (sister linkages and past donations).[15] The results in Table 3 show that, while economic linkages matter in general, they can be compensated with political ties. Bilateral diplomatic relations captured by donations to the province in early 2020 result in significantly more medical exports in the following two months, but at the same time they also reduce the relevance of the previous strength of economic linkages in both specifications. *Sister linkages* show the same pattern and emphasize that economic and political ties are imperfect substitutes. Table D.12 in the Online Appendix examines the robustness of these findings by using total medical exports aggregated across the 11 HS8 products as the dependent variable, and the results are similar.

4 Conclusion

The first weeks of the COVID-19 pandemic revealed the dependence of many economies on vital goods imported from China. Countries entered a race on who can source Chinese medical equipment to secure the sufficient amount of face masks, protective equipment, and ventilators. This article investigated the factors that explain the resulting trade pattern. To do so, we

[15] We present the corresponding regression equation of the interaction model in Online Appendix B.

collected data on trade in critical medical equipment between China and trade partner countries. Controlled for demand factors, we observed significant positive correlations between past trade ties and the value of traded medical equipment at the country level. With the exception of aid and donations, China's exports of medical equipment do not appear to follow political factors. However, this non-finding could be the result of aggregation and omitted-variable biases.

To mitigate these biases, we carried out dyadic regressions that exploit variation between province-country pairs only. Country fixed effects fully captured demand factors, such as the degree of affectedness by the COVID-19 pandemic. Province fixed effects captured supply factors, such as the production capacities of the medical industry in Chinese provinces. In this conservative setting, countries were shown to receive more than double the amount of donations from sister provinces than they would otherwise obtain. Moreover, China reciprocated recent aid receipts through significantly larger exports of medical equipment. Interactions with economic linkages further suggested that political ties can work as substitutes for economic ties.

These findings imply that, to secure access to Chinese medical equipment in crises, countries are well advised to either diversify their sources of strategic goods or to develop closer relations with Beijing and China's provinces. Future research could delve deeper into the role of migrant networks as a facilitator of trade once dyadic diaspora data at the level of Chinese provinces are available. Moreover, rather than exploring the drivers of China's trade in medical equipment, scholars may want to study their effects on attitudes towards China in its trade partner countries. Finally, in light of anecdotal evidence on "poor quality" mask and ventilator exports, future analyses of China's exports of medical equipment could account for quality differences.

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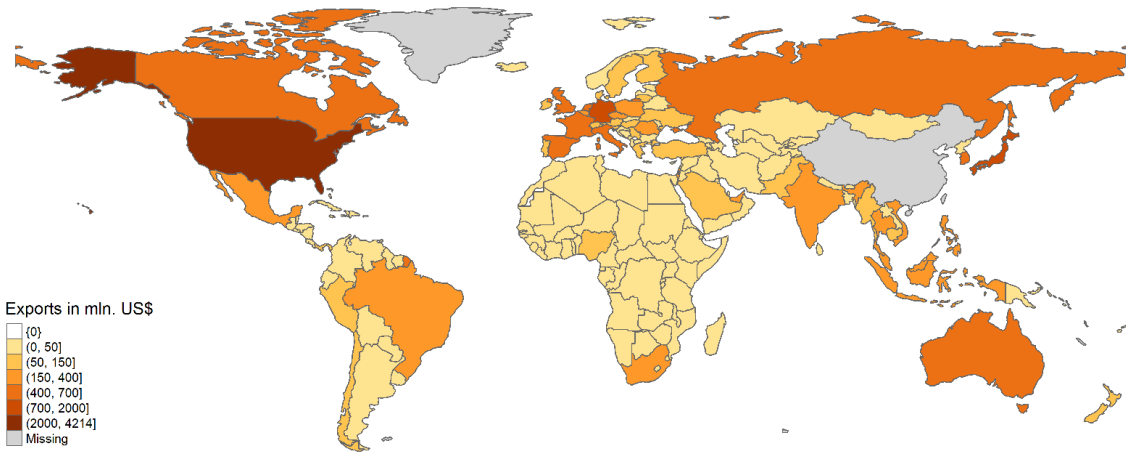
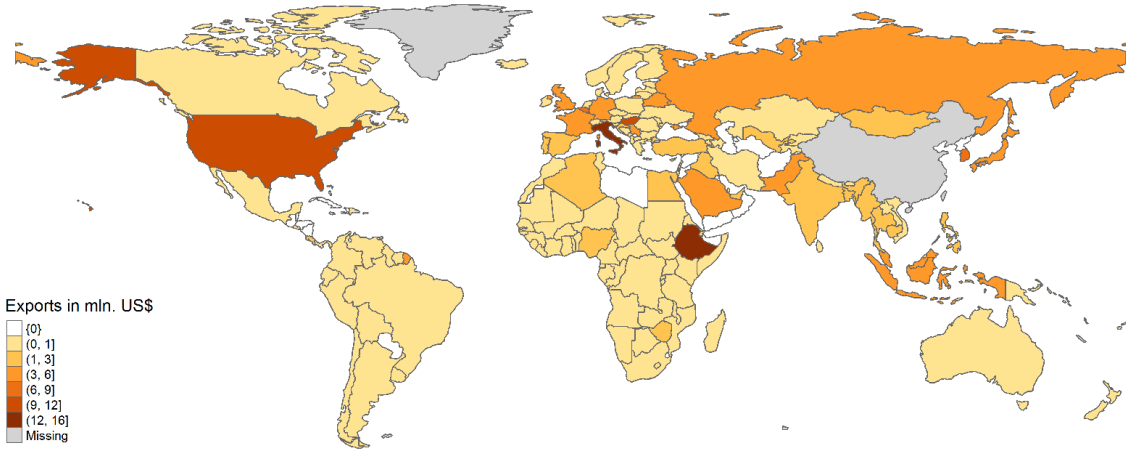
Figures

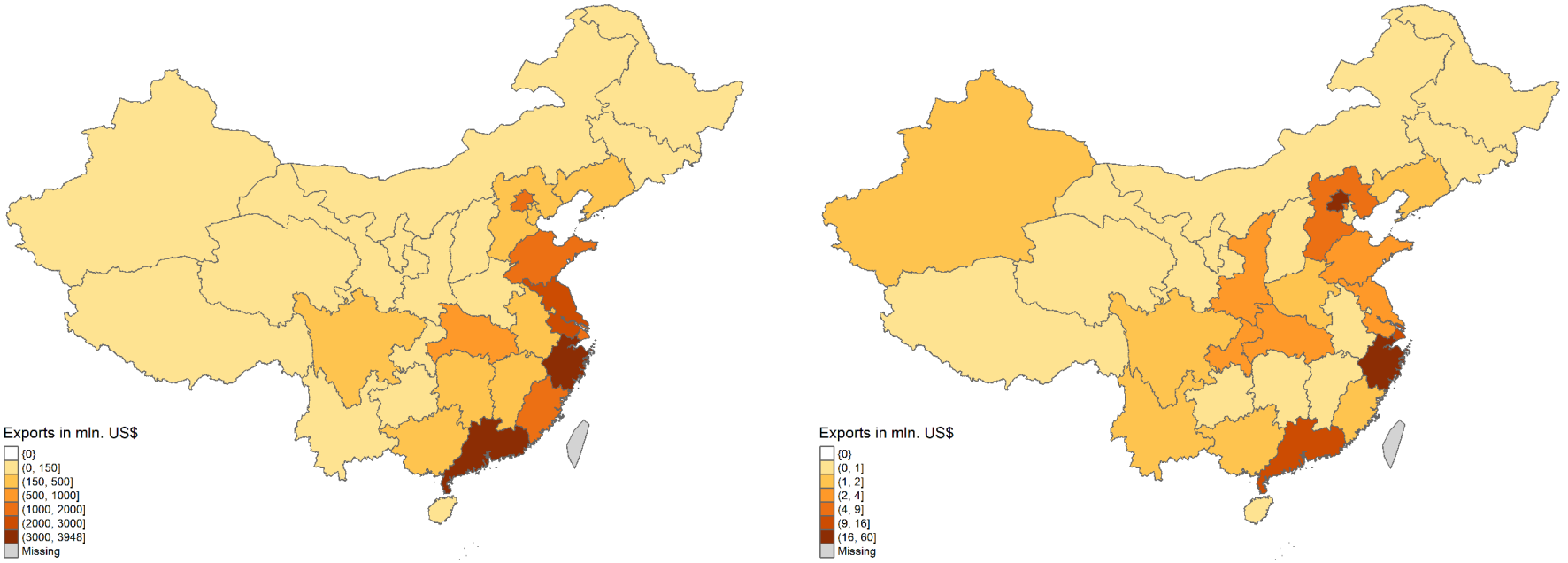


(a) Commercial exports of medical equipment



(b) Donation exports of medical equipment

Figure 1 – Exports of medical equipment from China by partner country, March and April 2020



(a) Commercial exports of medical equipment

(b) Donation exports of medical equipment

Figure 2 – Exports of medical equipment from Chinese provinces to all partner countries, March and April 2020

Tables

Table 1 – Cross-country correlates of Chinese medical exports (March–April 2020)

Exports by type (*asinh*):	Total (1)	Comm. (2)	Donat. (3)	Masks (4)	Ventil. (5)
asinh Commercial medical exports 2019	0.202***	0.195***	-0.009	0.369*	0.438
	(0.055)	(0.061)	(0.221)	(0.208)	(0.283)
asinh Donation medical exports 2019	0.014	0.014	0.115**	0.026	-0.020
	(0.010)	(0.011)	(0.045)	(0.020)	(0.063)
asinh Non-medical exports 2019	0.432***	0.508***	0.190	-0.109	-0.145
	(0.159)	(0.155)	(0.262)	(0.224)	(0.445)
asinh Product exports 2019				0.107	0.234**
				(0.068)	(0.102)
asinh Inward FDI	0.026	0.035	0.060	-0.072*	-0.066
	(0.030)	(0.030)	(0.115)	(0.038)	(0.120)
UN voting distance	0.211	0.215	-0.292	-0.056	0.348
	(0.141)	(0.142)	(0.515)	(0.191)	(0.476)
Recognition of Taiwan	-0.409	-0.163	-9.355***	-0.141	-1.367
	(0.700)	(0.695)	(0.741)	(0.586)	(1.035)
asinh Donations to China in Jan.-Feb.	0.008	0.005	0.070	0.039	0.104
	(0.014)	(0.014)	(0.071)	(0.024)	(0.064)
Sister linkages	-0.054	-0.049	1.810**	0.121	0.168
	(0.181)	(0.179)	(0.703)	(0.236)	(0.600)
asinh COVID-19 infection rates	0.205***	0.216***	0.170	0.496***	0.459
	(0.055)	(0.058)	(0.314)	(0.107)	(0.321)
Government effectiveness	0.059	0.026	1.108	0.783***	0.064
	(0.141)	(0.139)	(0.718)	(0.228)	(0.533)
R-squared	0.872	0.878	0.569	0.865	0.696

Note: Dependent variables measure the value of exports from China to each partner country in March and April 2020. Columns distinguish between total medical exports, commercial medical exports, donation medical exports, total exports of masks, and total exports of ventilators, all transformed by *asinh*. Columns 4 and 5 are based on HS 8-digit product classifications. All regressions control for a set of gravity determinants (contiguity, log of distance, log of population, and log GDP). $N = 187$ in all regressions. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2 – Determinants of medical exports between province-country pairs (March–April 2020)

Exports by type (*asinh*):	Total (1)	Comm. (2)	Donat. (3)	Masks (4)	Ventil. (5)
asinh Commercial medical exports 2019	0.409***	0.428***	0.018*	0.205***	0.031***
	(0.019)	(0.019)	(0.009)	(0.017)	(0.009)
asinh Donation medical exports 2019	0.034	0.031	0.180**	0.067	-0.072
	(0.047)	(0.045)	(0.070)	(0.051)	(0.060)
asinh Non-medical exports 2019	-0.002	-0.026	-0.004	-0.073***	-0.064***
	(0.016)	(0.016)	(0.010)	(0.016)	(0.009)
asinh Product exports 2019				0.278***	0.502***
				(0.023)	(0.029)
asinh Inward FDI	0.087***	0.099***	0.127***	0.161***	0.118***
	(0.020)	(0.021)	(0.023)	(0.026)	(0.021)
asinh Donations to province in Jan.-Feb.	0.027*	0.033**	0.086***	0.064***	0.086***
	(0.014)	(0.015)	(0.020)	(0.021)	(0.022)
Sister linkages	0.085	0.209	0.874***	0.318	0.228
	(0.176)	(0.190)	(0.252)	(0.219)	(0.204)
R-squared	0.782	0.781	0.436	0.720	0.555

Note: Dependent variables measure the value of exports from each Chinese province to each partner country in March and April 2020. Columns distinguish between total medical exports, commercial medical exports, donation medical exports, total exports of masks, and total exports of ventilators, all transformed by *asinh*. All regressions control for province and country fixed effects. $N = 6045$ in all regressions. Standard errors clustered at the country level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3 – Interactions between economic and political relations in dyadic medical exports (March–April 2020)

Economic linkages:	Total Medical Exports (1)	Inward FDI (2)
asinh Economic linkages	0.418***	0.234***
	(0.019)	(0.029)
× *asinh* Donations to province in Jan.-Feb.	-0.011***	-0.021***
	(0.004)	(0.002)
× Sister linkages	-0.032	-0.118***
	(0.037)	(0.038)
asinh Donations to province in Jan.-Feb.	0.190***	0.163***
	(0.056)	(0.021)
Sister linkages	0.641	0.850***
	(0.515)	(0.254)
R-squared	0.781	0.743

Note: Dependent variables measure the value of exports from each Chinese province to each partner country in March and April 2020, transformed by *asinh*. Column titles refer to the interacted variables that are used to capture economic linkages. All regressions control for province and country fixed effects. $N = 6045$ in all regressions. Standard errors clustered at the country level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

ONLINE APPENDIX

A Data generation and description of variables

Estimation sample Our cross-country results are based on 187 trading partners of China. We exclude 11 countries and territories (Democratic People's Republic of Korea, Holy See, Hong Kong, Liechtenstein, Macao, Monaco, Palestine, San Marino, South Sudan, Taiwan, and Western Sahara) due to missing political or gravity controls.

Our dyadic results are based on bilateral linkages between 195 partner countries and 31 Chinese provinces, which results in a total of 6,045 province-country pairs.

Classifying medical exports We classify exports into medical and non-medical exports primarily by relying on a list of 80 commodities, jointly established by the World Customs Organization (WCO) and the World Health Organisation (WHO) within the *HS Classification Reference for Covid-19 Medical Supplies*. It relies on the 6-digit level classification according to the Harmonized System (HS6) and its purpose is to provide a guideline to countries in order to facilitate trade in medical equipment. We consider all products on this list as related to *Medical exports* and all other products as *Non-medical exports*.

Alternatively, for robustness checks and descriptive evidence, we rely on a list of 11 essential medical products, which was announced in early April 2020 by the General Administration of Customs of China as a response to mounting quality complaints with respect to Chinese medical exports. The 11 medical products cover 19 HS 10-digit codes, which we concord to 17 HS 8-digit codes, for which export data are available. Products on the list require statutory quality inspections before being exported.

Source: For the 80-product list (HS6), see WCO/WHO (2020); for the official announcement on the product list (HS8) see `http://www.customs.gov.cn/customs/302249/302266/302267/2961602/index.html` (accessed June 18, 2020).

Distinguishing between commercial exports and donation exports We rely on the custom reporting system by the official monthly China Custom Statistics to distinguish between commercial exports and donations. Donations refer to exports under the custom regimes "Aid or Donation between Governments and International Organizations" (code

11) and "Other Donations" (code 12). Commercial exports cover all other custom regimes, including, among others, ordinary trade and processing trade.

Source: China Customs Statistics (GACC 2020).

Measuring monthly exports Our dependent variables measure the total US$ value of exports (medical and non-medical, commercial exports, and donations, product exports of masks and ventilators) over the first two months of the global pandemic, March and April 2020. We sum up export values over these two months, but re-run regressions by month in robustness checks. We transform all export values using an inverse hyperbolic sine transformation.

To control for economic links, we compute past exports during the same two months of the previous year (March and April 2019). We decompose past exports into the mutually exclusive categories of *Commercial medical exports 2019*, *Donation medical exports 2019*, and *Non-medical exports 2019*, which are distinguished based on the 80-product HS6 list by WCO/WHO (2020) and jointly add up to total exports.

By contrast, *Product exports 2019* (used as additional control in regressions for exports of masks and ventilators) is based on the Chinese list of 11 essential medical products at the HS8 level and refers to the exports of the specific product under analysis.

In cross-country regressions, exports are aggregated for each partner country, and in dyadic regressions they refer to country-province pairs.

Source: Official Monthly China Customs Statistics (GACC 2020).

Inward FDI In cross-country regressions, the variable measures the average annual value of inward foreign direct investment inflows into China originating from each of the partner countries from 2015 to 2017, measured in US$. In dyadic regressions, the variable measures the average annual value of inward foreign direct investment inflows into each province originating from each of the partner countries from 2015 to 2017, measured in US$.

Source: China's Ministry of Commerce (MOFCOM 2019).

UN voting distance In cross-country regressions, the variable records the ideal-point distance between China and each partner country. Ideal-point distance measures disagreement among country pairs during UN voting sessions, weighting each roll call according to the relative importance of any given topic for a reference country. In order to flatten out

yearly variation, we rely on a sum of all sessions from 2017 to 2019 in ideal-point distance, which ranges from 0.04 (Seychelles) to 3.12 (United States), as depicted in the descriptive statistics in Table D.2.

Source: Bailey et al. (2017).

Recognition of Taiwan In cross-country regressions, this binary variable takes the value of one for countries officially recognizing the Republic of China on Taiwan (capital: Taipei) instead of the People's Republic of China (capital: Beijing). In 2020, the following 15 countries have diplomatic relations with Taipei according to the website of the Ministry of Foreign Affairs of the Republic of China (Taiwan): Belize, Eswatini, Guatemala, Haiti, Holy See, Honduras, Marshall Islands, Nauru, Nicaragua, Palau, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Tuvalu.

Source: https://www.mofa.gov.tw/en/AlliesIndex.aspx?n=DF6F8F246049F8D6&sms=A76B7230ADF29736 (accessed June 19, 2020).

Donations to China/province in Jan.-Feb. In cross-country regressions, asinh *Donations to China in Jan.-Feb.* measures the inverse hyperbolic sine of the US$ value of total aid and donation imports to China by each partner country between January and February of 2020. In dyadic regressions, asinh *Donations to province in Jan.-Feb.* records the inverse hyperbolic sine of the US$ value of total aid and donations imports to each Chinese province by each partner country.

Source: Official Monthly China Customs Statistics (GACC 2020).

Sister linkages In cross-country regressions, the indicator variable takes a value of one if any administrative entity in a partner country maintained a sister relationship with at least one Chinese province at the beginning of 2020. In dyadic regressions, the indicator variable takes one if a partner country maintained a sister relationship with the Chinese province in question at the beginning of 2020. The variables are based on a dataset of 662 province-level sister relationships from China International Friendship Cities Association (CIFCA).

Source: Liu and Hu (2018).

COVID-19 infection rates In cross-country regressions, *COVID-19 infection rates* are calculated per 10 million people by the end of April 2020 and are transformed by an

inverse hyperbolic sine transformation. They provide us a proxy for the early spread of the pandemic in each importing country. By the end of April, San Marino showed the largest infection rate, followed by Andorra, and Luxembourg.

Source: Open COVID-19 Dataset (Wahltinez 2020).

Government effectiveness In cross-country regressions, this variable is captured by an index that measures the quality of public services, the capacity of the civil service and its independence from political pressures, and the quality of policy formulation. The index is provided yearly and we average it over the years 2014 to 2016. In our sample, its values range from -2.3 to 2.2.

Source: Worldwide Governance Indicators (Kaufmann et al. 2011).

Gravity controls Partner-country GDP in constant US$ as well as population size have been accessed via *wbopendata* (Azevedo 2011) and always refer to the latest available year. The partner country's geographic distance is measured from China's most populous city, Shanghai. *Contiguity* encodes a binary variable for a common border with China. GDP, population, and distance are all converted by the inverse hyperbolic sine transformation.

Source: World Bank (2020) for GDP and population, CEPII (Mayer and Zignago 2011) for distance and contiguity.

B Interaction model

To investigate whether economic and political ties can also act as substitutes when sourcing medical supplies from Chinese provinces, we extend our bilateral trade model from Equation (2) to include interactions of past economic and political linkages $E_{ij} \times P_{ij}$:

$$Y_{ij} \quad = \quad \gamma_0 \, P_{ij} + \gamma_1 \, E_{ij} + \gamma_2 \, E_{ij} \times P_{ij} \; + \theta_i + \rho_j + \epsilon_{ij}. \tag{3}$$

As before, our political measures, P_{ij}, capture prior donations to provinces and bilateral sister linkages between countries and provinces. In each specification, we only include one selected measure of past economic ties, E_{ij}, which captures either past medical trade or inward FDI. Additionally, we interact our dyadic measures of political ties with the selected economic ties indicators. This estimation strategy allows us to investigate whether political factors enhance or mitigate the importance of past economic linkages.

C Figure

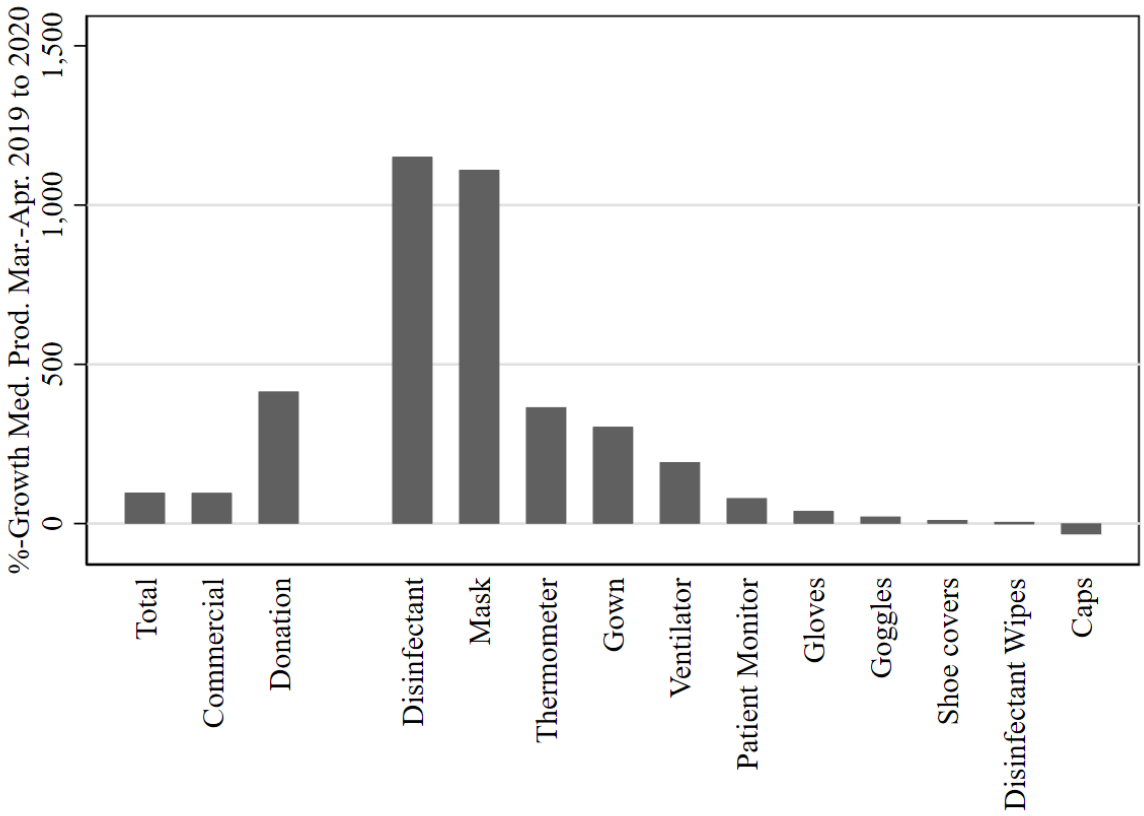


Figure C.1 – Growth in medical equipment exports in March and April between 2019 and 2020

Note: The graph shows the growth rate for total, commercial and donation exports of medical equipment (based on HS 6-digit classification), as well as for 11 medical products measured at the 8-digit level (HS8) that are deemed essential by the Chinese government for COVID-19 treatment and control. Data are taken from GACC (2020). Rates refer to the percent increase between March and April 2020 and the reference months in 2019.

D Tables

Table D.1 – Essential medical equipment exports from China in March and April 2020

Product	Value	Quantity	Av. Price	Main exporter	Top three importers
Surgical masks	9430.9	226.7	72.4	Zhejiang	USA, Germany, Japan
Shoe covers	2319.2	410.6	17.3	Guangdong	USA, Japan, S. Korea
Surgical gowns	1031.1	53.8	33.5	Zhejiang	USA, Spain, Russia
Surgical gloves	419.4	105.2	12.3	Shandong	USA, Japan, Germany
Infrared thermometers	353.3	55.9	95.0	Guangdong	USA, India, Singapore
Ventilators	342.8	142.3	2590.1	Guangdong	USA, Italy, Hungary
Surgical goggles	242.0	10.8	37.9	Zhejiang	USA, Germany, Czech Rep.
Medical disinfectants	218.6	62.1	13.3	Guangdong	USA, Australia, UK
Surgical caps	212.7	391.7	2.0	Jiangsu	USA, Japan, S. Korea
Medical disinfectant wipes	144.9	23.2	21.6	Jiangsu	USA, Japan, Germany
Patient monitors	144.5	5.5	580.6	Guangdong	USA, Netherlands, Italy

Notes: This table shows export value, quantity, average price, main exporting Chinese province, and top three importers of 11 medical products that were designated as essential for COVID-19 treatment and control by Chinese authorities. The 11 medical products are from a list released by the General Administration of Customs of China in early April 2020 that require statutory quality inspections before their shipment to other countries. Export values are measured in millions of US dollar, export prices in US dollar. Export quantities are measured in million number of units for infrared thermometers, ventilators, surgical caps, and patient monitors, and million kilograms for others. The last two columns show the main Chinese exporting province and top three importing countries for each product.

Table D.2 – Descriptive statistics of key variables at the country level

	Mean	St. dev.	Min.	Max.
DEPENDENT VARIABLES:				
asinh Total med. exports 2020	16.718	2.812	0.000	22.857
asinh Commercial med. exports 2020	16.618	2.919	0.000	22.855
asinh Donation med. exports 2020	11.231	4.755	0.000	17.241
asinh Product exports: Masks 2020	15.132	3.390	0.000	22.086
asinh Product exports: Ventilators 2020	10.527	5.718	0.000	18.390
EXPLANATORY VARIABLES:				
asinh Commercial med. exports 2019	15.999	2.858	0.000	22.365
asinh Donation med. exports 2019	2.084	4.470	0.000	16.884
asinh Non-medical exports 2019	19.817	2.382	11.912	25.511
asinh Product exports: Masks 2019	11.795	4.261	0.000	20.193
asinh Product exports: Ventilators 2019				
asinh Inward FDI	7.822	4.080	0.000	15.669
UN voting distance	0.656	0.599	0.043	3.121
Recognition of Taiwan	0.075	0.264	0.000	1.000
asinh Donations to China in Jan.-Feb.	7.531	6.442	0.000	17.477
Sister linkages	0.513	0.501	0.000	1.000
asinh COVID-19 infection rates	1.764	1.647	0.000	6.207
Government effectiveness	-0.074	0.972	-2.274	2.209
Contiguity	0.070	0.255	0.000	1.000
asinh Distance	9.702	0.495	7.556	10.561
asinh Population	16.344	2.120	10.044	21.718
asinh GDP	25.007	2.355	18.260	31.347

Note: The number of observations is 187.

Table D.3 – Cross-country correlates of Chinese medical exports (March 2020)

	Total (1)	Comm. (2)	Donat. (3)	Masks (4)	Ventil. (5)
asinh Comm. med. exports 2019	0.361**	0.837***	-0.415**	0.072	0.096
	(0.150)	(0.132)	(0.202)	(0.202)	(0.143)
asinh Donation med. exp. in 2019	0.036**	0.057***	0.105	0.045	0.040
	(0.014)	(0.015)	(0.104)	(0.043)	(0.080)
asinh Non-medical exports in 2019	0.550***	0.208	0.488	0.346	0.089
	(0.205)	(0.212)	(0.495)	(0.298)	(0.397)
asinh Product exports in 2019				0.389***	0.260***
				(0.108)	(0.088)
asinh Inward FDI	0.028	-0.014	0.357**	0.040	0.075
	(0.034)	(0.038)	(0.142)	(0.067)	(0.106)
UN voting distance	0.106	0.077	-0.631	-0.112	-0.879*
	(0.150)	(0.160)	(0.880)	(0.305)	(0.488)
Recognition of Taiwan	-0.496	0.561	-4.070***	-1.548*	-0.313
	(0.660)	(0.665)	(1.171)	(0.908)	(0.817)
asinh Donations to China in Jan.-Feb.	-0.012	-0.011	0.018	0.018	0.174**
	(0.017)	(0.018)	(0.107)	(0.036)	(0.083)
Sister linkages	-0.138	-0.070	1.686	0.086	-0.401
	(0.180)	(0.183)	(1.057)	(0.375)	(0.701)
asinh COVID-19 infection rates	0.097	0.086	0.073	-0.026	0.072
	(0.074)	(0.070)	(0.441)	(0.175)	(0.338)
Government effectiveness	-0.004	0.119	0.790	-0.024	-0.603
	(0.155)	(0.194)	(0.867)	(0.334)	(0.608)
R-squared	0.882	0.887	0.289	0.819	0.706

Note: Dependent variables measure the value of exports from China to each partner country in March 2020. Columns distinguish between total medical exports, commercial medical exports, donation medical exports, total exports of masks, and total exports of ventilators, all transformed by *asinh*. Columns 4 and 5 are based on HS 8-digit product classifications. All regressions control for a set of gravity determinants (contiguity, the log of distance, log of population, and log GDP). $N = 187$ in all regressions. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.4 – Cross-country correlates of Chinese medical exports (April 2020)

	Total (1)	Comm. (2)	Donat. (3)	Masks (4)	Ventil. (5)
asinh Comm. med. exports in 2019	0.106**	0.089*	-0.026	0.221	0.231
	(0.047)	(0.047)	(0.229)	(0.158)	(0.208)
asinh Donation med. exp. in 2019	-0.003	0.003	0.165**	0.044*	-0.128
	(0.015)	(0.016)	(0.067)	(0.024)	(0.107)
asinh Non-medical exports in 2019	0.414***	0.499***	0.427	0.065	0.363
	(0.149)	(0.139)	(0.305)	(0.212)	(0.454)
asinh Product exports in 2019				0.044	0.249**
				(0.055)	(0.104)
asinh Inward FDI	0.035	0.049	-0.058	-0.088*	-0.138
	(0.033)	(0.035)	(0.132)	(0.048)	(0.129)
UN voting distance	0.239	0.244	-0.624	-0.086	0.664
	(0.150)	(0.152)	(0.625)	(0.216)	(0.497)
Recognition of Taiwan	-0.425	-0.130	-8.612***	-0.199	-0.301
	(0.703)	(0.691)	(0.800)	(0.642)	(1.053)
asinh Donations to China in Jan.-Feb.	0.015	0.012	0.094	0.050*	0.119
	(0.014)	(0.014)	(0.078)	(0.027)	(0.081)
Sister linkages	-0.012	-0.013	1.956**	0.090	0.827
	(0.179)	(0.179)	(0.758)	(0.275)	(0.759)
asinh COVID-19 infection rates	0.258***	0.281***	0.463	0.575***	0.870**
	(0.062)	(0.064)	(0.370)	(0.132)	(0.343)
Government effectiveness	0.131	0.061	1.281*	0.965***	0.514
	(0.148)	(0.145)	(0.735)	(0.267)	(0.566)
R-squared	0.869	0.875	0.466	0.838	0.645

Note: Dependent variables measure the value of exports from China to each partner country in April 2020. Columns distinguish between total medical exports, commercial medical exports, donation medical exports, total exports of masks, and total exports of ventilators, all transformed by *asinh*. Columns 4 and 5 are based on HS 8-digit product classifications. All regressions control for a set of gravity determinants (contiguity, the log of distance, log of population, and log GDP). $N = 187$ in all regressions. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.5 – Cross-country results: Quantities and prices of masks and ventilators (March and April 2020)

Dependent (*asinh*):	Quantities		Prices	
	Masks (1)	Ventilators (2)	Masks (3)	Ventilators (4)
asinh Product export quantities 2019	0.175***	0.465***		
	(0.056)	(0.067)		
asinh Product export prices 2019			0.167	0.556***
			(0.131)	(0.131)
asinh Commercial med. exports 2019	0.227**	0.027	-0.017	-0.334
	(0.105)	(0.132)	(0.104)	(0.687)
asinh Donation med. exports 2019	0.022	-0.015	0.002	-0.005
	(0.016)	(0.035)	(0.013)	(0.056)
asinh Non-med. exports 2019	0.078	0.215	-0.111	-0.137
	(0.144)	(0.296)	(0.115)	(0.653)
asinh Inward FDI	-0.045	-0.073	-0.017	0.050
	(0.035)	(0.067)	(0.026)	(0.110)
UN voting distance	-0.092	-0.075	0.059	0.136
	(0.144)	(0.328)	(0.111)	(0.407)
Recognition of Taiwan	0.059	0.296	0.117	-1.124
	(0.387)	(0.630)	(0.325)	(1.155)
asinh Donations to China in Jan.-Feb.	0.022	0.157***	0.021*	-0.127*
	(0.019)	(0.052)	(0.012)	(0.070)
Sister linkages	0.164	0.740	0.072	-0.287
	(0.187)	(0.495)	(0.111)	(0.584)
asinh COVID-19 infection rates	0.239***	0.203	0.248***	0.129
	(0.088)	(0.228)	(0.058)	(0.277)
Government effectiveness	0.579***	-0.383	0.173	0.805*
	(0.172)	(0.358)	(0.139)	(0.473)
Observations	187	187	174	128
R-squared	0.905	0.848	0.303	0.458

Note: Dependent variables measure the quantities and prices of masks and ventilators exported from China to each partner country in March and April 2020, all transformed by *asinh*. All regressions control for a set of gravity determinants (contiguity, the log of distance, log of population, and log GDP). Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.6 – Descriptive statistics of key variables at the province level

	Mean	St. Dev.	Min.	Max.
DEPENDENT VARIABLES:				
asinh Total med. exports 2020	7.188	6.832	0.000	21.361
asinh Commercial med. exports 2020	7.063	6.839	0.000	21.361
asinh Donation med. exports 2020	1.129	3.444	0.000	17.195
asinh Product exports: Masks 2020	5.084	6.413	0.000	20.513
asinh Product exports: Ventilators 2020	1.486	3.918	0.000	17.604
EXPLANATORY VARIABLES:				
asinh Total med. exports 2019	6.842	6.511	0.000	20.949
asinh Donation med. exports 2019	0.078	0.916	0.000	16.884
asinh Commercial med. exports 2019	6.821	6.509	0.000	20.949
asinh Product exports: Masks 2019				
asinh Product exports: Ventilators 2019				
asinh Inward FDI	1.654	3.414	0.000	15.117
asinh Donations to prov. in Jan.-Feb.	1.340	3.708	0.000	16.298
Sister linkages	0.094	0.292	0.000	1.000

Note: The number of observations is 6045.

Table D.7 – Determinants of dyadic medical exports between province-country pairs (March and April 2020): Robustness check based on the HS 8-digit medical product list

	Total (1)	Comm. (2)	Donat. (3)
asinh Comm. med. exports in 2019	0.412***	0.436***	0.016
	(0.021)	(0.022)	(0.011)
asinh Donation med. exp. in 2019	0.089	0.053	0.333***
	(0.075)	(0.069)	(0.096)
asinh Non-medical exports in 2019	-0.004	-0.028*	-0.004
	(0.015)	(0.015)	(0.010)
asinh Inward FDI	0.092***	0.098***	0.125***
	(0.021)	(0.021)	(0.023)
asinh Donations to prov. in Jan.-Feb.	0.030*	0.039**	0.088***
	(0.016)	(0.017)	(0.020)
Sister linkages	0.117	0.264	0.880***
	(0.188)	(0.195)	(0.254)
R-squared	0.771	0.771	0.441

Note: Dependent variables measure the value of medical exports from each Chinese province to each partner country in March and April 2020, aggregated from the HS 8-digit medical product list. Columns distinguish between total medical exports, commercial medical exports, and donation medical exports, all transformed by *asinh*. All regressions control for province and country fixed effects. $N = 6045$ in all regressions. Standard errors clustered at the country level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.8 – Determinants of dyadic medical exports between province-country pairs (March and April 2020): Robustness check using Poisson Pseudo-Maximum-Likelihood estimation

	Total (1)	Comm. (2)	Donat. (3)	Masks (4)	Ventil. (5)
asinh Comm. med. exports 2019	0.338***	0.347***	0.058	0.217***	0.322**
	(0.060)	(0.061)	(0.051)	(0.063)	(0.132)
asinh Donation med. exp. 2019	-0.027	-0.022	-0.199*	-0.041	0.059
	(0.044)	(0.046)	(0.102)	(0.068)	(0.072)
asinh Non-medical exports 2019	0.318***	0.310***	0.489***	0.323***	-0.247
	(0.088)	(0.088)	(0.139)	(0.113)	(0.176)
asinh Product exports 2019				0.030*	0.072**
				(0.017)	(0.029)
asinh Inward FDI	0.020*	0.021*	-0.007	0.014	-0.018
	(0.012)	(0.012)	(0.056)	(0.013)	(0.034)
asinh Donations to province in Jan.-Feb.	0.012**	0.012**	0.010	0.017**	0.024
	(0.006)	(0.006)	(0.036)	(0.008)	(0.026)
Sister linkages	0.106	0.103	-0.054	0.086	0.182
	(0.069)	(0.069)	(0.395)	(0.100)	(0.343)
Observations	5,952	5,952	5,115	5,921	3,473
Pseudo R-squared	0.954	0.747	0.954	0.948	0.772

Note: Dependent variables measure the value of exports from each Chinese province to each partner country in March and April 2020. Columns distinguish between total medical exports, commercial medical exports, donation medical exports, total exports of masks, and total exports of ventilators in levels. The regressions are estimated with the *ppmlhdfe* command in Stata 15.1 by Correia et al. (2020). All regressions control for province and country fixed effects. Standard errors clustered at the country level are reported in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.9 – Determinants of dyadic medical exports between province-country pairs (March 2020)

	Total (1)	Comm. (2)	Donat. (3)	Masks (4)	Ventil. (5)
asinh Comm. med. exports in 2019	0.430***	0.442***	0.001	0.095***	0.008
	(0.020)	(0.020)	(0.008)	(0.013)	(0.007)
asinh Donation med. exp. in 2019	0.071	0.075	0.049	0.020	-0.050
	(0.060)	(0.064)	(0.072)	(0.067)	(0.069)
asinh Non-medical exports in 2019	-0.043***	-0.050***	-0.017***	-0.069***	-0.048***
	(0.013)	(0.013)	(0.006)	(0.011)	(0.006)
asinh Product exports in 2019				0.399***	0.475***
				(0.023)	(0.034)
asinh Inward FDI	0.136***	0.144***	0.053***	0.141***	0.127***
	(0.024)	(0.024)	(0.017)	(0.023)	(0.020)
asinh Donations to prov. in Jan.-Feb.	0.074***	0.079***	0.058***	0.128***	0.061***
	(0.015)	(0.015)	(0.016)	(0.020)	(0.020)
Sister linkages	0.399**	0.442**	0.470**	0.985***	0.423**
	(0.182)	(0.188)	(0.205)	(0.209)	(0.186)
R-squared	0.765	0.766	0.296	0.672	0.502

Note: Dependent variables measure the value of exports from each Chinese province to each partner country in March 2020. Columns distinguish between total medical exports, commercial medical exports, and donation medical exports, all transformed by *asinh*. All regressions control for province and country fixed effects. $N = 6045$ in all regressions. Standard errors clustered at the country level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.10 – Determinants of dyadic medical exports between province-country pairs (April 2020)

	Total (1)	Comm. (2)	Donat. (3)	Masks (4)	Ventil. (5)
asinh Comm. med. exports in 2019	0.381***	0.395***	0.025***	0.208***	0.034***
	(0.020)	(0.020)	(0.009)	(0.020)	(0.010)
asinh Donation med. exp. in 2019	-0.013	-0.039	0.279***	-0.010	-0.033
	(0.065)	(0.066)	(0.077)	(0.079)	(0.087)
asinh Non-medical exports in 2019	0.032*	0.016	-0.002	-0.046***	-0.051***
	(0.017)	(0.017)	(0.009)	(0.016)	(0.008)
asinh Product exports in 2019				0.252***	0.456***
				(0.024)	(0.031)
asinh Inward FDI	0.112***	0.121***	0.104***	0.182***	0.101***
	(0.020)	(0.021)	(0.023)	(0.029)	(0.021)
asinh Donations to prov. in Jan.-Feb.	0.054***	0.060***	0.072***	0.091***	0.096***
	(0.016)	(0.016)	(0.019)	(0.020)	(0.021)
Sister linkages	0.099	0.215	0.821***	0.367	0.193
	(0.186)	(0.200)	(0.231)	(0.233)	(0.173)
R-squared	0.761	0.759	0.366	0.710	0.489

Note: Dependent variables measure the value of exports from each Chinese province to each partner country in April 2020. Columns distinguish between total medical exports, commercial medical exports, and donation medical exports, all transformed by *asinh*. All regressions control for province and country fixed effects. $N = 6045$ in all regressions. Standard errors clustered at the country level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.11 – Dyadic determinants of new trade linkages

	Total (1)	Comm. (2)	Donat. (3)	Masks (4)	Ventil. (5)
asinh Non-medical exports 2019	0.006***	0.005***	-0.000	-0.002	-0.005***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
asinh Inward FDI	0.014**	0.014*	0.010***	0.023***	0.009***
	(0.007)	(0.007)	(0.002)	(0.004)	(0.002)
asinh Donations to province in Jan.-Feb.	0.005	0.000	0.007***	0.011***	0.004**
	(0.010)	(0.011)	(0.002)	(0.004)	(0.002)
Sister linkages	0.080	0.059	0.079***	0.064**	0.002
	(0.053)	(0.055)	(0.022)	(0.032)	(0.019)
Observations	2,690	2,699	5,997	4,463	5,369
R-squared	0.327	0.297	0.399	0.421	0.208

Note: Dependent variable is a binary variable which equals one for province-country pairs exporting in 2020, but not in 2019, and is zero for those without export linkages in both 2019 and 2020. We, hence, estimate those regressions for a subsample of province-country pairs with no exports in 2019. All regressions control for province and country fixed effects. Standard errors clustered at the country level are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.12 – The role of economic linkages in dyadic medical exports (March and April 2020): Robustness check based on the HS 8-digit medical product list

Economic linkages:	Total Medical Exports (1)	Inward FDI (2)
asinh Economic linkages	0.432***	0.257***
	(0.021)	(0.032)
× *asinh* Donations to province in Jan.-Feb.	-0.009***	-0.020***
	(0.003)	(0.003)
× Sister linkages	-0.070*	-0.108**
	(0.037)	(0.042)
asinh Donations to province in Jan.-Feb.	0.160***	0.181***
	(0.047)	(0.022)
Sister linkages	1.003**	1.017***
	(0.474)	(0.286)
R-squared	0.771	0.735

Note: Dependent variables measure the value of exports from each Chinese province to each partner country in March and April 2020, aggregated from the HS 8-digit medical product list and all transformed by *asinh*. Column titles refer to the interacted variables that are used to capture economic linkages. All regressions control for province and country fixed effects. $N = 6045$ in all regressions. Standard errors clustered at the country level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.