Global supply chains at work: A tale of three products to fight COVID-19

4 April 2022

The goods needed to vaccinate, protect and test during the COVID-19 pandemic are produced across many different countries. This brief tells the tale of three products – vaccines, face masks and tests – and highlights the role of trade in the fight against COVID-19. International markets and global supply chains played a pivotal role during the COVID-19 pandemic: first, by helping countries avail themselves of the goods needed to address the pandemic; second, by providing a means to ease temporary supply constraints; and third, by enabling access to key components to ramp up production to meet surging demand.

Key Insights

- The goods needed to vaccinate, protect and test during the COVID-19 pandemic are produced across many different countries. Trade and global supply chains in three very different, but key, products – vaccines, face masks and tests – played a crucial role in helping support the fight against COVID-19. Each product has a story:
  - *COVID-19 vaccines – trade and global supply chains enabled sustained production and access*. During the first six months of 2021, global trade in vaccines was already 26% higher than for the full 12 months of 2020. Although obtaining vaccines remains difficult for many, this unprecedented growth enabled access to vaccines for a range of countries that lacked the capacity to produce them. Vaccines trade was also accompanied by increasing trade in related or intermediate inputs underpinning their wider manufacturing and distribution. Production of vaccines against COVID-19 only temporarily displaced exports of other types of vaccines in some important producers such as the European Union. This highlights the capacity of global supply chains to ramp up and boost distribution and production of essential products in record time.
  - *Face masks – trade helped mitigate temporary supply constraints*. In the space of three months in 2020, face masks imports increased more than 15-fold in both value and volume in the United States, with similar surges observed in other major economies such as Canada, the European Union, and Japan. This surge in demand was largely met by greater imports from the People's Republic of China (hereafter "China"). However, this was short-lived; demand for imports of face masks fell dramatically after the initial spike and sources of imports since diversified rapidly. In this instance, international trade and global supply chains enabled countries to mitigate temporary supply constraints for essential goods in the face of surges in demand.
  - *COVID-19 tests – trade helped address temporary shortages and enabled sustained access*. COVID-19 tests are composed of a number of different products, including nasal swabs, viral transport media, laboratory reagents, absorption pads, and other plastic consumables (e.g. container; tube; cap; cassette case). Some products saw a sustained growth in trade during the early stages of the pandemic – exports of laboratory reagents were up to 77% higher relative to pre-crisis levels. By contrast, products such as nasal swabs or viral transport media saw initial surges in demand that later stabilised at levels somewhat above those observed before the pandemic. Overall, trade in COVID-19 tests enabled both the mitigation of temporary supply constraints in the face of demand surges, as well as more sustained access for essential products.
- The fight against COVID-19 remains an ongoing and global challenge. Global supply chains played a key role in allowing countries to: i) avail themselves of essential products when they may not have had the capacity to produce them; ii) to mitigate temporary supply shortages; and iii) to ramp up production of key components. Supply chains proved to be both agile and resilient in the face of unprecedented surges and changes in demand for products needed to fight COVID-19.
- All countries are facing challenges in ensuring that their populations are vaccinated, protected and tested, but not all countries produce all the goods needed to do this. Trade enables access to the final and intermediate goods that underpin their supply. Open markets, transparency and trade facilitation can ensure greater ease of access to these products.

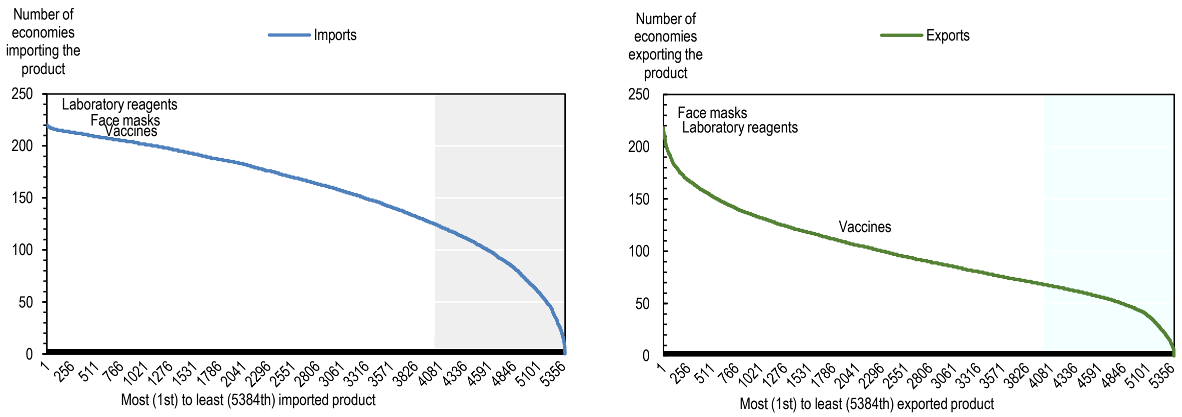
Whether personal protective equipment (PPE), medical goods or vaccines, no country alone can efficiently produce all the goods it needs to fight COVID-19 (OECD (2020[1]), OECD (2021[2]). Indeed, the final and intermediate goods needed to vaccinate, protect and test during the COVID-19 pandemic are produced across many different countries.

Important insights can be gained from delving deeper into the trade statistics for three key products critical for the fight against COVID-19: vaccines, face masks and tests. While these are all among the most imported products globally (Figure 1), they differ in a number of ways. Vaccines are exported by fewer countries, since their production is more complex and R&D-intensive (OECD, 2021[2]) (Bown and Bollyky, 2021[3]). Face masks, although complex to produce (OECD (2020[4]), are less technology intensive and tend to be exported by more countries. COVID-19 tests, including RT-PCR or (rapid) antigen tests, often combine a number of products, containing laboratory reagents, swabs, sample holders, and other simpler plastic consumables. While laboratory reagents are also imported and exported by most countries (Figure 1), they are characterised by different supply chain configurations.[1]

New and up-to-date data on cross-country exports and imports provide an opportunity to tell an evidence-based story of the role that trade played in addressing issues of access to COVID-19 goods and in meeting supply constraints during the different stages of the pandemic. This is notwithstanding a number of challenges and caveats in the use of trade data for this analysis (Box 1).

Figure 1. Vaccines, face masks and tests are among the most traded products worldwide

Products ranked by the number of economies importing and exporting them in 2019



Note: 'Face masks' refer to the broader HS 6-digit code 6307.90 "Other made-up textile articles", which includes several other items than face masks. 'Laboratory reagents' (to proxy for tests) refer to HS 3822.00. 'Vaccines' refer to HS 3002.00 including all types of vaccines for human medicine. The two figures rank products according to how many economies import (panel a) and export (panel b) them. For instance, in terms of imports, laboratory reagents, face masks and vaccines are all imported by more than 200 economies (y-axis), making them the 9th, 62nd, and 470th most imported product of the 5384 traded products overall (x-axis). Face masks and laboratory reagents are also exported by more than 200 economies, while 116 economies exported vaccines in 2019.
Source: Authors' calculations using the CEPII BACI (2021[5]) dataset for 2019.

[1] One clear difference with face masks, for example, is that in the case of tests, different components are assembled together at the moment of consumption, while face masks inputs (e.g. paper pulp, petroleum oil, polypropylene, aluminium, etc.) are assembled at earlier stages to be part of a final stand-alone product (OECD, 2020[4]).

Box 1. Caveats and challenges in analysing trade patterns of COVID-19 medical goods

The lack of up-to-date and comparable trade data during the COVID-19 pandemic has complicated analysis of the role that trade has played in fighting COVID-19. Two developments make it now possible to use trade data to shed more light on what has happened since the onset of COVID-19:

(i) Monthly data on trade flows for 2020 and 2021 have since been released by major traders and have been compiled (at the Harmonised System HS 6-digit level) in international databases (including the ITC Trade Map and the United Nations COMTRADE databases);

(ii) Many Customs authorities have introduced specific codes for COVID-19-related medical items to ensure better tracking of *COVID-19 goods* within the categories indicated by the World Customs Organisation's guidelines (see *WCO list of HS 6-digit codes for COVID-19 goods*). This now makes it possible to undertake more granular analysis at the product level, including through the use of national statistical sources.

Important challenges and caveats remain. First, international trade statistics at the HS 6-digit level (available through ITC Trade Map and UN COMTRADE) tend to cover products at a more aggregate level than those directly relevant to COVID-19.[1] For example, HS code 3002.20 covers vaccines for human medicine of all types, which includes COVID-19 vaccines since 2021 but also other vaccines. In addition, some key producers and traders may not be covered in the databases available with the most up-to-date data for all products of interest.

Second, quantities traded are often reported in different units or not at all across different countries (and are generally less well reported than trade values). This means that it can be difficult to identify unit values needed for tracking price or quantity effects. Using customs information for codes at 8-digit or 10-digit levels helps to partly address some of these challenges in the case of selected countries and products, but it is also difficult to compare across countries, as customs codes are no longer harmonised at that level of disaggregation.

Third, there is an important gap in up-to-date, comparable data on domestic production of COVID-19 medical goods (trade data is more detailed than domestic production data). This makes it difficult to map the evolution of domestic output relative to imports and exports of COVID-19 medical goods. In the case of vaccines, potential complications also arise in terms of tracking donations (via COVAX or direct donations). The WTO-IMF Vaccines Trade Tracker (WTO-IMF, 2022[6]) provides estimations of donations from key regions where vaccines are produced.

Last, there are significant challenges in identifying the inputs and components destined for the production of final COVID-19 goods. Initiatives such as the 'living' *WCO list of HS 6-digit codes for COVID-19 goods* and the *WTO Joint Indicative List of Critical COVID-19 Vaccine Inputs* (a joint effort led by the WTO and including the Asian Development Bank, OECD, WCO, think-tanks, researchers as well as private sector – vaccines manufacturers, express carriers, etc.) are aimed at identifying HS 6-digit classifications for a wide range of COVID-19 medical goods and, respectively, vaccine inputs and manufacturing equipment. An important challenge is again that HS 6-digit codes are broader than many of the specialised goods, inputs or equipment in addition to the fact that the list of goods is not static – new vaccines enter the manufacturing process (and thus new ingredients are added) or new medical goods are used to address COVID-19.

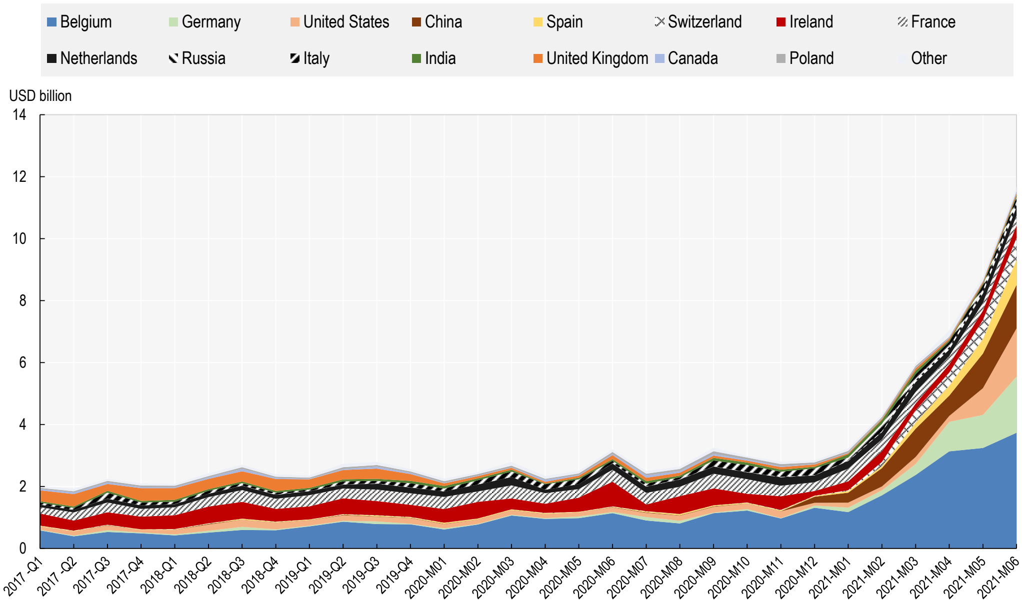
[1] However, ITC Trade Map data allows for more granular analysis (at the 8- or 10-digit level) for specific countries.

1. COVID-19 vaccines: Trade and global supply chains enabled sustained production and access

The increase in global vaccines trade seen over 2021 has been unprecedented. The value of global trade in vaccines (i.e. all types of vaccines for human medicine, HS code 3002.20) in the first six months of 2021 was 26% higher than for the whole 12 months of 2020, and 30% higher than in 2019 (USD 41 billion for the first 6 months of 2021 compared to an annual trade in vaccines of approximately USD 31 billion in 2019 and USD 32.5 billion in 2020).[2] Five economies – Belgium, Germany, the United States, the People's Republic of China (hereafter "China"), and Spain – accounted for about 73% of the value of exports in 2021 (Figure 2).[3]

Figure 2. No trade, no vaccines: Global exports of vaccines have witnessed record growth in the COVID-19 pandemic

HS 3002.20 (including COVID-19 vaccines since 2021), USD billion, January 2017 – June 2021



Note: Figure 2 is based on 52 countries for which data was available with monthly frequency from January 2017 to June 2021. These countries accounted in 2019 for 99.4% of the global value and 98.7% of the global volume of trade in vaccines for human medicine (HS 3002.20) according to CEPII BACI data, indicating that they provide a representative sample for world trade in vaccines. The data for India is obtained from the UN COMTRADE database. Countries are sorted by export value in June 2021, and the average quarterly value is displayed for years 2017 to 2019.
Source: ITC Trade Map (2021[7]) and UN COMTRADE (2021[8]).

[2] Differences exist between available trade databases in recording latest available data across a wide range of countries. While the CEPII BACI data provides HS 6-digit trade data reconciling declarations of importers and exporters, the latest year available is currently 2019. Databases such as ITC Trade Map and UN COMTRADE provide monthly-level trade data up to Q4 2021, but the coverage of country data may differ. Estimates from the CEPII BACI database indicate that global vaccines trade amounts to USD 32.4 billion in 2019, while the corresponding figure from ITC Trade Map (for a smaller sample of countries available) amounts to USD 31.3 billion for the same year. The estimate for 2020 from ITC Trade Map is USD 32.5 billion. The figures for 2021 are based on 52 countries for which data was available with monthly frequency from January 2017 to June 2021. These countries accounted in 2019 for 99.4% of the global value and 98.7% of the global volume of trade in vaccines for human medicine (HS 3002.20) according to CEPII BACI data, indicating that they provide a representative sample for global trends.

[3] This analysis focuses on the *value* of trade in vaccines. For a mapping of trade in vaccine *doses*, see the WTO-IMF Vaccines Trade Tracker (WTO-IMF, 2022[6]).

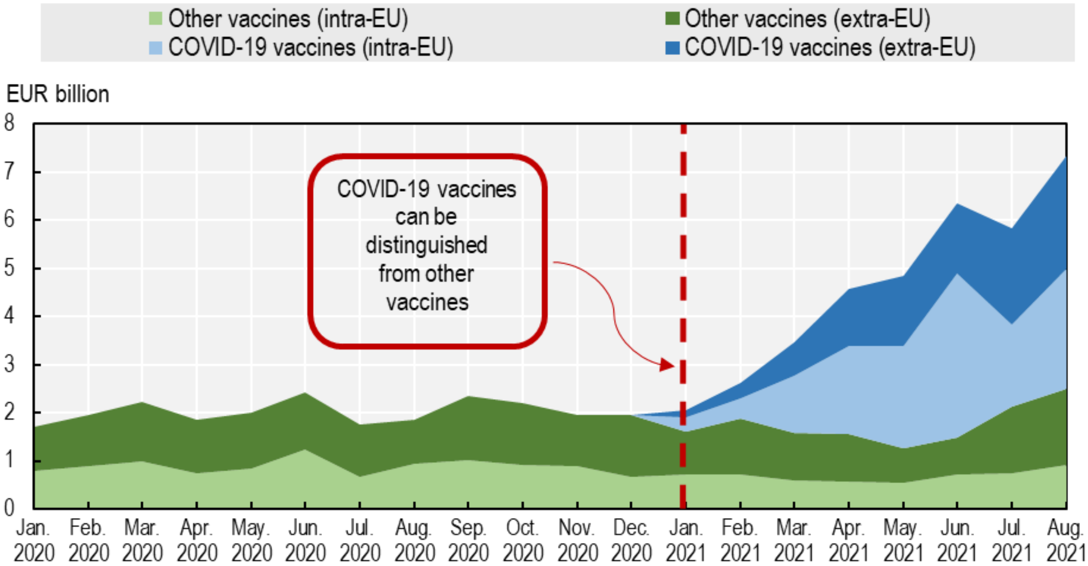
The development of supply chains for producing COVID-19 vaccines was the result of global cross-border public-private co-operation (see Brown and Bollyky (2021[3])),[4] involving the countries highlighted in Figure 2 and more. However, a major constraint in assessing the exact contribution of global trade to availability of COVID-19 vaccines to date has been the lack of specificity in product nomenclatures (i.e. the challenge of distinguishing, under HS 6-digit code 3002.20, COVID-19 vaccines from those needed to prevent other diseases) (OECD, 2021[2]).

This distinction is now possible for the European Union, which introduced a specific customs code for COVID-19 vaccines. This shows that the overall rise in vaccines trade largely reflects the surge in exports of COVID-19 vaccines (Figure 3). COVID-19 vaccines accounted for around 21% of total EU vaccines exports by value in January 2021, reaching 66% of vaccine exports by August 2021. In absolute terms, the growth in the European Union's COVID-19 vaccines exports, both within and external to the EU, between January and August 2021 was more than considerable, from EUR 432 million (USD 494 million) to EUR 4.8 billion[5] (USD 5.5 billion), or an 11-fold increase (+1 000%) (Eurostat, 2022[9]).

Two other important observations emerge. The first is that the increase in exports of COVID-19 vaccines seems to have temporarily led to a decrease in exports of other vaccines, largely during the first half of 2021. However, these exports returned to pre-pandemic levels by the middle of 2021 (Figure 3). The second is that, as of mid-2021, exports became more geographically diversified (notably towards non-EU countries).

Figure 3. Exports of COVID-19 vaccines from the European Union surged in 2021

EUR billion, January 2020 – August 2021



Note: The vertical line indicates when a separate classification for COVID-19 vaccines was first adopted in the EU's Combined Nomenclature (CN). The EU CN code for COVID-19 vaccines is 3002.20.10.
Source: EUROSTAT (2022[9]).

[4] Annex Table 1.A.1 illustrates the product- and location-specific manufacturing supply chains that emerged in 2020-21 for selected COVID-19 vaccines such as Pfizer/BioNTech, Moderna, AstraZeneca/Oxford, Johnson & Johnson, and Novavax based on the analysis in Brown and Bollyky (2021[3]).

[5] This includes both intra-EU (EUR 2.5 billion) and extra-EU (EUR 2.3 billion) exports.

Export and import data for inputs needed to manufacture and distribute[6] COVID-19 vaccines highlight the role that trade and global supply chains played for vaccines and in ensuring steady access to a wide range of materials and ingredients. For example, global exports of consumable materials, such as cell culture media or filters, used to manufacture vaccines, increased by more than 66% between Q1 2020 and Q1 2021 – from the start of vaccine clinical trials to vaccination campaigns (Figure 4).[7] More than two-thirds of these materials were sourced by selected COVID-19 vaccine manufacturers (including economies involved in the *fill and finish* process).[8] A similar pattern emerges for packaging materials for COVID-19 vaccines. In this case, despite an initial drop in global exports during the first stage of the COVID-19 pandemic (Q1 2020), imports by key manufacturers and fill and finish countries rose by over 18% (Figure 4).

The role of trade in ensuring access to materials is also highlighted by the emergence of new suppliers of specialised ingredients. Using more granular product classifications, Figure 5 shows the example of imports of lipid nanoparticles, a specialised ingredient essential to the production of mRNA vaccines (Pfizer/BioNTech and Moderna), by the United States. The five-fold increase in imports between January 2020 and November 2021 was largely supported by new suppliers, such as Germany.

This analysis for ***COVID-19 vaccines*** suggests that these increases in trade in 2021 have not only been unprecedented, but were also sustained throughout the entire year. Trade played a critical role, supporting the ramping up of production through global supply chains. Indeed, trade in some specialised inputs underpinning the manufacture of COVID-19 vaccines increased more than five-fold. Production of new vaccines against COVID-19 also appears to have only temporarily displaced exports of other vaccines from the EU. Overall, this highlights the capacity of global supply chains to ramp up and enable sustained production in record time, supporting access to new essential products for countries unable to produce them. Given that access to vaccines remains challenging in many economies,[9] trade is likely to continue to play a key role in helping countries obtain COVID-19 vaccines and the inputs needed for their production.

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[6] OECD (2021[2]) highlighted that it requires a wide range of materials and ingredients to produce, transport and administer COVID-19 vaccines. These inputs include cell culture media, chemical ingredients, different types of lipid nanoparticles, single-use reactor bags, filters, vials, etc.

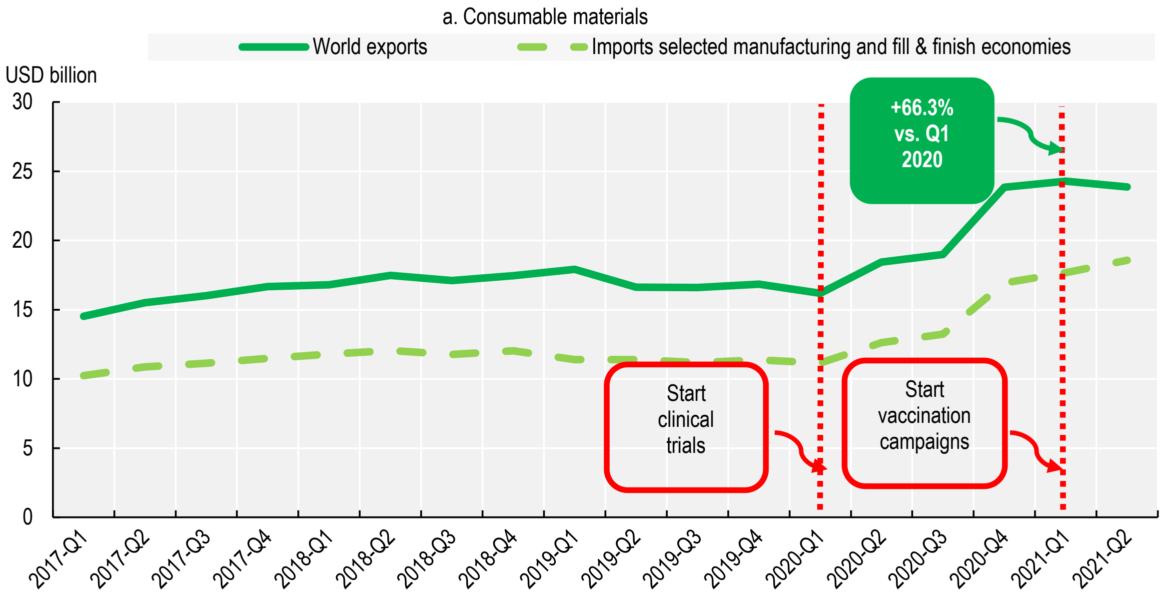
[7] Groupings based on the *WTO Joint Indicative List of Critical COVID-19 Vaccine Inputs* at HS 6-digit level. ‘Consumables’ include items such as single-use bioreactor bags, filters, or cell culture media. ‘Packaging materials’ include vials, metal crimp sealers, or stoppers (Annex Table 1.B.3).

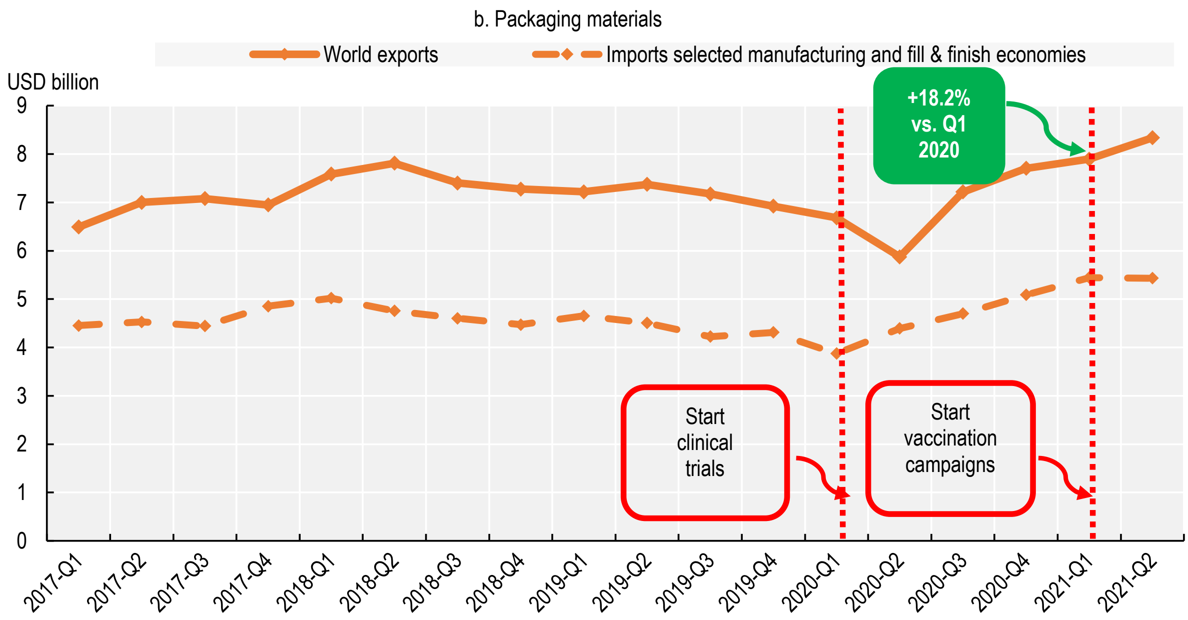
[8] *Fill and finish* represents the process of filling vials with the vaccine substance and finishing the process of packaging the medicine for distribution. Many vaccine manufacturing companies use third parties to fill and finish their vaccines.

[9] https://www.wto.org/english/blogs_e/ddg_anabel_gonzalez_e/blog_ag_22feb22_e.htm.

Figure 4. The growth in COVID-19 vaccines trade has been underpinned by rising exports and imports in materials needed to produce them

USD billion, quarterly data, Q1 2017 – Q2 2021

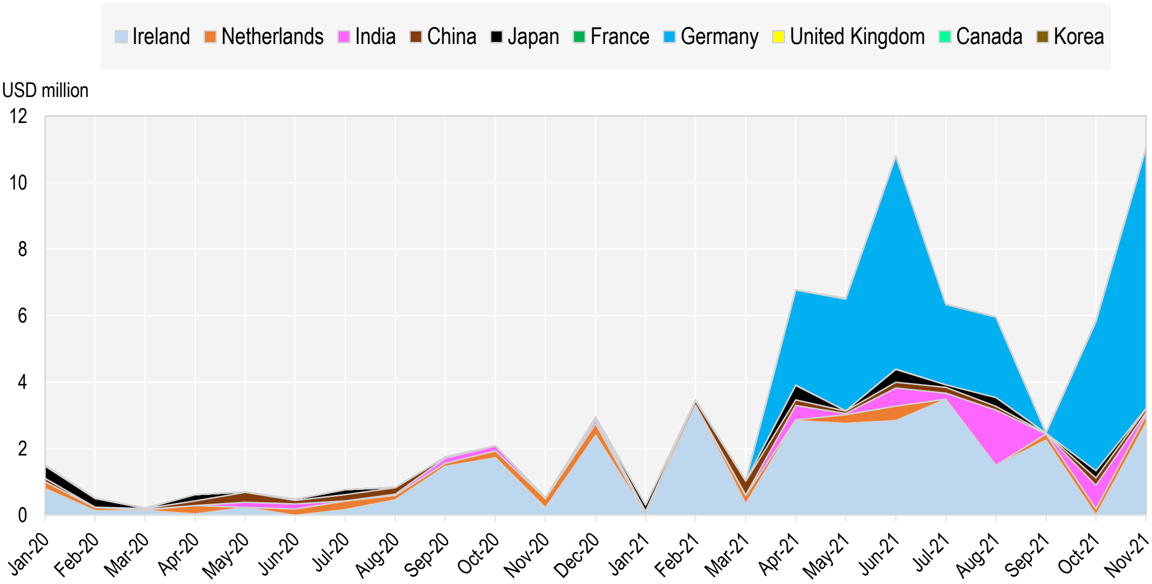




Note: The list of selected manufacturing countries and countries involved in the fill and finish process for five vaccines (Pfizer/BioNTech, Moderna, AstraZeneca, Johnson & Johnson, Novavax) is based on the analysis in Brown and Bollyky (2021[3]) (Annex Table 1.A.1). The list includes the following economies: United States, Belgium, Germany, Ireland, France, Switzerland, Italy, Spain, the Netherlands, Korea, Austria, United Kingdom, India, Australia, Japan, Argentina, Thailand, Mexico, Brazil, Czech Republic. Product categories are identified on the basis of *WTO Joint Indicative List of Critical COVID-19 Vaccine Inputs* and listed in Annex Tables 1.B.3.
Source: ITC Trade Map (2021[7]) and UN COMTRADE (2021[8]) data for India.

Figure 5. Trade enabled access to specialised inputs needed to manufacture COVID-19 vaccines

United States imports of lipid nanoparticles (LNPs), USD million, January 2020 – November 2021



Note: LNPs refers to US HTS code 2906.13.10 covering 'sterols' (using HS 6-digit classification based on the *WTO Joint Indicative List of Critical COVID-19 Vaccine Inputs*).
Source: USITC (2022[10]).

2. Face masks: Trade helped mitigate temporary supply constraints

Face masks have been a key product in helping people protect themselves against the spread of COVID-19. The response of global supply chains to meet worldwide demand for face masks was impressive (OECD, 2020[4]). The example of the United States shows the importance of trade in times of need: imports of face masks rose from a monthly value of around USD 240 million in March 2020 to USD 3.7 billion in May 2020 – a more than 15-fold (+1 449%) increase in just three months (Figure 6). The number of units imported experienced a similar increase (+1 447%) – from 600 million items to 9.4 billion items over the same period – suggesting that the surge was not driven by price effects.[10]

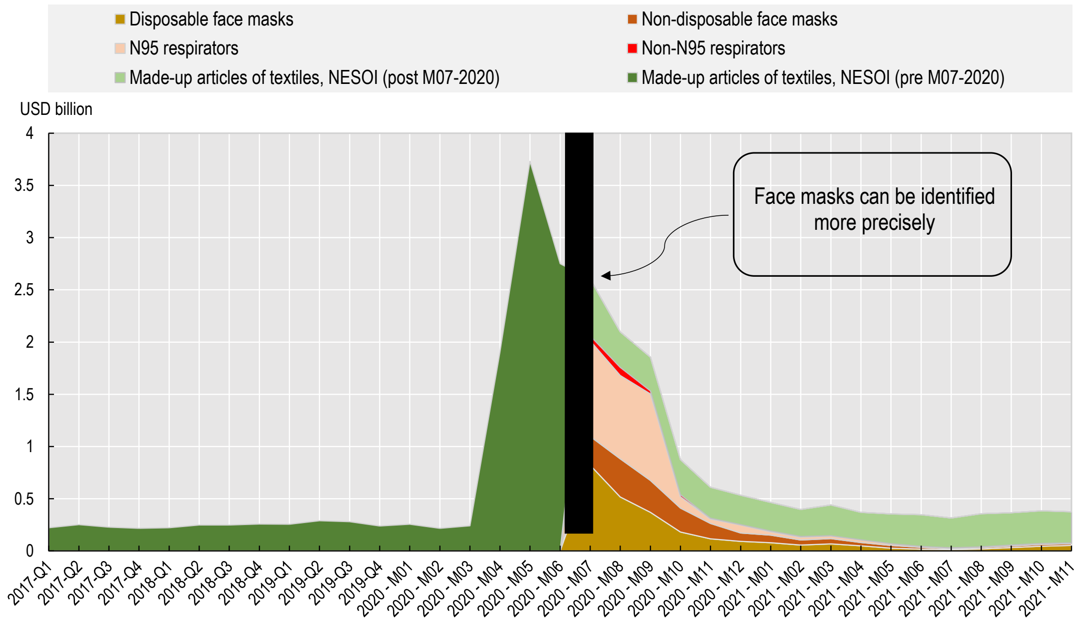
More granular data suggest that N95 respirators and disposable face masks accounted for the largest share of imports in July-October 2020 (35% and 25% respectively), followed by non-disposable face masks (16%). After the initial surge, the data show that imports of face masks stabilised around USD 350-450 million per month throughout 2021, a value slightly above pre-crisis levels.[11] The data also point to a diversification of suppliers. While China accounted for about 94% of the value of disposable face masks imported by the United States in July 2020, the origin of disposable face masks has since diversified with new suppliers emerging: Mexico, Korea, and other countries accounted for 11%, 5% and 4% respectively of the United States' imports of face masks in November 2021 (Figure 7).

[10] These figures refer to changes in the 8-digit code covering face masks (6307.90.98) before further refinements in July 2020 at the 10-digit level.

[11] Underscoring these figures is the role of domestic supply, where there is less visibility (as explained in Box 1). Drawing on business statements, annual production in the United States is estimated to have been three to four times higher in 2020 compared to 2019 (Bown, 2021[15]; USITC, 2020[16]). Information on precise changes in domestic supply for face masks is, however, not available with a comparable degree of detail.

Figure 6. Trade helped meet significant shortages in the face of surging demand at the onset of the pandemic

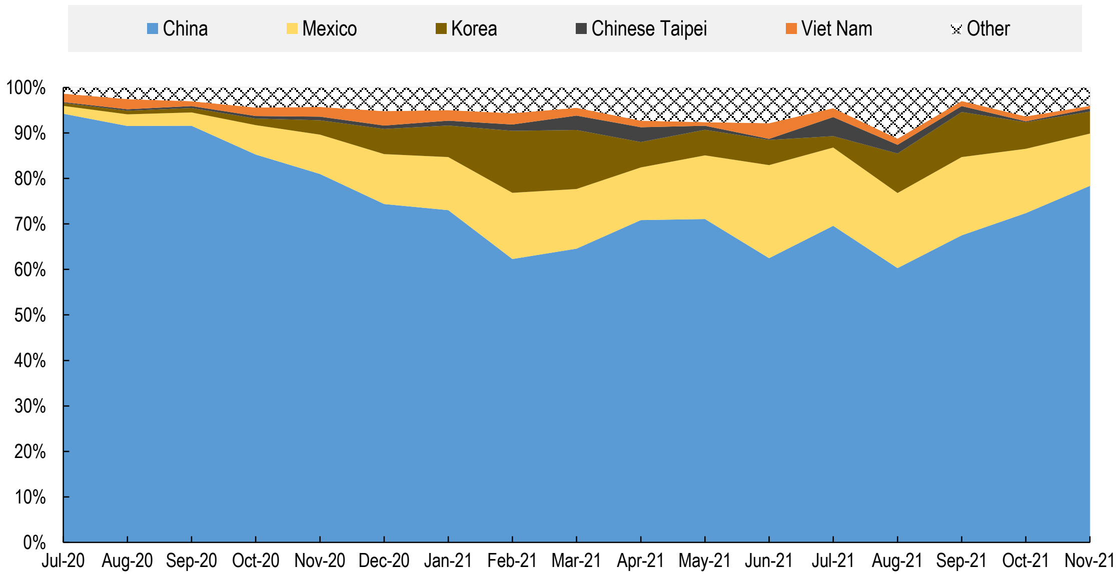
USD billion, January 2017 – November 2021



Note: The figure shows imports into the United States from all partners for HTS code 6307.90.98.89 ("Other made-up articles of textile, not elsewhere specified or included") from January 2017 to July 2020, and imports of disposable face masks (6307.90.98.70), non-disposable face masks (6307.90.98.75), N95 respirators (6307.90.98.45), non-N95 respirators (6307.90.98.50), and other made-up articles of textile, not elsewhere specified or included (post July 2020, code 6307.90.98.91). The average quarterly value is shown for years 2017 to 2019.
Source: USITC (2022[10]).

Figure 7. Supply of disposable face masks to the United States gradually diversified

Origin of disposable face masks imports into the United States, share in imports (%), July 2020 – November 2021

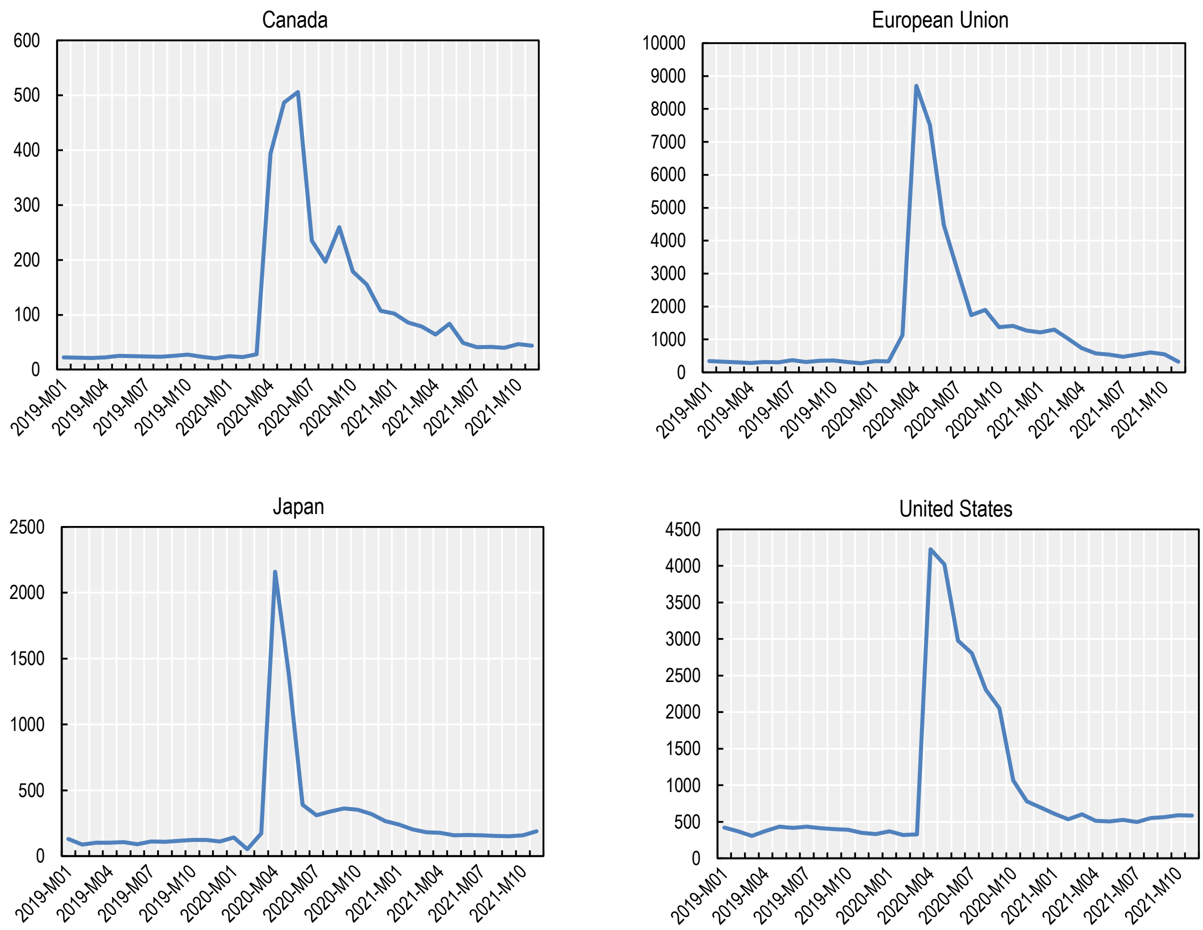


Note: US new HTS code 6307.90.98.91 was introduced in July 2020.
Source: USITC (2022[10]).

The surge and subsequent decline in face mask imports observed in the United States is also common to other major economies, such as Canada, the European Union and Japan (Figure 8). In all these economies, the surge in value was concurrent with a rise in the concentration of imports (i.e. more face masks imported from fewer sources), with China as the main import source. However, imports of specific items, such as N95 and FFP2 face masks, display lower concentration, and countries have since diversified their sourcing towards suppliers such as Korea, Tunisia and Viet Nam (Figure 9).[12]

Figure 8. Imports of face masks helped many economies meet temporary shortages in the face of surging demand

USD million, face masks as captured by the aggregate 6-digit HS code 6307.90

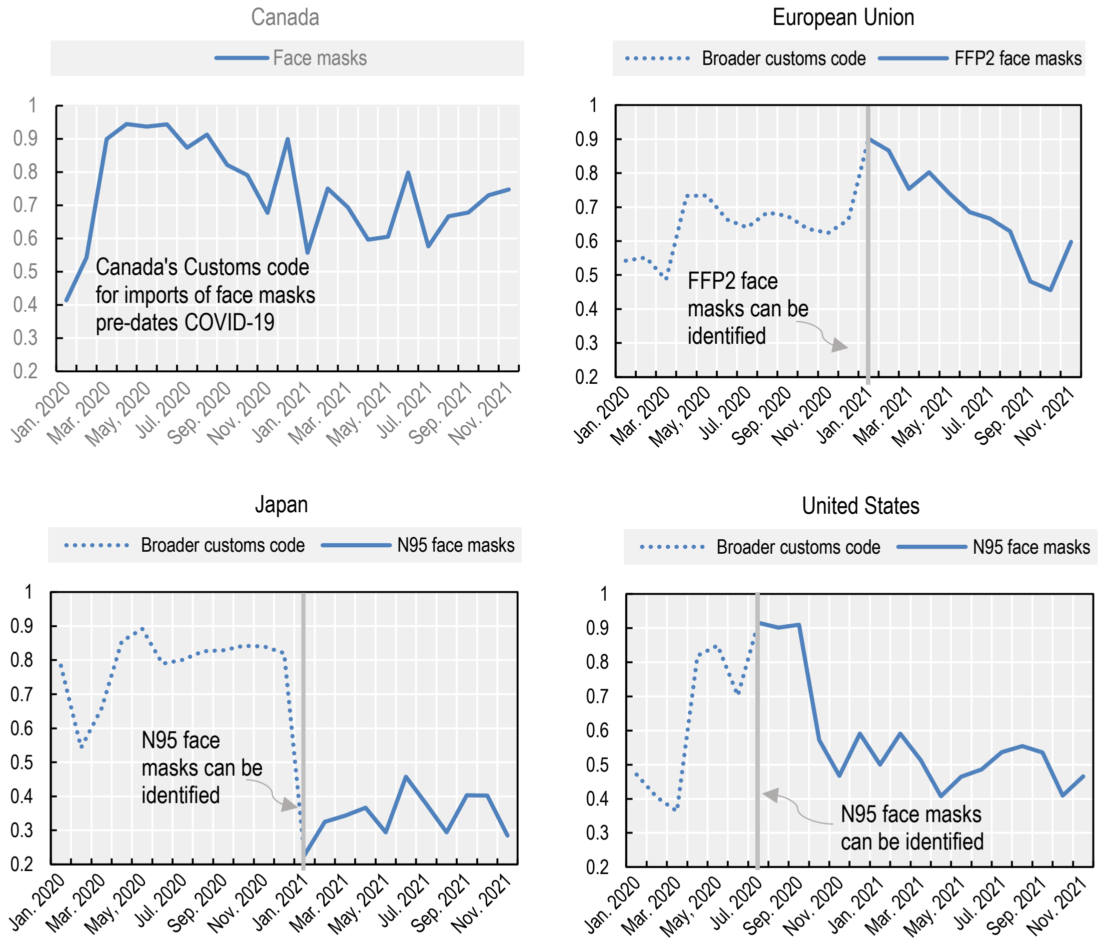


Note: Face masks refer to the aggregate 6-digit HS code 6307.90 in order to observe imports since 2019.
Source: ITC Trade Map (2022[11]) .

[12] The different timings at which these economies introduced dedicated customs codes for these items condition the detail with which trade in face masks can be mapped in the first phases of the crisis.

Figure 9. Supply of face masks imports became less concentrated at later stages of the COVID-19 pandemic

Concentration index for imports of face masks (N95, FFP2 and other types)



Note: The charts show the HH index (HHI) for face masks imports into Canada, European Union, Japan and the United States, calculated as the sum of the following: the share of each country's exported quantity of face masks over the total face masks exported to a given partner (e.g. Canada) to the power of two. HHI index for imports of N95 (United States and Japan), FFP2 (European Union) and generally defined face masks (Canada). Concentration is shown in terms of number of units imported for the United States, European Union and Japan, and in terms of kg of face masks imported for Canada. HS code 6307.90.99.20 (Face masks) is used for Canada as NIOSH approved respirators are grouped in a different customs code with other textile items. The code 6307.90.99.20 for Canada pre-dates the COVID-19 pandemic. Only extra-EU trade is considered for the European Union index. The concentration index is shown for the period specific customs nomenclatures that are available for the four economies. Broader customs code refer to 6307.90.90.98 for the European Union, 6307.90.29 for Japan, and 6307.90.98.89 for the United States.

Source: Statistics Canada (2022[12]), EUROSTAT (2022[9]), Statistics of Japan (2022[13]) and USITC (2022[10]).

Overall, the analysis for ***face masks*** suggests an impressive, albeit temporary, increase in imports to meet unprecedented surges in demand in the early stages of the pandemic. In the space of three months, face mask imports increased more than 15-fold in both value and volume in the United States, with similar surges observed in other major economies such as Canada, the European Union, and Japan. This surge in demand was largely met by greater imports from China, but this was temporary, with imports of face masks falling dramatically after the initial spike and sources of imports becoming more diversified. This suggests that trade and global supply chains played an important role in enabling countries to mitigate temporary supply constraints for essential goods in the face of surges in demand.

3. COVID-19 tests: Trade helped address temporary shortages and enabled sustained access

COVID-19 tests[13] have been another key element in the fight against COVID-19, helping to detect the virus and thereby enabling action to prevent its spread. Tests are composed of a number of products, including nasal swabs, laboratory reagents (i.e. the liquid that changes colour when in contact with the virus), viral transport media (i.e. the "packaging" needed to transfer sample tests to laboratories without contamination), and simpler plastic consumables (e.g. packaging for the swabs; container; tube; cap; cassette case) (USITC, 2021[14]). This implies that there is no single customs code identifying "COVID-19 tests". The different components are also generally more difficult to track in national nomenclatures than other COVID-19 items.[14]

Laboratory reagents can provide a proxy measure for the analysis of trade in COVID-19 tests. Here, the data show that trade exhibited a more moderate, yet more sustained, increase during the pandemic relative to products like face masks. Compared to pre-pandemic levels, exports of laboratory reagents were between 33% and 77% higher in some of the previously top exporters such as the United States (39% increase), Germany (33%), the Netherlands (77%), or Belgium (67%) (Figure 10).[15]

In addition to the notable increase in exports, new suppliers have emerged in the global market for inputs since the onset of the pandemic. For instance, Korea and China have experienced a more than 10-fold increase in exports of laboratory reagents since February 2020 (Figure 11). While Korea accounted for around 1% of laboratory reagents exports in 2019,[16] it became the 5th largest global supplier of laboratory reagents in 2020, accounting for almost 6% of global exports.[17]

[13] COVID-19 tests refer to RT-PCR and (rapid) antigen tests.

[14] The United States is an exception, as it created dedicated customs codes for flocked nasal swabs (HTS code 5601.22.00.50) or PCR laboratory reagents (HTS code 3822.00.50.50). The codes for antigen laboratory reagents (HTS code 3822.00.10.10 and 3822.00.10.90) pre-date COVID-19.

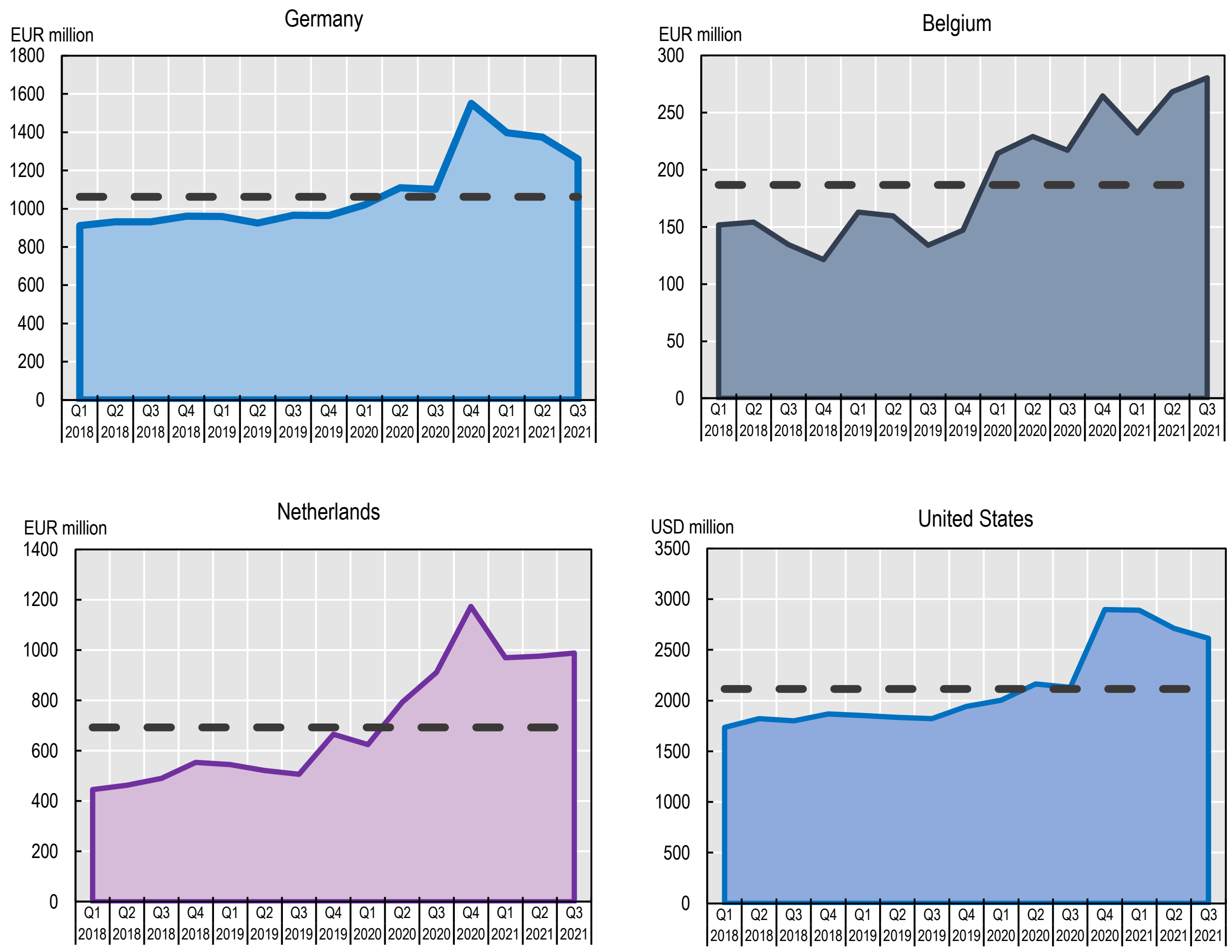
[15] The percentage increase is calculated as the difference between the periods March 2020 – November 2021 and March 2018 – November 2019. According to the CEPII BACI database, the United States was the top exporter of laboratory reagents in 2019, Germany the 2nd top exporter, the Netherlands the 4th top exporter, and Belgium the 12th top exporter.

[16] Estimates from the CEPII BACI database.

[17] Estimates from the ITC Trade Map database – based on the sample of available countries for the period.

Figure 10. Top exporters of laboratory reagents saw sustained increases in export growth

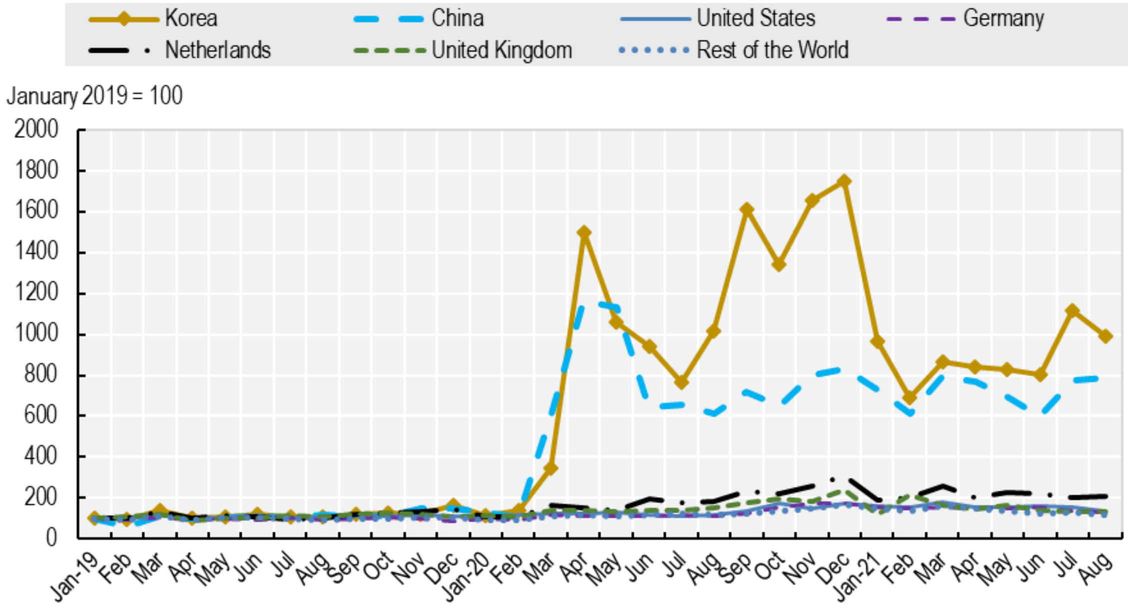
EUR and USD million, January 2017 – November 2021



Note: The blue dashed line refers to the average exports over the sample period (Q1 2018 – Q3 2021) for each country. Laboratory reagents identified by the HS 6-digit code 3822.00.
Source: EUROSTAT (2022[9]) and USITC (2022[10]). Creative Commons for the flags.

Figure 11. Korea and China significantly scaled up exports of laboratory reagents relative to the pre-pandemic top exporters

January 2019=100

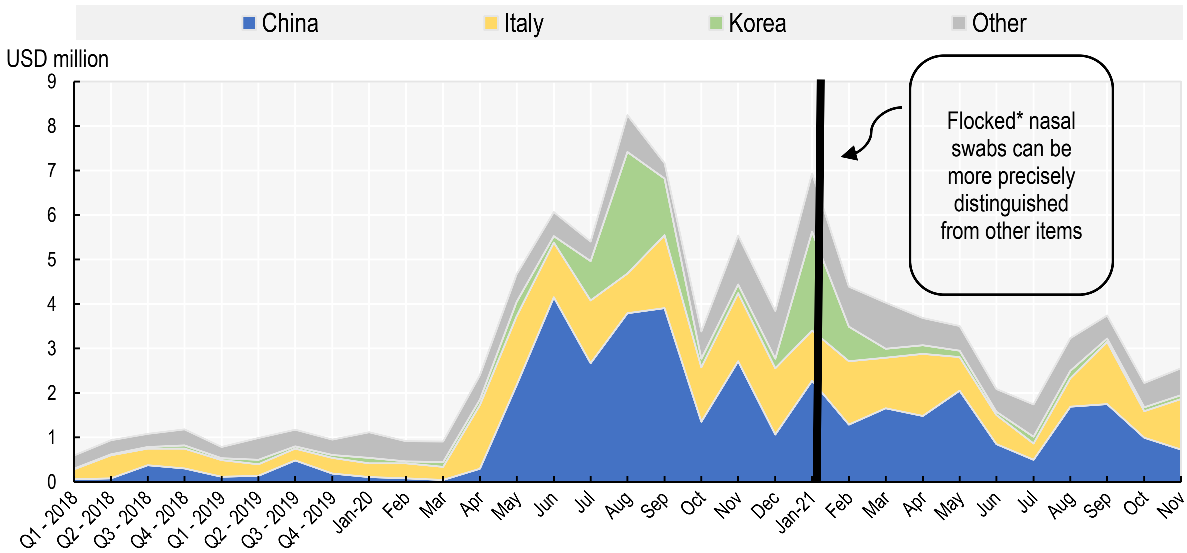


Note: Laboratory reagents identified by the HS 6-digit code 3822.00. The United States, Germany, the United Kingdom and the Netherlands were respectively the first, second, third and fourth top exporters of laboratory reagents in 2019, according to the CEPII BACI database.
Source: ITC Trade Map (2021[7]).

Trade in different items needed in the testing process helps illustrate some of the interlinkages that underpin the role of trade in availability of COVID-19 products. Access to complementary components via imports was key in addressing shortages in nasal swabs required for COVID-19 testing in the United States (Figure 12) (USITC, 2021[14]) or in meeting higher demand for viral transport media during the Q4 2020 – Q1 2021 COVID-19 wave in the United Kingdom (Figure 12).

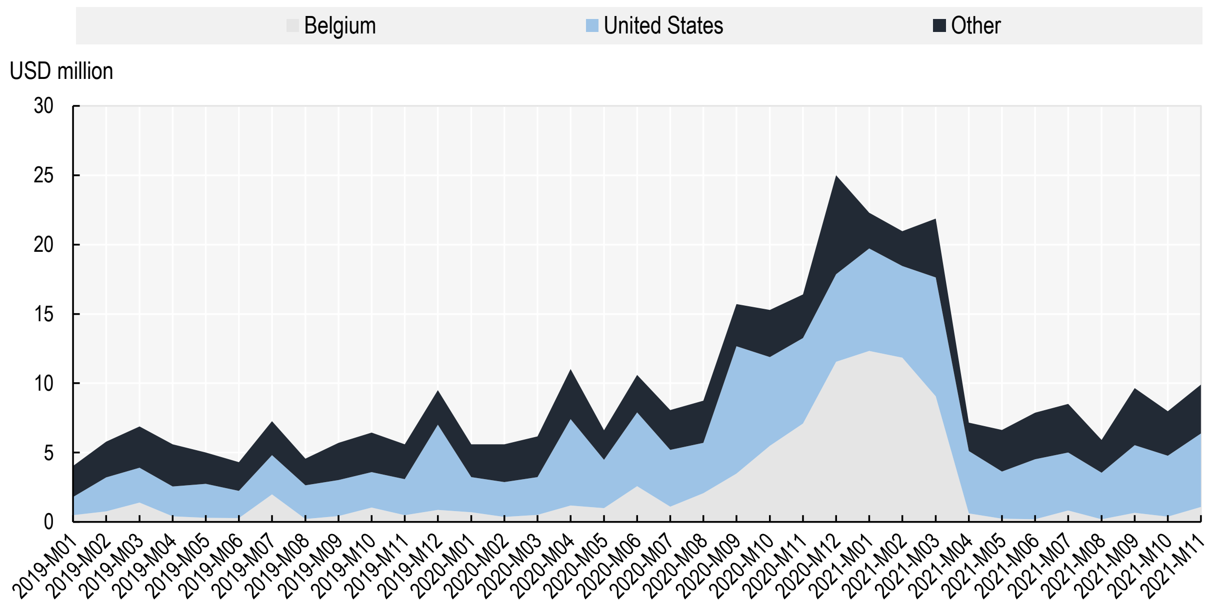
Figure 12. Trade helped mitigate the impact of demand pressures in the short-run for specific components of COVID-19 tests

a. United States imports of flocked nasal swabs, USD million, Q1 2018 – November 2021



Note: *Flocked nasal swabs are characterised by fibres attached to the plastic stick in controlled configurations, which make them particularly suitable for COVID-19 testing (USITC, 2021[14]).The figure shows the evolution of nasal swabs imports into the United States, as captured by HS code 5601.22 before January 2021 and HTS 5601.22.50 (flocked swabs) from January 2021 onwards (as indicated by the blue line, when the code was introduced in HTS). The average quarterly value is displayed for years 2018-2019.
Source: USITC (2021[14]) and USITC (2022[10]).

b. United Kingdom imports of viral transport medium, USD million, January 2019 – November 2021



Note: Viral transport medium as captured by the HS 6-digit code 3821.00.
Source: ITC Trade Map (2022[11]).

The analysis for ***COVID-19 tests*** shows a further role for trade in helping countries fight COVID-19 through supply of essential inputs. Some products saw sustained growth during the early stages of the pandemic – exports of laboratory reagents were up to 77% higher relative to pre-crisis levels across a number of countries. By contrast, products such as nasal swabs or viral transport media saw initial surges in demand that later stabilised at levels somewhat above those observed before the pandemic. Overall, trade enabled both the mitigation of temporary supply constraints in the face of demand surges, as well as more sustained access for these essential products.

4. Conclusions

The COVID-19 pandemic has generated a wide-ranging debate on the role of trade in supplying essential goods, such as those needed to fight the COVID-19 pandemic. To inform this debate, in the early stages of the COVID-19 pandemic, OECD analysis mapped international trade in COVID-19 medical goods, vaccines and related inputs using data that pre-dated the pandemic (OECD, 2020[4]; OECD, 2020[1]; OECD, 2021[2]). This painted a broad picture of supply and demand conditions that prevailed in international markets ahead of the pandemic, highlighting interdependencies in the production of COVID-19 medical goods, vaccines and related inputs. But data limitations meant that it was unable to provide insights into the ongoing role of trade as the pandemic unfolded.

This note uses new cross-country trade data to provide preliminary insights into the role of trade during the COVID-19 pandemic, focusing on selected products that were key in the fight against COVID-19: vaccines, face masks and tests.

The analysis confirms that trade and global supply chains played a critical role in helping countries gain access to the essential products needed to fight COVID-19. Trade enabled access to COVID-19 vaccines for many countries that could not produce them. Trade and global supply chains helped address severe supply shortages in access to face masks during the initial stages of the pandemic. Trade also played a key role in addressing more sustained access to laboratory reagents that are needed for the production of COVID-19 tests, and in helping meet supply shortages in related products like nasal swabs. This analysis shows global supply chains at work: agile and resilient supply chains, enabled by global trade, support access in the face of unprecedented changes in demand for the products needed to fight COVID-19.

By highlighting the role of trade in helping fight COVID-19, this brief also underscores that risk management and broader resilience strategies going forward can usefully draw more on new and up-to-date data reflecting the developments during the pandemic for whole-of-supply-chain considerations.

All countries are facing challenges in ensuring that their populations are vaccinated, protected and tested, but not all countries produce all the goods needed to do this. Trade enables access to the final and intermediate goods that underpin their supply. Open markets, transparency and trade facilitation can ensure greater ease of access to these products.

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Annex 1.A. Global supply chains in the manufacturing of COVID-19 vaccines

Annex Table 1.A.1. The manufacturing of COVID-19 vaccines is taking place across a wide set of countries

By type of vaccine

COVID-19 vaccine type	COVID-19 vaccine producer	Selected specialised inputs	Manufacturing	Fill & finish process
mRNA	Pfizer/BioNTech	*Lipid nanoparticles*: United States, United Kingdom, Austria, Germany	United States, Belgium, Germany, Ireland, Brazil[1]	United States, Belgium, Germany, France, Switzerland, Italy
	Moderna	*Lipid nanoparticles*: United States, France, Switzerland	United States, Switzerland, Spain, Netherlands	United States, Spain, France, Korea
Adenovirus	AstraZeneca		United Kingdom, United States, Belgium, Netherlands, India, Australia, Japan, Argentina, Thailand	United Kingdom, United States, Italy, Germany, Australia, Japan, Mexico, Brazil
	Johnson & Johnson		Netherlands, United States, India	United States, Italy, Spain, France, Germany, India, South Africa
Protein	Novavax		Czech Republic, Spain, United States, United Kingdom, Korea, India, Japan	Germany, United States, United Kingdom

Note: [1] Production foreseen to start in 2022.
Source: Brown and Bollyky (2021[3]).

Annex 1.B. Harmonised System codes for COVID-19 products and vaccines

Annex Table 1.B.1. HS 6-digit codes for face masks and eye protection in the WCO list of COVID-19 goods

Product group	Product name	HS 6-digit code
Face and eye protection	Cellulose/paper masks	4818.90
Face and eye protection	Textile face-masks, without a replaceable filter or mechanical parts, including surgical masks and disposable face-masks made of non-woven textiles. This includes the masks known as N95 Particulate Respirators	6307.90
Face and eye protection	Gas masks with mechanical parts or replaceable filters for protection against biological agents. Also includes such masks incorporating eye protection or facial shields	9020.00
Face and eye protection	Protective spectacles and goggles	9004.90
Face and eye protection	Plastic face shields	3926.90

Source: WCO list COVID-19 goods, Edition 3, http://www.wcoomd.org/-/media/wco/public/global/pdf/topics/nomenclature/covid_19/hs-classification-reference_edition-3_en.pdf?la=en.

Annex Table 1.B.2. HS 6-digit codes for COVID-19 tests and instruments used in diagnostic testing in the WCO list of COVID-19 goods

Product group	Product name	HS 6 digit code
COVID-19 Test kits / Instruments and apparatus used in Diagnostic Testing	COVID-19 Test kits Diagnostic reagents based on polymerase chain reaction (PCR) nucleic acid test	3822.00
COVID-19 Test kits / Instruments and apparatus used in Diagnostic Testing	COVID-19 Test kits Diagnostic reagents based on immunological reactions	3002.15
COVID-19 Test kits / Instruments and apparatus used in Diagnostic Testing	COVID-19 Diagnostic Test instruments and apparatus Instruments used in clinical laboratories for In Vitro Diagnosis	9027.80
COVID-19 Test kits / Instruments and apparatus used in Diagnostic Testing	Swab and Viral transport medium set (a vial containing a culture media for the maintenance of a viral sample and a cotton tipped swab to collect the sample put up together)	3821.00

Source: WCO list COVID-19 goods, Edition 3, http://www.wcoomd.org/-/media/wco/public/global/pdf/topics/nomenclature/covid_19/hs-classification-reference_edition-3_en.pdf?la=en .

Annex Table 1.B.3. Selected COVID-19 vaccines inputs based on the WTO Joint Indicative List of Critical COVID-19 Vaccine Inputs

Product group	Product name	HS 6-digit code
COVID-19 vaccines	Vaccines	3002.20
COVID-19 vaccines: Inactive ingredients - mRNA	1,2-distearoyl-sn-glycero-3-phosphocholine	2923.20
COVID-19 vaccines: Inactive ingredients - mRNA	SM-102: heptadecane-9-yl 8-((2-hydroxyethyl) (6-oxo-6-(undecyloxy) hexyl) amino) octanoate	2922.50
COVID-19 vaccines: Inactive ingredients - mRNA	(4-hydroxybutyl)azanediyl)bis(hexane-6,1-diyl)bis(2-hexyldecanoate)	2922.50
COVID-19 vaccines: Inactive ingredients - mRNA	Cholesterol (LNPs)	2906.13
COVID-19 vaccines: Inactive ingredients - mRNA	Monobasic potassium phosphate	2835.24
COVID-19 vaccines: Inactive ingredients - mRNA	Dibasic sodium phosphate dihydrate	2835.22
COVID-19 vaccines: Inactive ingredients - mRNA	Tromethamine; Tromethamine hydrochloride	2922.19
COVID-19 vaccines: Inactive ingredients - mRNA	Acetic acid	2915.21
COVID-19 vaccines: Inactive ingredients - mRNA	Sodium acetate	2915.29
COVID-19 vaccines: Inactive ingredients - mRNA	Potassium chloride	3104.20
COVID-19 vaccines: Inactive ingredients - mRNA, adenovirus	Sodium chloride	2501.00
COVID-19 vaccines: Inactive ingredients - mRNA, adenovirus	Chemically pure sucrose, in solid form	1701.99
COVID-19 vaccines: Inactive ingredients - adenovirus	Polysorbate-80	3402.13
COVID-19 vaccines: Inactive ingredients - adenovirus	2-hydroxypropyl-○̂cyclodextrin	3505.10
COVID-19 vaccines: Inactive ingredients - adenovirus	Citric acid monohydrate	2918.14
COVID-19 vaccines: Inactive ingredients - adenovirus	Trisodium citrate dihydrate	2918.15
COVID-19 vaccines: Inactive ingredients - adenovirus	Ethanol	2207.10
COVID-19 vaccines: Inactive ingredients - adenovirus	Sodium hydroxide, solid	2815.11
COVID-19 vaccines: Inactive ingredients - adenovirus	Sodium hydroxide, in aqueous solution (sodalye or liquid soda)	2815.12
COVID-19 vaccines: Inactive ingredients - adenovirus	Hydrochloric acid	2806.10
COVID-19 vaccines: Inactive ingredients - adenovirus	L-Histidine; L-Histidine hydrochloride monohydrate	2933.29
COVID-19 vaccines: Inactive ingredients - adenovirus	Magnesium chloride hexahydrate	2827.31
COVID-19 vaccines: Inactive ingredients - adenovirus	Disodium edetate dihydrate	2922.49
COVID-19 vaccines: Consumables	Single-use bioreactor bags	3926.90
COVID-19 vaccines: Consumables	Liquid storage bags, of polymers of ethylene	3923.21
COVID-19 vaccines: Consumables	Plastic bag with inbuilt filter for the sterile filtration, storage and transfer of biopharmaceutical fluids, of polymers of ethylene	3923.21
COVID-19 vaccines: Consumables	Liquid storage bags, of other plastics	3923.29
COVID-19 vaccines: Consumables	Plastic bag with inbuilt filter for the sterile filtration, storage and transfer of biopharmaceutical fluids, of other polymers	3923.29

Product group	Product name	HS 6-digit code
COVID-19 vaccines: Consumables	Erlenmeyer flasks, of fused quartz or other fused silica	7017.10
COVID-19 vaccines: Consumables	Erlenmeyer flasks, of other glass having a linear coefficient of expansion not exceeding 5 x 10-6 per Kelvin within a temperature range of 0 °C to 300 °C	7017.20
COVID-19 vaccines: Consumables	Erlenmeyer flasks, of other glass	7017.90
COVID-19 vaccines: Consumables	Cell culture media	3821.00
COVID-19 vaccines: Consumables	PETG sterile bottle	3923.30
COVID-19 vaccines: Consumables	Reagents, reagent packs, and laboratory kits	3822.00
COVID-19 vaccines: Consumables	Sterile connector, of plastic	3917.40
COVID-19 vaccines: Consumables	Microporous plastic membrane materials incorporated in a housing	8421.29
COVID-19 vaccines: Consumables	Filters for fluids	8421.29
COVID-19 vaccines: Consumables	Filters and tubing, single-use assemblies consisting of plastic components that are used in diverse bioprocessing step	8421.29
COVID-19 vaccines: Equipment	Bioreactor (biological reactor), with thermal control mechanism	8419.89
COVID-19 vaccines: Equipment	Bioreactor (biological reactor), fitted with mechanical devices but no heating or cooling (including not being a double walled system for circulating heating or cooling fluid)	8479.89
COVID-19 vaccines: Equipment	Medical, surgical or laboratory sterilisers	8419.20
COVID-19 vaccines: Equipment	Machinery for filling, closing, sealing, or labelling bottles, cans, boxes, bags or other containers; machinery for capsuling bottles, jars, tubes and similar containers	8422.30
COVID-19 vaccines: Equipment	Microfluid and nanofluid mixers	8479.82
COVID-19 vaccines: Equipment	Incubating shakers	8479.82
COVID-19 vaccines: Equipment	Chromatography system	9027.20
COVID-19 vaccines: Equipment	Part of chromatography equipment	9027.90
COVID-19 vaccines: Equipment	Regulating or controlling instruments and apparatus, excluding thermostats, manostats and hydraulic or pneumatic instruments	9032.89
COVID-19 vaccines: Packaging	Vials	7010.90
COVID-19 vaccines: Packaging	Metal crimp seals for glass vials	8309.90
COVID-19 vaccines: Packaging	Stoppers, of vulcanised rubber (excluding hard rubber)	4016.99
COVID-19 vaccines: Transportation and storage	Cold boxes of plastics	3923.10
COVID-19 vaccines: Transportation and storage	Freezers of the chest type, not exceeding 800 l capacity	8418.30
COVID-19 vaccines: Transportation and storage	Freezers of the upright type, not exceeding 900 l capacity	8418.40
COVID-19 vaccines: Transportation and storage	Dry ice	2811.21
COVID-19 vaccines: Administration	Adhesive dressings and other articles having an adhesive layer	3005.10
COVID-19 vaccines: Administration	Syringes	9018.31
COVID-19 vaccines: Administration	Needles, of metal	9018.32

Source: WTO joint list of critical COVID-19 vaccines inputs (Version1.0), https://www.wto.org/english/tratop_e/covid19_e/vaccine_inputs_report_e.pdf .

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