Using trade to fight COVID-19: Manufacturing and distributing vaccines

11 February 2021

All countries need vaccines but not all can produce them. Vaccine production is highly specialised, subject to comparative advantages, and concentrated in few countries, making trade a vital means to deploying vaccines broadly. Keeping markets open by reducing tariffs, streamlining trade-related processes at and behind the border while ensuring better co-ordination of logistical processes will be key to ensuring timely access to vaccines for all. This note discusses trade and trade policy considerations underpinning access to the final and intermediate goods needed to effectively produce, deliver and administer COVID-19 vaccines. It focuses on the international aspects of the vaccine supply chain, discussing the sourcing, production, distribution and need to expedite international border crossing and transportation (including in the context of the cold supply chain).

Key messages

Announcements on the efficacy of emerging COVID-19 vaccines have provided a glimmer of light at the end of the tunnel. However, **mass manufacturing and distribution of vaccines will continue to pose challenges**. An analysis of the international aspects of the vaccine supply chain shows that:

- **All countries need vaccines, but not all are able to produce them**. Vaccine production is highly specialised and subject to comparative advantages. Trade will therefore play a key role in enabling access to COVID-19 vaccines, especially for developing countries.
- **There are strong trade interdependencies in the goods needed to produce, distribute and administer vaccines**. Besides the active ingredients needed to produce vaccines, distribution and administration requires access to goods produced across a range of countries: vials to move the vaccines, syringes to administer, cold boxes to transport, dry ice to maintain cold temperatures, and freezers to store.
- **The production of COVID-19 vaccines is likely to be geographically concentrated, but the demand is global**. Distributing vaccines poses significant logistical challenges that could be addressed by:
  - **Promoting online communications hubs to share information** on existing manufacturing facilities and connecting potential distributors.
  - **Keeping markets open**. Despite strong trade interdependencies, tariffs on vaccines and key inputs remain and will negatively impact the ability to get vaccines to where they are needed. Duties on vaccines exist in 22% of economies, with 8% applying duties above 5%. Average world tariffs on vaccine ingredients such as preservatives, adjuvants, stabilisers, antibiotics range between 2.6% and 9.4%. It will also be important that countries avoid export restrictions on both intermediate and final goods to ensure vaccines can be effectively distributed.
  - **Increasing international co-operation and co-ordination to enable vaccines to move seamlessly across borders**. Focus might be best placed on streamlining processes at the border, ensuring better co-ordination of logistical processes, and relaxing, where possible and without prejudice to safety, trade-related regulatory burdens.

Ensuring access to the medical equipment and related goods needed to fight COVID-19 was an immediate challenge during the first wave of the pandemic. Analysis revealed that no country was able to efficiently produce all the goods needed to fight the virus, highlighting the high degree of trade interdependencies between countries (OECD, 2020[1]). During the second wave, promising announcements by Pfizer-BioNTech, Moderna, and Astra-Zeneca/Oxford University on the efficacy of vaccines in development, and subsequent publications of clinical trial results and marketing authorisations for these products in several OECD countries, have provided a glimmer of light at the end of the tunnel. Here too, trade will play a key role in enabling mass production and distribution of vaccines across the globe (WTO, 2020[2]).

All countries need vaccines, but not all are able to produce them

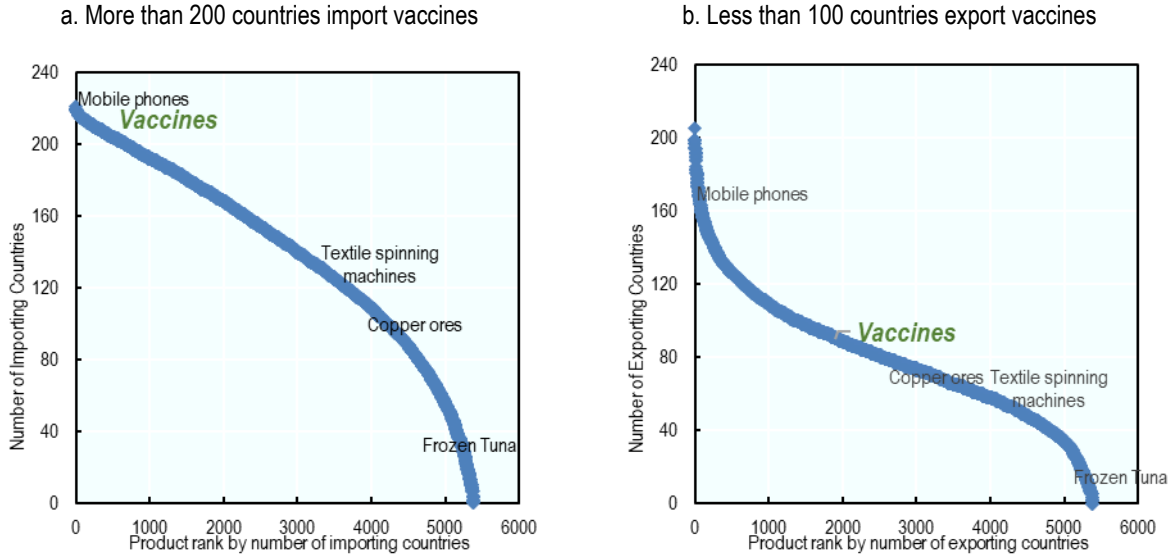
Vaccine manufacturing is a sophisticated process that requires access to specialised equipment and inputs, storage facilities, and highly skilled labour.

Trade data can provide useful insights into the supply and demand conditions that existed for vaccines prior to COVID-19, thereby helping to identify the production capacities and existing trade infrastructure that can be exploited for the distribution of new vaccines. Vaccines (for human use) are

classified under a single Harmonised System (HS) code (300220).[1] This facilitates the analysis of broad supply and demand conditions, albeit at the expense of more detailed information on which vaccines are traded by which countries.

The most recently available trade data reveal that **while vaccines are imported by most countries around the globe, they are in relative terms exported by few countries** (Figure 1).[2] Vaccines are imported by 208 economies (relative to other products, vaccines are in the 6th percentile in terms of the total number of importing countries); whereas they are exported by 90 economies (relative to other products, vaccines are in the 35th percentile in terms of total number of exporting countries). All countries need vaccines but not all are able to produce them.

Figure 1. All countries need vaccines, but not all are able to produce these



Note: These graphs rank products according to how many countries import/export these. For instance, in terms of imports, vaccines, imported by 208 countries, are the 347th most imported product out of a possible 5 384 traded products; in contrast, mobile phones are the 50th most imported product and frozen tuna the 5 327th most imported product. Where exports are concerned, vaccines are exported by 90 countries, making these the 1 904th most exported product.
Source: Own calculations using BACI database.

There is significant concentration in the exports of vaccines. The top 10 exporters account for 93% of global export value (80% in terms of volume). Ireland is the top exporter by value, accounting for 28% of global exports, followed by Belgium (which is the top exporter by volume) representing 21%[3] (Figure 2). Rankings of export volumes differ from value rankings, revealing significant heterogeneity in unit prices across suppliers. Imports are, in relative terms, less concentrated in both value and volume although the

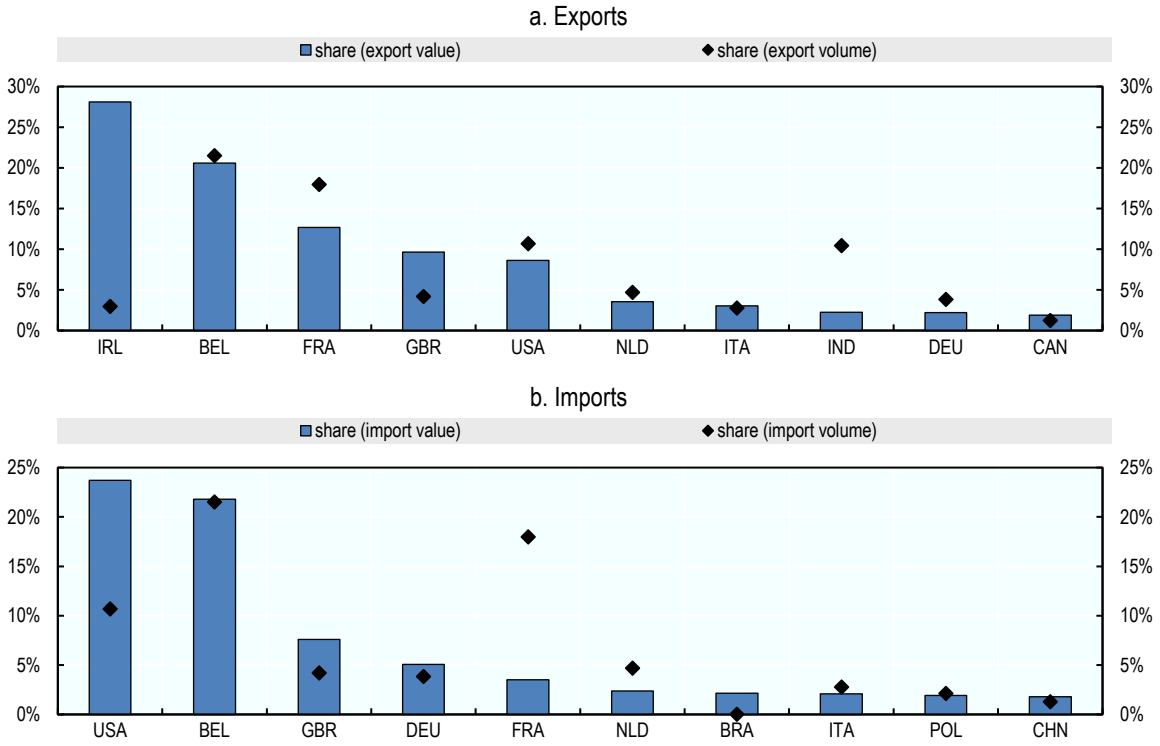
[1] This category includes all possible vaccines for human use.

[2] Latest available CEPII BACI data for 2018 was used. Trade patterns for vaccines seem stable in recent years for which data are available; as such, 2018 data accurately reflect trade patterns prior to the COVID-19 outbreak.

[3] Different vaccine producers locate across different markets. For instance, COVID-19 vaccine producers such as Astra-Zeneca, Pfizer, or Johnson & Johnson have affiliates established across the top vaccine exporters in Figure 2a (OECD Analytical Database on Individual Multinationals and Affiliates, 2019[16]).

top 10 importers still represent 72% of global import values (69% in terms of volume). The United States is the top importer with 24% of global imports, followed by Belgium with 22% of global imports (Figure 2b).[4]

Figure 2. Exports of vaccines are concentrated in few countries



Note: Share of global export and import values and volumes in 2018.
Source: Own calculations using BACI database.

Developing economies depend on high-income countries for vaccines. The European Union (EU) is the main source of vaccine imports for all regions. In particular, South Asia and Sub-Saharan Africa import more than two-thirds of their vaccines from the European Union (Annex A). East Asia and South Asia are nevertheless increasingly becoming a source of vaccines for other developing regions.

Countries with higher per capita GDP export vaccines having higher unit values, suggesting that richer countries specialise in higher-end, more complex vaccine production (Annex A). However, in terms of imported vaccines there is less dispersion in unit values.[5] This indicates strong specialisation patterns along comparative advantages: **countries will specialise in the production of some types of vaccine but use imports to access others.**[6]

[4] Belgium is both a strong exporter and importer owing to its strong pharmaceutical cluster which includes not only production but also packaging of vaccines. Moreover, Belgium has a fast clinical trial approval process and is therefore one of the world's prime locations for clinical trials in per capita terms (Abrahamsen et al., 2011[17]).

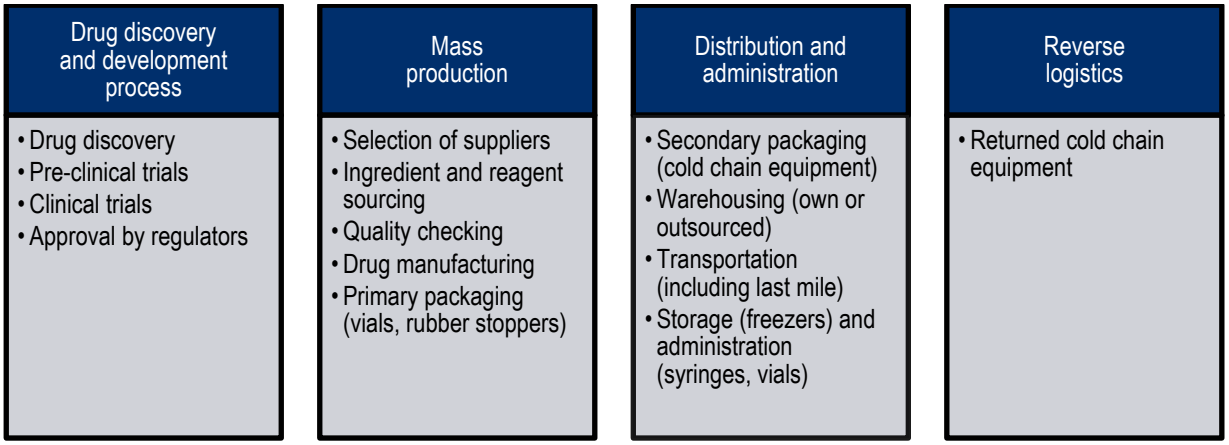
[5] For example, in Ireland (28% of global exports in value, but 3% in volume) vaccines are exported at a unit value of around USD 10 000 per kg. By contrast, the export unit value of India (2% of global exports in value, but 8% in volume), is USD 230 per kg. In turn, the import unit value of the top importer (the United States, representing 24% of global imports in value and 11% in volume) is USD 3 800 per kg, while it is around USD 1 000 per kg in India (representing 1% of global imports in value and 10% in volume).

[6] This is further supported by evidence of specialisation in manufacturing of the drug substances used in vaccines. Survey results show that for substances such as microbial or yeast expression systems, recombinant protein from

There are strong trade interdependencies along the vaccine supply chain

The safe and timely delivery of vaccines depends on the efficiency of the supply chains that underlie their production and distribution. Although each vaccine will involve different components, the vaccine supply chain can be broken down into three, and sometimes four, key steps (depending on the vaccine) (Figure 3). The first is the *drug discovery process*, the second *mass production*, the third *distribution and administration*, and the last the *reverse logistics* (in the event that products such as cool boxes need to be returned). Different stages of this supply chain will be located in different countries. Indeed, while mass production might be geographically concentrated, many of the ingredients needed in production or for primary and secondary packaging will come from different sources. This means that trade will play an important role in enabling mass production, distribution, and administration of vaccines.

Figure 3. The vaccine supply chain



Note: For illustrative purposes only as the supply chain will differ across different vaccines.
Source: Authors' elaboration.

Vaccine production involves a complex range of steps that require not only significant up-front investment in R&D (WTO, 2020[2]), but also in selecting suppliers of key ingredients, setting up manufacturing processes[7] and quality checks, and sourcing primary and secondary packaging. Each vaccine has specific active components (the antigen) that generate different immune responses. Some contain an inactivated form or component of the disease-causing organism; in the case of some of the novel COVID-19 vaccines, a blueprint enables the intercellular production of the antigen.[8] The latter will determine the manufacturing process and the type of production facility that is needed.

suspension cells, recombinant protein from insect cells; and viruses, India has the largest production capacity followed by Europe and North America. Europe has the largest production capacity for DNA and RNA-based drug substance, followed by the United States (CEPI, 2020[3]).

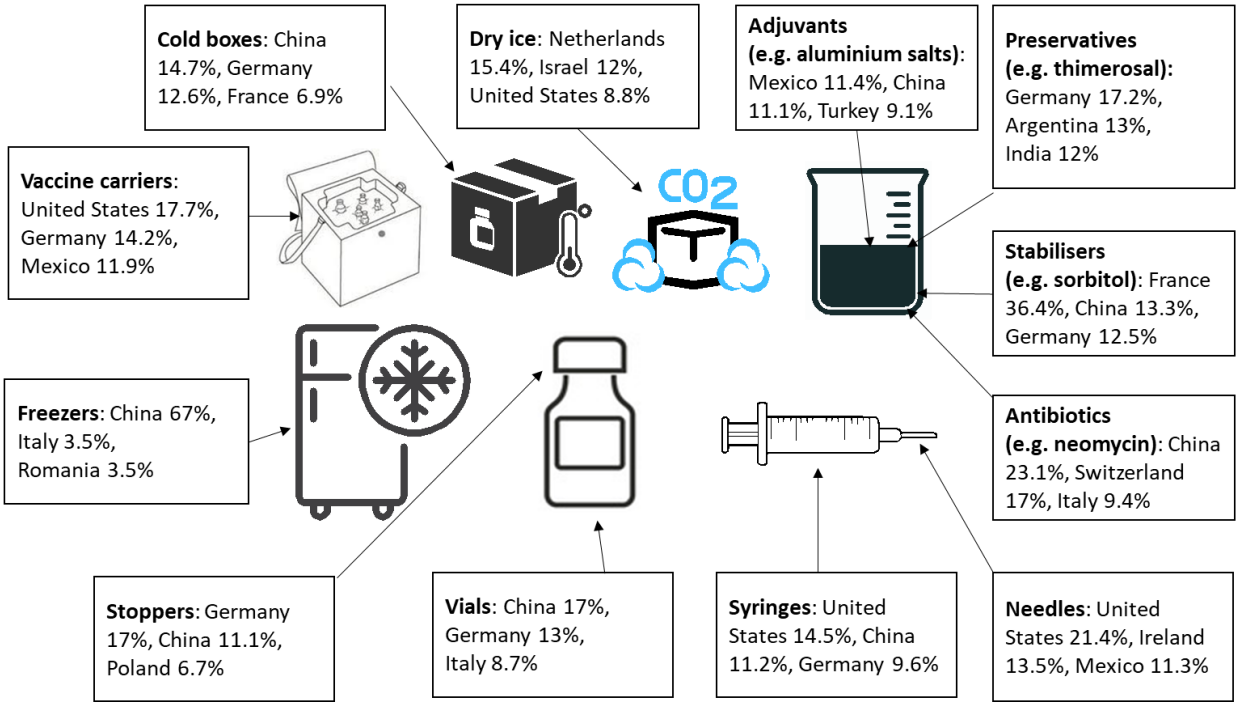
[7] For issues around Trade-Related Aspects of Intellectual Property Rights (the TRIPS Agreement) and COVID-19, see (WTO, 2020[15]).

[8] Vaccines also contain a range of common ingredients (https://www.who.int/emergencies/diseases/novel-coronavirus-2019/covid-19-vaccines/how-are-vaccines-developed): *preservatives* prevent contamination of the vaccine, which is especially important when these are stored in multi-dose vials; *stabilisers* prevent further chemical reactions from occurring, keeping the vaccine potency stable as it is being transported; *surfactants* ensure that ingredients remain blended, avoiding the clumping of elements that are in liquid form; *adjuvants* are sometimes used to enhance the immune response; other substances, including *antibiotics* to prevent contamination and diluents to temper the concentration of vaccines before use. In both the Moderna and Pfizer-BioNTech COVID-19 vaccines, the

Vaccine production requires more than the core ingredients, however. Vials and rubber stoppers are needed to store the vaccines, cold boxes to transport[9] them, and dry ice to keep these at appropriate temperatures. Drawing on trade data and product codes identified by the Asian Development Bank (ADB),[10] Figure 4 highlights the diverse origins of the ingredients and goods needed to produce, distribute and administer vaccines, from adjuvants to vials. As was the case with the goods needed to fight COVID-19 (OECD, 2020[1]), **trade data reveal a high degree of trade interdependence in the goods needed to produce, distribute and administer vaccines**.

Figure 4. Top exporters of items needed in the production, distribution and administration of vaccines

Share in global exports (%), 2018



Note: For illustrative purposes only. See Annex B for the list and description of products covered, including HS codes. Note that many of these products will belong to broader categories of goods than those captured in the shares, meaning that these include other products which might not be directly relevant to vaccine production, delivery and administration.
Source: Own calculations using CEPII BACI data and the Asian Development Bank database.

messenger ribonucleic acid (mRNA) is encapsulated in "lipid nanoparticles", microscopic droplets of oily liquid that enclose and protect the fragile genetic instructions as they are manufactured, transported and finally administered.

[9] For both mRNA COVID-19 vaccines, cold storage is needed to keep the nanoparticles in good shape and to prevent the mRNA from degrading. While Moderna's vaccine is stable enough to survive storage for six months at -20°C (i.e. the temperature of a standard domestic or medical freezer), the Pfizer-BioNTech vaccine must be stored and transported at -70 °C. Pfizer and BioNTech have designed special "thermal shippers" that can maintain the product for up to 15 days at that temperature when regularly refilled with dry ice.

[10] See ADB Mapping on Supply Chains for Pandemic-fighting Products, https://www.adb.org/multimedia/scf/#/. See also the World Customs Organisation HS classification reference for COVID-19 vaccines and related supplies and equipment (29 January 2021) for an extended list: http://www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/activities-and-programmes/natural-disaster/covid-19-list-for-vaccines/hs-classification-reference-vaccines-english.pdf?la=en .

The distribution of vaccines will also require the use of specialised warehousing, different modes of transport, and last-mile delivery. Once distributed, vaccines will require qualified personnel and a range of goods to store (freezers) and administer (syringes, needles and vials). Lastly, and particularly for vaccines that require a specialised cold supply chain, some of the secondary packaging will need to make its way back so that it can be re-used.

Manufacturing capacity for COVID-19 vaccines is concentrated in few countries

Leveraging existing manufacturing capacity to meet global COVID-19 vaccination goals will require moving goods into factories and transporting finished products to their final destination. Existing evidence on production capacity is scarce, especially in light of the uncertainty on which vaccine(s) will be administered the most extensively.

Survey results from the Coalition for Epidemic Preparedness Innovations (CEPI) highlight that potential manufacturing capacity is concentrated in a few high income and emerging economies, with the United States, the People's Republic of China (hereafter "China"), and India being the largest potential producers. These are followed by several economies in the European Union, Australia, Brazil, Canada, the Russian Federation, and the United Kingdom (CEPI, 2020[3]).[11]

Visualising the location of potential COVID-19 vaccine manufacturers and distributors (Figure 5) confirms this, and highlights the strong degree of concentration of producers and distributors in high income and emerging economies (ADB, 2020[4]). Few firms are registered as vaccine distributors in South America or Southeast Asia, and no producer or distributor firms are registered in Africa and Central Asia[12] (Figure 5).[13]

This geographical concentration underscores the importance of trade links for the production and supply of COVID-19 vaccines, and the logistical challenge of supplying vaccines globally. Vaccines will need to be shipped from relatively few locations to individuals across the entire globe. Ensuring their timely delivery and maintaining them at adequate temperatures would favour air freight as mode of delivery. However, belly cargo capacity continues to be constrained.[14] Recent data proxy for cargo availability shows that for most trade lanes, air cargo capacity was between 2% and 50% lower in Q4 2020 as compared to the same period in 2019 (Figure 6) (IATA, 2021[5]).

[11] Results reflect the response of 113 manufacturers as a snapshot of manufacturing capacity in June 2020. Respondents were asked to report on their available manufacturing capacity for Q4 2020 – Q4 2021.

[12] According to data extracted on 1 December 2020. The online information-sharing repository set up by the Asian Development Bank gathers available information from various sources (WHO, ECRI, the Milken Institute and BioCentury) and then verifies this against Bureau van Djik, Open Corporates and GLEIF data. In light of the difficulties with identifying potential manufacturers and distributors of COVID-19 vaccines in some regions of the world, information sharing efforts such as those undertaken by the ADB should continue to be promoted.

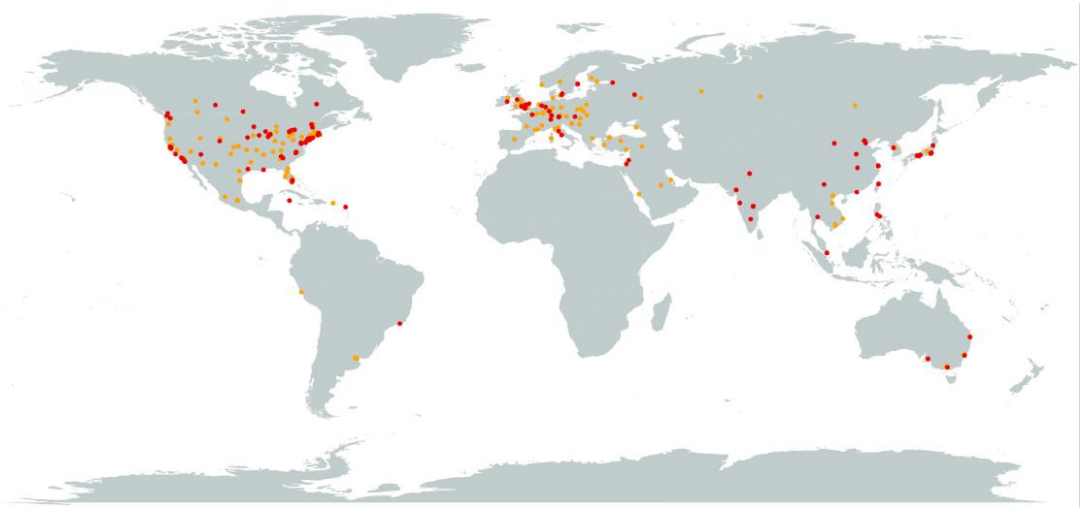
[13] Initiatives such as the COVID-19 Vaccines Global Access (or COVAX, co-led by the Global Alliance for Vaccines and Immunization, the World Health Organization, and the Coalition for Epidemic Preparedness Innovation) include a donor-funded Advance Market Commitment to support procurement of vaccines for 92 low-and middle-income economies. In addition to global initiatives, a number of regional initiatives have emerged, such as the COVID-19 African Vaccine Acquisition Task Team (AVATT) to support the roll out of the African Union's Africa Vaccine Strategy or the Asia-Pacific Vaccine Access Facility (OECD, 2021[18]).

[14] In addition, airlines have been increasingly using narrow-body passenger aircraft that cannot accommodate as much cargo as larger wide-body planes. This matters because there are limitations on these narrow-bodied aircrafts for cargo that require special handling like temperature control or unitised loading. While a wide-bodied aircraft can carry goods between 10-30 tonnes per flight depending on the aircraft type, the capacity of a narrow-bodied aircraft is only 2-6 tonnes per flight. Also, smaller aircrafts cannot fly for more than 4-5 hours at a stretch, so long-haul air cargo movement is hindered.

Monitoring specific air cargo capacity available across main trade routes will be key to enabling the effective supply of vaccine ingredients to manufacturers and the distribution of finished vaccines and ancillary equipment. Many of the most impacted trade lanes are those that might be significant in distributing COVID-19 vaccines and related ingredients (e.g. Asia, Europe, and North America exporting to other regions such as Asia-Pacific, Middle East, Central and South America, and Sub-Saharan Africa) (IATA, 2021[5]). Constrained capacity directly relates to higher air freight costs, and prioritisation of COVID-19 vaccines is also likely to have displacing effects on other trade that travels via air.

Figure 5. COVID-19 vaccine manufacturing and distributing firms are geographically concentrated

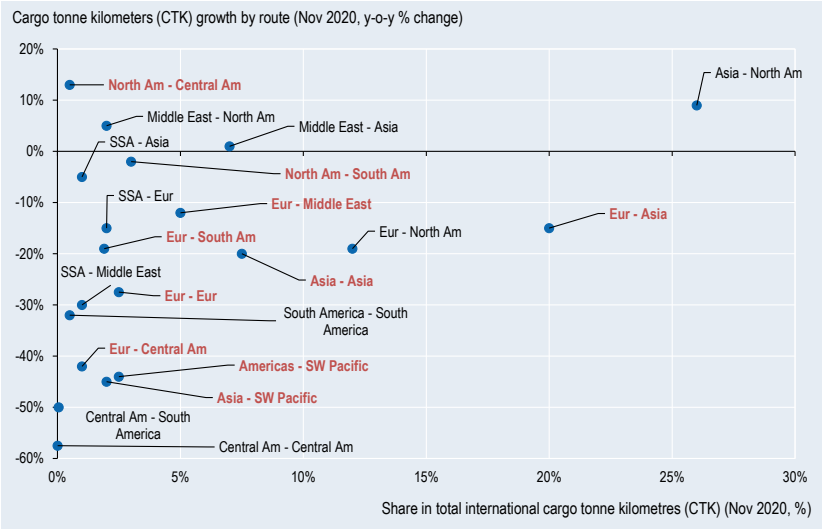
Red dots = manufactures; orange dots = distributors



Note: Based on ADB's *Mapping on Supply Chains for Pandemic-fighting Products* (2020), data extracted 1 December 2020; the ADB continues to update the database. Includes distributors and manufacturers of COVID-19 vaccines at all levels of relevance (1, 2 and 3); excludes observations for which location information was not available at the city-level. Red dots overwrite orange dots.
Source: ADB (2020[4]).

Figure 6. Air cargo capacity for most trade lanes remains constrained

November 2020, year-on-year % change



Note: CTK is used as proxy for available air cargo capacity, using information released by IATA. The trade lanes labelled in red highlight regions such as Asia-Pacific, Europe and North America which are likely to be exporting vaccines to other regions such as Asia, Middle East, Central and South America, and Sub-Saharan Africa. For the routes where November 2020 data are not available, information for October 2020 is used (IATA, 2020[6]).
Source: IATA (2021[5]).

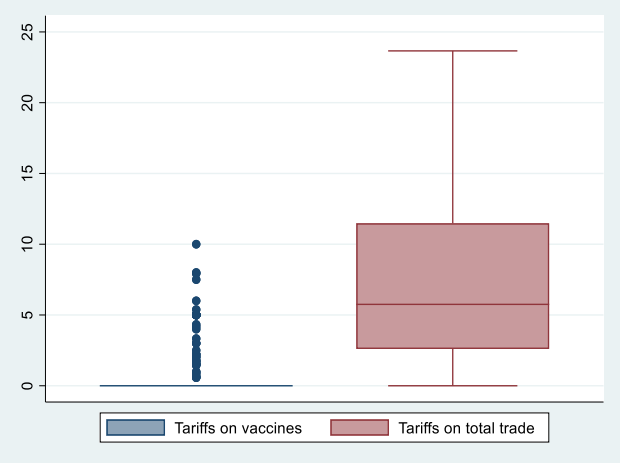
Trade policies should be leveraged to enable the manufacturing and distribution of COVID-19 vaccines

While tariffs on vaccines are unlikely to pose a major challenge, they remain a barrier in selected markets and for important vaccine-related inputs

Tariffs are unlikely to pose major challenges to the vaccine distribution efforts overall: the simple average world tariff on vaccines is 0.76% (Figure 7) – about one-tenth of the average tariff imposed on total trade (7.1%). Out of 183 countries, four-fifths apply zero duties.[15] This still means that one-fifth of countries have positive duties on vaccines, with 8% having a duty equal to or greater than 5%. So while tariffs are less likely to pose major challenges, additional steps could be taken to ensure that vaccines meet zero duties in all countries.

Figure 7. Tariffs on vaccines are significantly lower than average tariff rates on total trade

Boxplot of simple applied average tariffs on vaccines and total trade, 2019 or latest available year



Note: Vaccines are identified using the HS code 300220 - 'Vaccines for human medicine'. This figure includes data for *ad valorem* tariff rates in the period 2012-19 for 183 countries. The boxplot shows that countries imposing tariffs on vaccines tend to be outliers (blue boxplot), whereas the median average tariff imposed on total trade is 5.75%, ranging between 2.6% (25th percentile) and 11.5% (75th percentile) (red boxplot). Some countries also apply average tariffs on total trade as low as 0% or as high as 23.7%.
Source: TRAINS database.

Higher tariffs remain on vaccine-related inputs, increasing the final price. For instance, average world tariffs on vaccine ingredients such as preservatives, adjuvants, stabilisers, antibiotics range between 2.6% and 9.4%. Tariffs on materials to administer vaccines, such as syringes and needles, are in a similar range

[15] Vaccines (HS code 300220) are covered by the 1994 WTO Pharma Agreement, which eliminates tariffs and other duties and charges on many pharmaceutical products and substances used to produce them. Canada; the European Union; Japan; Macao, China; Norway; Switzerland; and the United States currently participate in this Agreement.

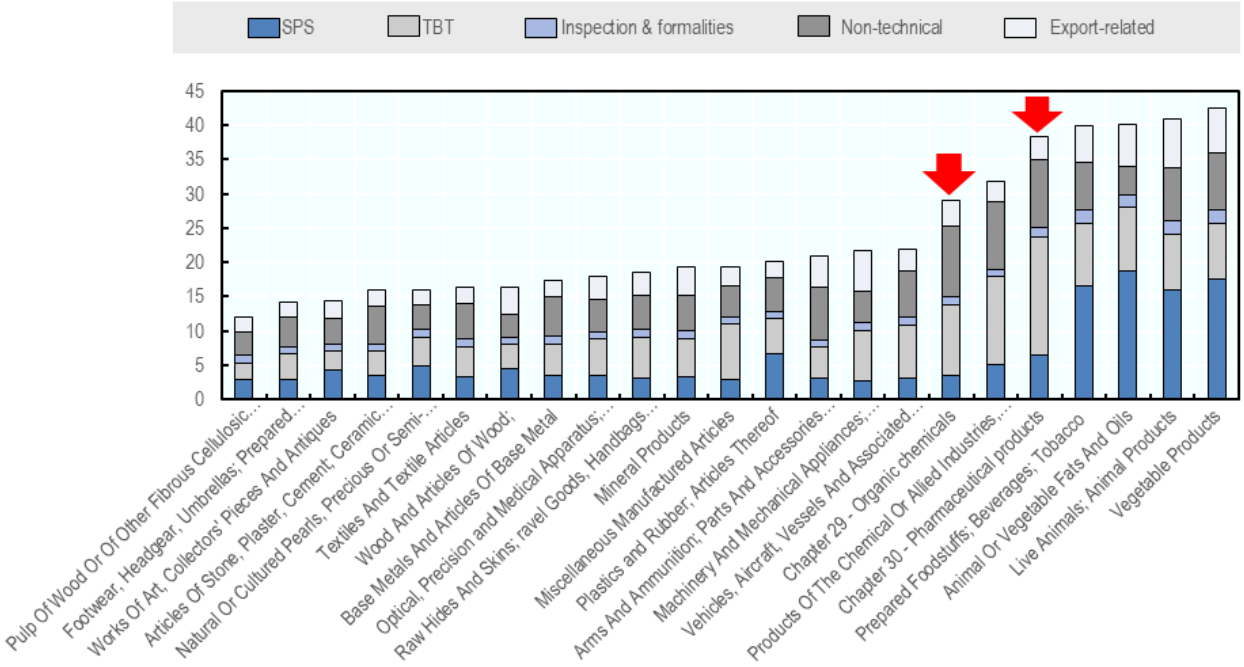
(4.4% and 4.5%). Tariffs for primary packaging (e.g. vials and stoppers) or distribution materials (such as cold boxes, freezers, or dry ice) can go up to 12.7%.

A high number of standards and regulations apply to pharmaceutical products and organic chemicals

Pharmaceutical products and organic chemicals, which include vaccines as well as a number of their ingredients, are among the products that attract the highest number of non-tariff measures (NTMs). In OECD countries, these two sectors must comply with on average around 38 and 29 different NTMs respectively – mainly in the form of technical barriers to trade (TBT), sanitary and phytosanitary measures (SPS), price-control measures, and import licensing measures (Figure 8).[16]

Figure 8. A high number of standards and regulations apply to pharmaceuticals products and organic chemicals

Average number of NTMs per product in OECD countries, 2018 or latest available year



Note: Products grouped by section of the Harmonised System of classification. Non-technical measures include import licensing, price-control measures, finance measures, measures affecting competition, investment measures, distribution restriction, and intellectual property measures. This figure includes measures of partial coverage though only measures applied to all countries are included (Partner=World). NTMs for the European Union are reported for the group as a whole. Products of the Chemical and allied industry (Harmonised System Section VI) exclude HS Chapters 29 and 30.
Source: UNCTAD (2020[7]) TRAINS, latest available data.

[16] Examples of TBT measures applied to pharmaceutical and organic chemicals include: measures regulating the kind, colour and size of printing on packages and labels, and defining the information that should be provided to the consumer; or information disclosure requirements that make it possible to track a product through the stages of production, processing and distribution. Examples of SPS measures applied to these products are requirements that the establishments and equipment used during the manufacturing and processing stages of the products meet specified sanitary conditions.

While some of these standards and regulations can reduce information asymmetries and strengthen confidence in imported products (Cadot, Gourdon and van Tongeren, 2018[8]), they also translate into compliance costs and controls at the border. These regulations are undoubtedly important to protect the health and safety of citizens, but there may be areas where unnecessary duplication or cumbersome processes exist. Mapping the relevant regulatory requirements, processes, and approvals for access to different markets will therefore be key to enabling more efficient vaccine distribution and reducing unnecessary trade costs.

International co-operation is needed to streamline border processes

Trade facilitating measures introduced at the height of the COVID-19 pandemic have helped streamline border processes for pharmaceutical and medical goods (OECD, 2020[9]) (Evenett et al., 2020[10]). These can continue to be useful tools for expediting border clearance for vaccines and related ingredients, including the "green lanes" or "corridors" for fast clearance (e.g. those introduced at intra-EU borders), electronic submission of documents for pre-arrival processing, simplified import and export declaration forms, and extended business hours at specific border posts. They will be important not just to facilitate border clearance for vaccines, but also for the inputs needed to manufacture, distribute, and administer them.[17]

Co-operation and co-ordination between Customs and other relevant agencies need to be improved to streamline processes at the border. Continuing to invest in digital infrastructure to support the use of automated tools such as electronic pre-arrival processing and electronic data exchange between relevant border agencies can play an important role in improving co-operation mechanisms and risk management. This would allow border agencies to better respond to actors along the vaccine supply chain on the release status of goods through electronic channels within strictly defined time limits (Global Express Association, 2020[11]).

Logistics operators show different degrees of preparedness, highlighting the need for more co-operation with and amongst the private sector. For instance, ground handlers and airport operators feel they are less prepared than do forwarders and airlines (Pharma-Aero/TIACA, 2020[12]). Top concerns revolve around managing the necessary infrastructure (facilities, cold chain ground equipment, containers, etc.), supply chain transparency on shipment transport conditions, transportation time, and customs clearance. According to IATA, up to 20% of temperature-sensitive pharmaceutical products are already damaged at arrival because the cold chain was disrupted during transport (IATA, 2015[13]). The specificities of transporting vaccines – e.g. some types of refrigerants are classified as dangerous goods and the reverse logistics needed to return cold chain equipment – also require attention.

Policy implications

A wide range of uncertainties remain in manufacturing and distributing COVID-19 vaccines across the globe. These include: the variety of inputs needed; the manufacturing capacity and pace of production; the roll-out schedules for administering vaccines; the requirements for transport and storage; and the availability of cargo. These uncertainties affect the ability to make decisions and reduce the level of preparedness.

[17] Trade facilitation aspects for the streamlining of border processes of medical goods – including vaccines – are acknowledged as being key in various initiatives: for instance, the Ottawa Group proposal to the WTO on *Trade and Health* (WT/GC/223 *COVID-19 and Beyond: Trade and Health*, Communication from Australia, Brazil, Canada, Chile, the European Union, Japan, Kenya, Korea, Mexico, New Zealand, Norway, Singapore and Switzerland, 24 November 2020); the European Union *Trade in Healthcare Products* Concept Paper, 11 June 2020; or the New Zealand and Singapore initiative to ensure the free flow of essential goods.

This note highlights the importance of trade in the effort to produce, distribute, and administer vaccines. As not all countries can produce these, trade enables access to vaccines and to their key ingredients, as well as to the goods needed for their distribution and administration.

In the face of existing uncertainties, trade needs to provide an environment that is conducive to broader vaccine distribution by:

- **Reducing remaining tariffs and streamlining non-tariff measures to trade** in vaccines, key related ingredients in their production, and the goods needed to safely distribute and administer these.
- **Avoiding export restrictions** to ensure the effective functioning of supply chains and the distribution of vaccines globally, in light of the concentration of input sourcing and vaccine manufacturing capacities.
- **Increasing co-operation within and between Customs and other relevant agencies** with a view to expediting processes at the border, ensuring better co-ordination of logistical processes, and relaxing, where possible and without prejudice to safety, trade-related regulatory burdens. The continued implementation of the WTO Trade Facilitation Agreement (TFA) is essential to streamlining border processes, while specific logistics and border challenges could be addressed through public-private consultation structures such as National Trade Facilitation Committees. This would include investing in the adoption of digital infrastructures and processes.
- **Improving transparency and information sharing across the entire value chain** to enable the different actors to find each other and enable more efficient production and distribution via trade channels. This could be achieved through the use and promotion of online information hubs, such as those undertaken by the Asian Development Bank (ADB).

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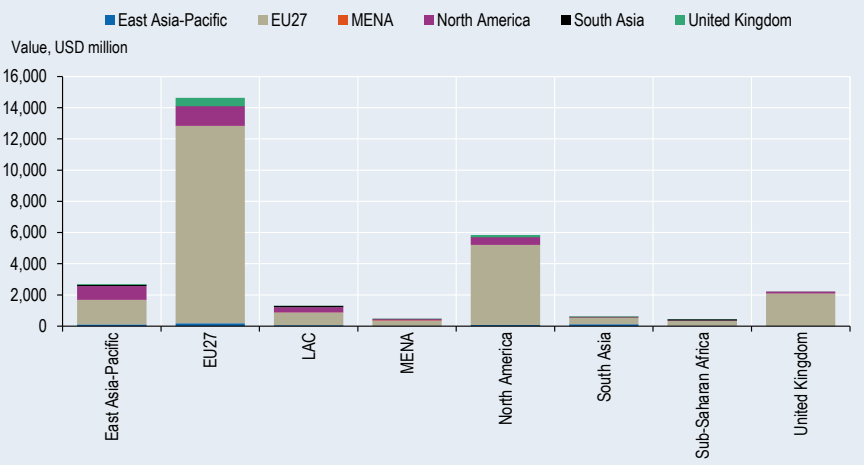
Annex A. There is strong dependence on high-income economies for access to vaccines

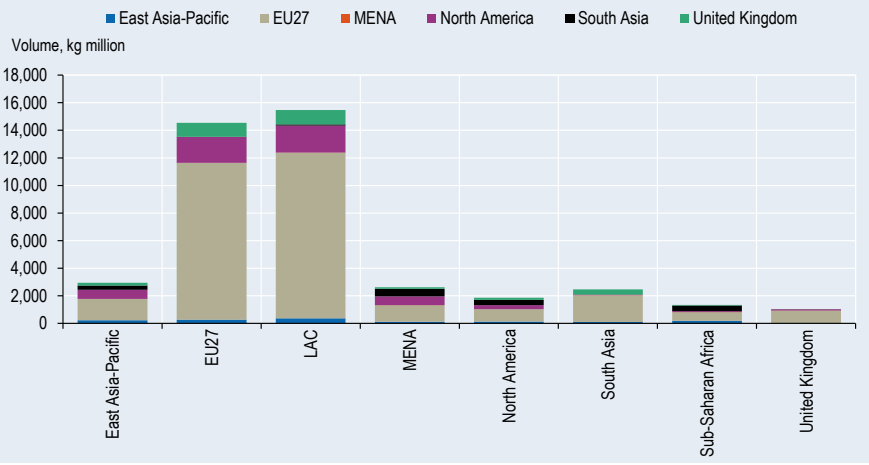
Annex Figure A.1. Developing economies depend on high-income economies for sourcing vaccines, but their overall imports remain low

Imports (in value and volume) by destination region from origin region, 2018

a. Value, USD million

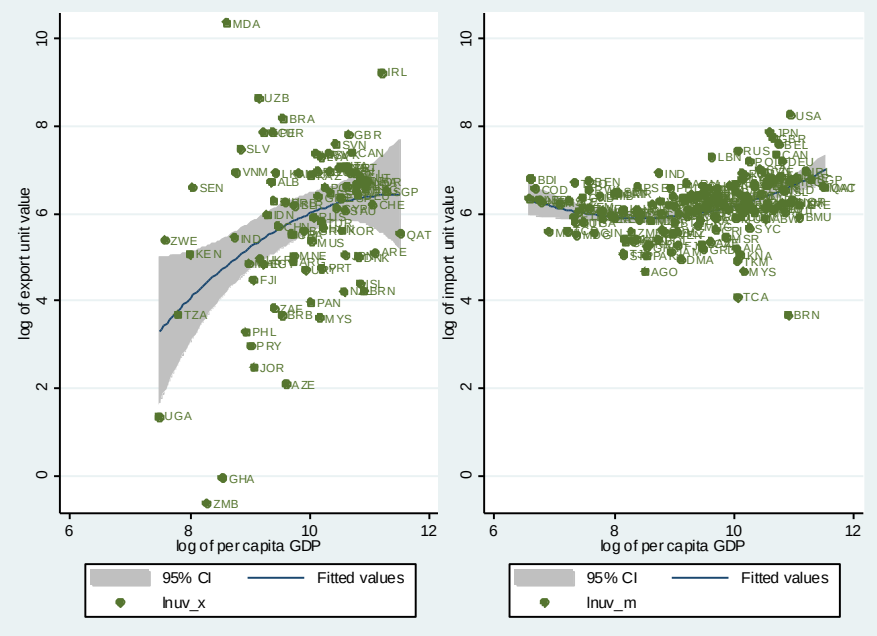


b. Volume, kg million



Source: UN COMTRADE data for 2018.

Annex Figure A.2. Richer countries produce vaccines with higher unit values



Note: Unit values calculated as export / import value divided by quantity.
Source: Own calculations using BACI database and Penn World Table.

Annex B. Harmonised System classification for selected vaccine-related inputs

Annex Table B.1. HS classification for selected vaccine-related inputs

Category	Product	Short description	HS code
Ingredients	Thimerosal	Preservatives - to prevent contamination	285210
	Aluminium salts	Adjuvants - to help stimulate a stronger immune response	283322
	Sorbitol	Stabilizers - to keep the vaccine potent during transportation and storage	290544
	Formaldehyde	Inactivating ingredients - to kill viruses or inactivate toxins	291211
	Neomycin	Antibiotics - to prevent contamination by bacteria	2941
	Sterols	Lipid nanoparticles (LNP) in mRNA vaccines	290613
Primary packaging	Vials	Serum bottles, vials, and other pharmaceutical containers of glass	701090
	Stoppers	Articles of vulcanised rubber n.e.s., except hard rubber	401699
Secondary packaging: Storage and distribution	Insulated cartons		4819
	Vaccine carriers		901890
	Cold boxes		392310
	Refrigerators/freezer chests		841850
	Freezers		841830
	Dry ice		281121
Secondary packaging: Vaccine administration	Syringes		901831
	Needles		901839

Source: Own compilation based on Harmonised System 2017 classification and ADB (2020[4]).

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