Challenges Facing Selected Industries and Related Global Supply Chains During the Ongoing COVID-19 Pandemic

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ECONOMICS WORKING PAPER SERIES
Working Paper 2022-02-C

U.S. INTERNATIONAL TRADE COMMISSION
500 E Street SW
Washington, DC 20436

February 2022

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Abstract

The COVID-19 pandemic induced demand and supply shocks simultaneously and caused major disruptions in global trade flows and supply chains. To help better understand the ongoing economic impact of the COVID-19 pandemic, this paper provides a qualitative analysis of selected manufacturing and services industries that have been significantly affected by the pandemic. It discusses industry trends through 2020 and the first three quarters of 2021 to the extent the information and data are available, the issues in related global supply chains if applicable, as well as the implications on the road to recovery. This paper primarily pulls data from international organizations and industry associations, supplemented with information from major media reports. This collection of industry-based analyses complements the other working paper simultaneously produced by Erika Bethmann, Emma Blair, Chang Hong, Lin Jones, Chris Montgomery, Huyen Nguyen— "Regional Macroeconomic and Trade Trends During the COVID-19 Pandemic," which provides a collection of region-based macroeconomic and trade analyses. Together, these two papers aim to provide a set of background information and data for future modeling work on the impact of the COVID-19 pandemic.

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Introduction

The COVID-19 pandemic induced demand and supply shocks simultaneously and left a profound impact on global economic activity. The pandemic caused major disruptions in global trade flows and supply chains, inflicting hardship in various ways on consumers, companies, and industries around the world.[1] It also added to inflationary pressure—consumer demand in the second half of 2020 picked up while supply chain bottlenecks, particularly at major maritime ports, led to goods shortage and rising prices.[2]

To help better understand the ongoing economic impact of the COVID-19 pandemic, this paper provides a qualitative assessment of selected manufacturing and services industries that have been significantly affected by the pandemic. It discusses industry trends through 2020 and the first half of 2021, the issues in related global supply chains if applicable, as well as the implications on the road to recovery.

This paper finds that overall, the high- and medium-high-tech manufacturing sectors (e.g., pharmaceuticals, computers and electronics) have outperformed the low-tech manufacturing sectors (e.g., food, wearing apparel). Digitally enabled services (e.g., e-commerce) have weathered this public health crisis better than services that rely on in-person interaction (e.g., tourism).

This paper also finds that the COVID-19 pandemic created unexpected big swings in global demand and supply of goods and services, resulting in the real-time misalignment between demand and supply. The pandemic accelerated the adoption of remote work and school, and thus fueled the demand for related goods such as computers and monitors, communication equipment, and other digital devices. The pandemic also drove up the demand for certain medical and pharmaceutical products (e.g., vaccines) for the treatment and prevention of COVID-19. On the other hand, due to the lockdown, travel restrictions, and reduced in-person interaction, global demand for certain goods (e.g., motor vehicles, aircraft, and fuel) and certain services (e.g., travel and transport services) plunged in the first half of 2020. Global demand, though, has rebounded since the third quarter of 2020.

As the pandemic created uncertainty in the global economic outlook and government policies, the industries faced great challenges in anticipating and adjusting for volatile global demand in a rapidly changing environment. Firms' response has been further hampered by other pandemic-induced problems, such as facility closure and a shortage of workers due to the COVID-19 outbreaks; supply shortage of inputs and components, and longer delivery time due to upstream production disruptions and logistic bottlenecks; and rising production cost due to inflation. At the time of writing, the world is undergoing another surge of COVID-19 caused by the highly contagious Omicron variant, and the challenges to the industries and related supply chains remain ongoing. For further updates, see the upcoming publication of *Year in Trade 2021*, anticipated in the summer of 2022.

Manufacturing

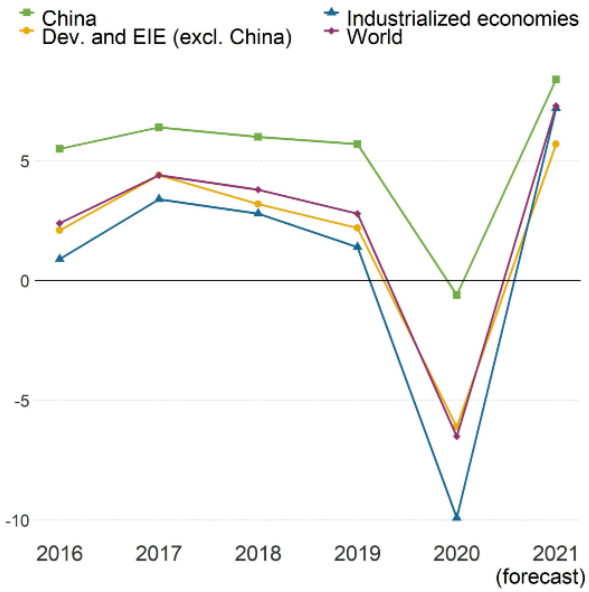
Since 2018, global manufacturing experienced a gradual slowdown due to uncertainties related to rising trade inflictions and restrictions. The ongoing COVID-19 crisis further exacerbated the overall decline, as

[1] OECD, "COVID-19 and International Trade," June 12, 2020.
[2] FT, "Inflation and the Supply Chain," October 22, 2021; NYT, "The Great Supply Chain Disruption," October 15, 2021.

it induced a unique combination of supply and demand shocks, which wreaked havoc on manufacturing sectors around the world.

In 2020, the United Nation Industrial Development Organization (UNIDO) estimated that global manufacturing production experienced a 6.5 percent contraction, with industrialized economies suffering a steeper decline than developing and emerging economies.[3] The latest forecast from the 3rd quarter of 2021 report for global manufacturing indicates a strong recovery, with an estimated annual growth rate at about 7 percent (figure 1).[4]

Figure 1 Annual growth rates by manufacturing value added in constant 2015 dollars, 2016–21
Dev. and EIE = developing and emerging industrial economies.

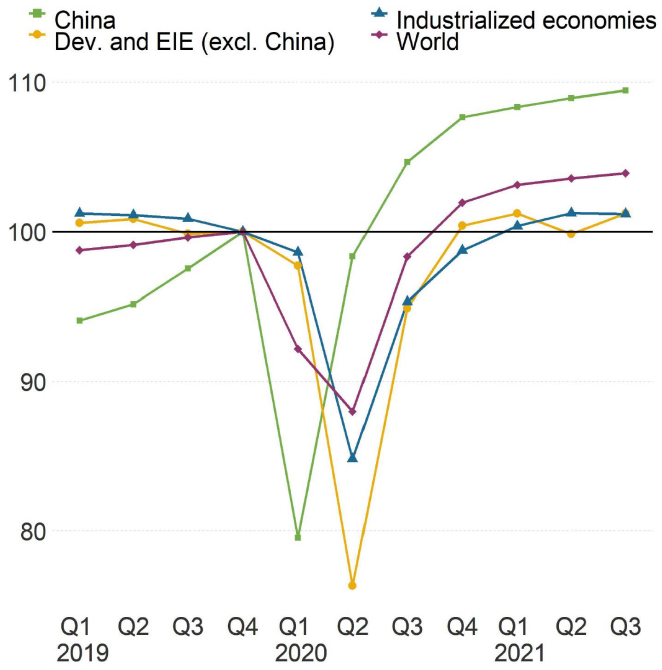


Source: UNIDO, *World Manufacturing Production: Statistics for Quarter III 2021*, December 8, 2021.

The biggest impact in manufacturing output registered in the second quarter of 2020, during which the world experienced an 11.1 percent decline—the largest decline since the global financial crisis of 2007–08. However, global manufacturing production bounced back quickly during the third quarter of 2020, attributable primarily to the production increase in China, the world's largest manufacturer. By the fourth quarter of 2020, global manufacturing output had fully recovered and surpassed pre-pandemic levels. Global manufacturing output continued to grow throughout the first three quarters of 2021, though at a slower pace (figure 2).

[3] UNIDO, *World Manufacturing Production: Statistics for Quarter III 2021*, December 8, 2021.
[4] UNIDO, *World Manufacturing Production: Statistics for Quarter III 2021*, December 8, 2021.

Figure 2 Index of manufacturing production (Q4 2019 = 100), Q1 2019–Q3 2021
Dev. and EIE = developing and emerging industrial economies.

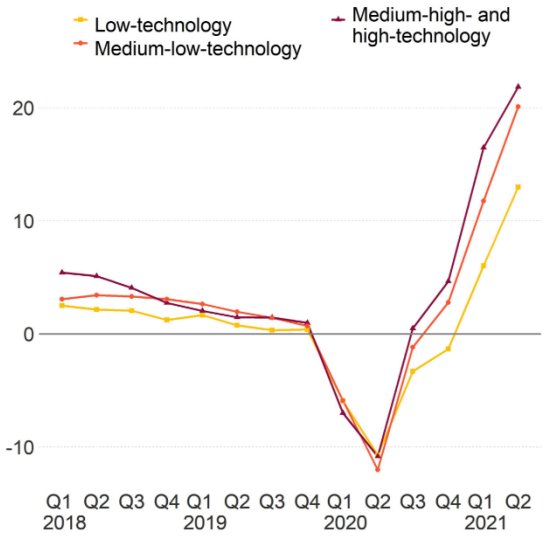


Source: UNIDO, *World Manufacturing Production: Statistics for Quarter III 2021*, December 8, 2021.

The pandemic's impact on different manufacturing industries varied significantly. Most median-high- and high-technology industries outperformed low-technology industries in weathering the pandemic and/or picking up the recovery pace (figure 3). Pharmaceuticals, computers and electronics, electrical equipment, and machinery were among the best-performing manufacturing industries. Transport equipment, including motor vehicles and other transport equipment such as aircraft, was among the hardest hit by the pandemic, making it the exception among the median-high- and high-technology industries. Petroleum is another industry which continued to suffer a negative growth rate in 2021 (figure 4).

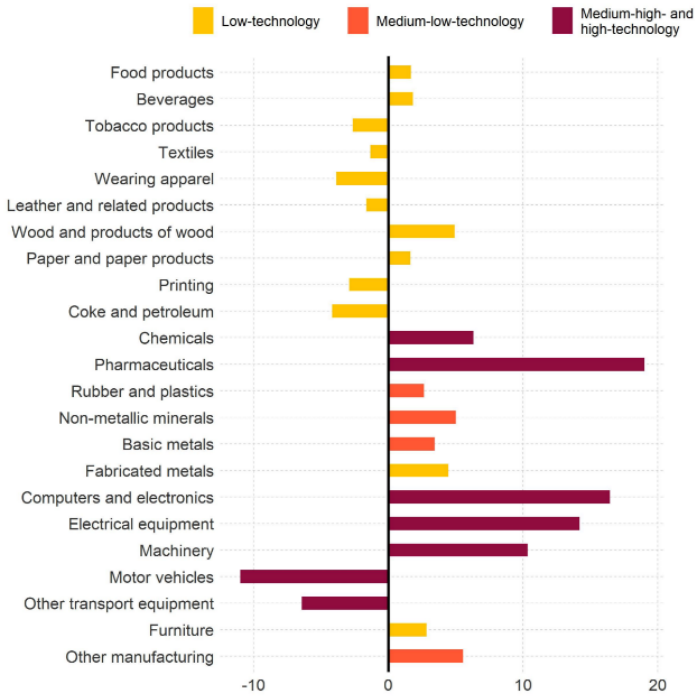
The overall trends of a few selected manufacturing industries and the challenges they continue to face during the recovery will be further discussed in sections below.

Figure 3 Estimated quarterly growth rates by industry and technological intensity, percentage change compared to the same quarter of previous year, Q1 2018–Q2 2021



Source: UNIDO, *World Manufacturing Production: Statistics for Quarter II 2021,* September 8, 2021.

Figure 4 Estimated global growth rates by industry and technological intensity of Q3 2021 compared to (pre-pandemic) Q4 2019



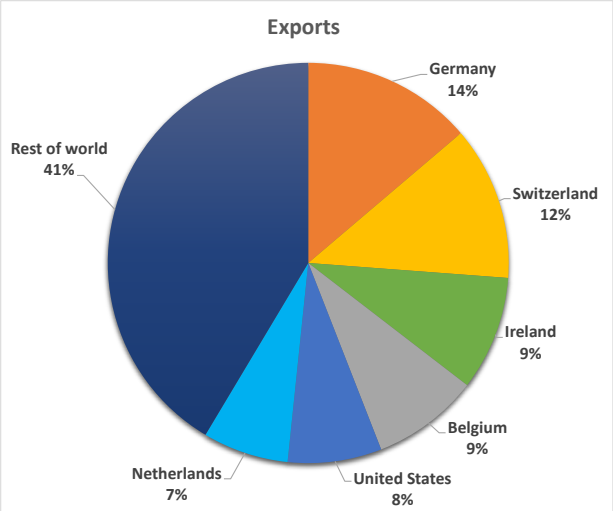
Source: UNIDO, *World Manufacturing Production: Statistics for Quarter III 2021*, December 8, 2021.

Pharmaceuticals

The pharmaceutical industry is responsible for research and development (R&D), production, and distribution of medications. It plays a critical role in fighting the pandemic, and is one of the best-performing manufacturing industries, with COVID-19 related medications and vaccines driving the overall growth. In 2020, the revenue of global pharmaceuticals industry was valued at $1.27 trillion, compared to $1.25 trillion in 2019.[5] The United States is the largest pharmaceutical market, accounting for 49 percent of global pharmaceutical revenue in 2020, followed by Europe at about 16 percent.[6]

Global trade in pharmaceutical products was valued at $1.390 trillion in 2020, compared to $1.329 trillion in 2019. In 2020, the top exporters in pharmaceutical industry were Germany, Switzerland, Ireland, Belgium, United States, and the Netherlands (figure 5). They together accounted for about 60 percent of global pharmaceutical exports. Leading importers in the world are the United States, Germany, Belgium, Switzerland, Netherlands, and China, which accounts for 54 percent of world pharmaceutical imports (figure 5.5).[7]

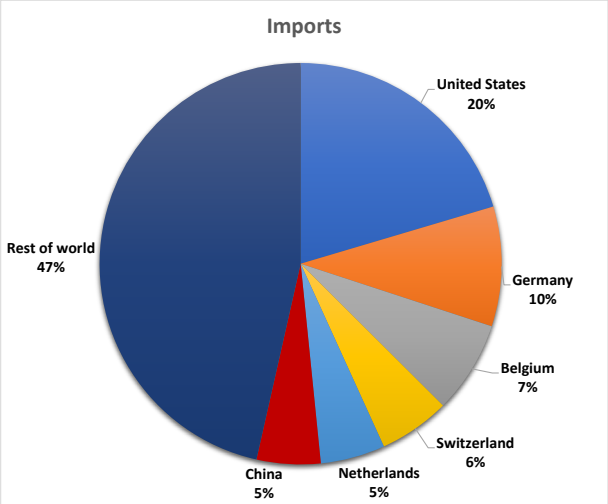
Figure 5 Global top pharmaceuticals exporters, by share, percentage, 2020



Source: IHS Markit, Global Trade Atlas database, total exports, HS chapter 30, accessed December 16, 2021.

[5] Statista, "Revenue of the Worldwide Pharmaceutical Market from 2001 to 2020," May 4, 2021.
[6] Statista, "Global Pharmaceutical Industry—Statistics and Facts," September 10, 2021.
[7] IHS Markit, Global Trade Atlas database, Total Exports and General Imports, HS chapter 30, accessed December 16, 2021.

Figure 5.5 Global top pharmaceuticals importers, by share, percentage, 2020



Source: IHS Markit, Global Trade Atlas database, general imports, HS chapter 30, accessed December 16, 2021.

COVID-19 Vaccines

Developing and delivering COVID-19 vaccines has been the top priority for the whole world throughout the pandemic. To speed up the development of the most promising vaccines, governments and companies joined forces in a manner never seen before.[8] Many governments provided funding to support R&D and subsidized the expansion of production capacity of firms providing critical inputs.[9] In the United States, for example, national regulatory agencies such as the U.S. Food and Drug Administration (FDA), the U.S. National Institutes of Health (NIH), and others launched public-private partnerships and coordinated research responses to vaccine and drug development.[10] Companies teamed up to set up cost-effective and more efficient approaches to manufacture vaccines at scale.[11] Although clinical development of a novel vaccine typically takes 5 to 10 years and sometimes even more, the development of COVID-19 vaccines occurred in a matter of months.[12] According to the World Health Organization (WHO), there were 194 vaccines in preclinical development and 137 in clinical development targeting COVID-19 as of December 24, 2021.[13] Several vaccines were authorized for emergency use in less than a year after the onset of COVID-19.[14]

According to the WTO-IMF Vaccine Trade Tracker, as of November 30, 2021, about 10 billion doses COVID-19 vaccines have been produced globally, with 6.4 billion doses fulfilling domestic need, and the remaining

[8] IMF, "Policy Response to COVID-19," accessed December 16, 2021.
[9] IMF, "Policy Response to COVID-19," accessed December 16, 2021.
[10] NIH, "NIH to Launch Public-private Partnership," April 17, 2020.
[11] Bown and Bollyky, "How COVID-19 Vaccine Supply Chains Emerged," August 2021.
[12] Bown and Bollyky, "How COVID-19 Vaccine Supply Chains Emerged," August 2021. After China shared the genetic sequence of the novel coronavirus with the WHO in early January 2020, Moderna, BioNTech, Oxford, Janssen, Novavax, and many other companies had all identified their leading COVID-19 vaccine candidates by early April 2020.
[13] WHO, COVID-19 Vaccine Tracker and Landscape, accessed December 24, 2021.
[14] Immunization Action Coalition, "Vaccine Timeline," accessed December 24, 2021. FDA issued Emergency Use Authorization (EUA) for Pfizer-BioNTech COVID-19 vaccine and Moderna COVID-19 vaccine on December 11 and December 18, 2020, respectively.

3.7 billion doses being exported.[15] China, the European Union (EU), India, the United States, South Korea, Russia, South Africa, and Japan are the major producers of COVID-19 vaccines. As of November 30, 2021, China produced more than 4.5 billion doses of its home-grown vaccines—Sinovac and Sinopharm—and exported about one-third of them to other countries. The United States and EU together produced about 3 billion highly effective vaccines including those from Pfizer-BioNTech, Moderna, Johnson & Johnson, and AstraZeneca. India dispensed nearly 1.6 billion doses, mostly of the AstraZeneca vaccine manufactured locally by the Serum Institute of India. Russia produced 233 million doses of the COVID-19 vaccine Sputnik V, with 40 percent being exported. South Korea, Japan, and South Africa produced over 250 million doses, which were primarily targeted for overseas markets (table 1).

Table 1 Number of COVID-19 vaccine doses produced and exported by producing economy, November 30, 2021

Producing economy	Production (millions of doses)	Exports (millions of doses)	Exports as share of production (%)	Share of global exports (%)
China	4,522	1,488	32.9	40.6
EU	2,248	1,367	60.8	37.3
India	1,583	73	4.6	2.0
United States	847	348	41.1	9.5
Russia	233	93	40.1	2.6
South Korea	157	134	84.9	3.6
South Africa	59	49	83.6	1.3
Japan	34	34	99.6	0.9
Rest of world	318	78	24.4	2.1
Total	10,000	3,663	36.6	100.0

Source: WTO and IMF, COVID-19 Vaccine Trade Tracker, accessed November 30, 2021.

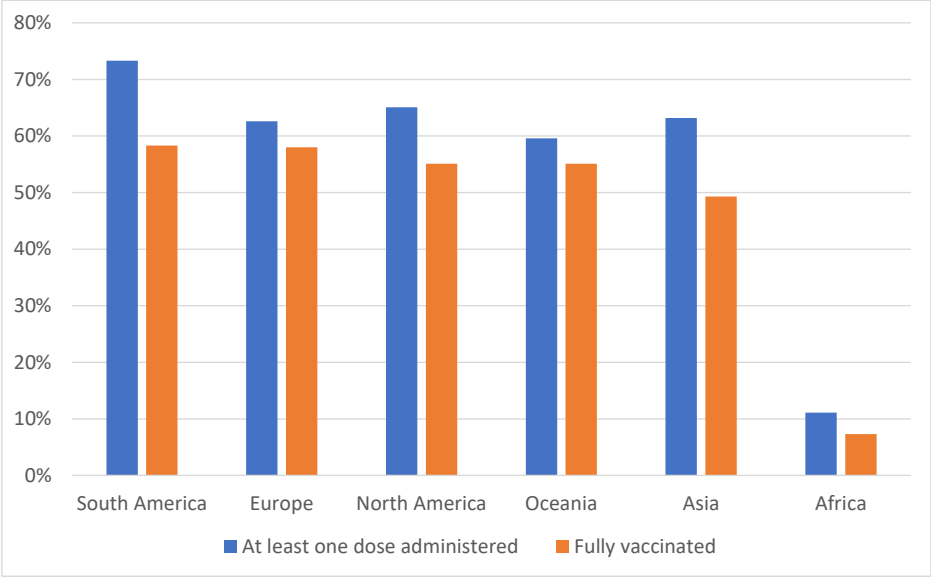
About 55 percent of the world population (4.2 billion people) had received one dose of a COVID-19 vaccine, and 44 percent (3.4 billion people) were fully vaccinated (received two doses) as of November 30, 2021.[16] More than half of the population is fully vaccinated in Asia, Europe, North America, South America, and Oceania. However, Africa has the lowest vaccination rate, with just 11 percent of the population having received at least one dose of a vaccine, and 7.3 percent being fully vaccinated (figure 6).[17]

The distribution of vaccines by income groups is strikingly different. The fully vaccinated rates in upper-middle-income and high-income countries are 61 percent and 67.2 percent, respectively. Comparatively, only 3.3 percent of the population in low-income countries is fully vaccinated. About 26 percent of the population is fully vaccinated in lower middle-income groups (figure 7). Less wealthy countries are relying mainly on the COVAX Facility, an international vaccine-sharing arrangement for fair and equitable access

[15] The tracker builds on the work of the World Trade Organization (WTO) Secretariat information notes on COVID-19 and world trade and the (International Monetary Fund) IMF Staff Discussion Note—A Proposal to End the COVID-19 Pandemic. WTO and IMF, COVID-19 Vaccine Trade Tracker, accessed November 30, 2021.
[16] In this report, full vaccination means receiving two doses of vaccines. Many countries now recommend that their citizens receive all recommended doses of COVID-19 vaccines, including booster dose(s) when eligible.
[17] WHO, COVID-19 Vaccine Tracker and Landscape, accessed December 24, 2021.

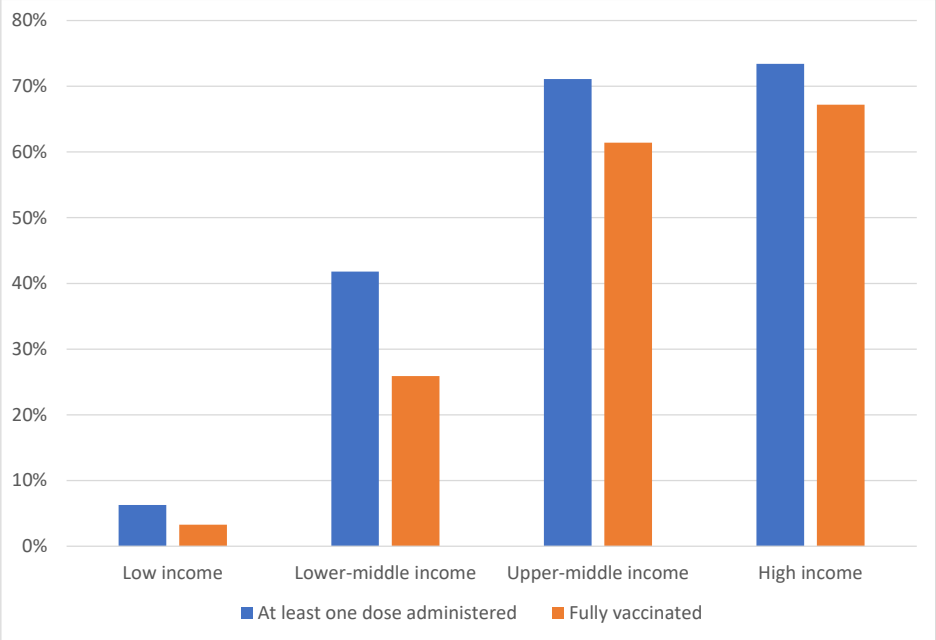
to COVID vaccines.[18] Although COVAX pledged to deliver at least 2 billion doses by the end of 2021, the target was lowered to 800 million due to production problems and export bans, as well as vaccine hoarding.[19] To accelerate COVID-19 vaccinations in Africa and low-income countries elsewhere, trade liberalization and production expansion in major vaccine-manufacturing countries are needed.[20]

Figure 6 Vaccination status by continent, November 30, 2021



Source: WTO and IMF, COVID-19 Vaccine Trade Tracker, November 30, 2021.

Figure 7 Vaccination status by income group, November 30, 2021



Source: WTO and IMF, COVID-19 Vaccine Trade Tracker, November 30, 2021.

[18] WHO, COVID-19 Vaccine Tracker and Landscape, accessed December 24, 2021; Washington Post, "Covax Promised 2 Billion Vaccine Doses," December 10, 2021.
[19] WHO, "COVAX Joint Statement," May 27, 2021.
[20] WHO, "COVAX Joint Statement," May 27, 2021.

Vaccine supply chains and trade play a critical role in the global combat of this public health crisis. Over the past three decades, the dominant business model in the pharmaceutical industry had shifted towards production fragmentation, segmenting the vaccine production process—firms could specialize in one step and leave the remainder to be fulfilled by other firms through arms' length contracts. With the increased availability of venture capital and external financing, it also has become easier and quicker to turn new drug innovations and inventions into production by hiring contract development and manufacturing organizations located in other countries.[21] A survey conducted by the Coalition for Epidemic Preparedness Innovations (CEPI) found that the existing vaccine manufacturing capacity was highly concentrated in a few countries and regions. India has the largest production capacity for drug substance, followed by Europe and North America. Europe has the largest production capacity for RNA-based drug substance. And China is estimated to have the largest production capacity of drug product, followed by North America.[22]

Similarly, due to the requirements for unique expertise in R&D, limited availability of critical inputs, and stringent quality and safety regulations, COVID-19 vaccine production has been characterized by the geographic concentration of suppliers. It is time-consuming and costly to set up vaccine production facilities globally, given the challenges of creating hyper-clean rooms and special vaccine freezer storage space, acquiring specialized capital equipment such as bioreactors and filtration pumps, and employing skilled personnel.[23] Therefore, leading pharmaceutical companies like Pfizer, Moderna, AstraZeneca, and Johnson & Johnson all need to set up their own supply chains and collaborations innovatively so that they can operate fewer plants but manufacture at a larger scale.[24]

Although trade enabled the cross-border technology transfer and global fragmentation for COVID-19 vaccine manufacturing, several issues, including trade disruptions and disagreements over waivers of vaccine intellectual property rights, impeded the establishment of global-wide production, and thus undermined the efficient, equitable distribution of COVID-19 vaccine. Export restrictions on raw materials and a shortage of critical inputs, as well as logistic bottleneck hampered pharmaceutical companies' abilities to reach production targets.[25] According to the WTO, measures are needed for governments to facilitate time-sensitive, cold chain distribution notably by air cargo and other logistics service providers. With large-scale and urgent vaccine distribution now being an imperative across the globe, governments need to work together to ensure that trade policy supports the development and prompt distribution of COVID-19 vaccines.[26]

Computers and Electronics

Computers and electronics have been among the relatively better-performing manufacturing sectors throughout the COVID-19 pandemic. This broad industry sector covers personal computers (PCs), smartphones and tablets, televisions, cameras and camcorders, audio/video devices, gaming consoles and

[21] Bown and Bollyky, "How COVID-19 Vaccine Supply Chains Emerged in the Midst of a Pandemic", August 2021.
[22] CEPI, "CEPI Survey Assesses Potential COVID-19 Vaccine Manufacturing Capacity," August 5, 2020.
[23] Bown and Bollyky, "How COVID-19 Vaccine Supply Chains Emerged in the Midst of a Pandemic", August 2021.
[24] Bown and Bollyky, "How COVID-19 Vaccine Supply Chains Emerged in the Midst of a Pandemic", August 2021.
[25] Reuters, "Indian Vaccine Giant SII Warns of Supply Hit from U.S. Raw Materials Export Ban," March 5, 2021; Guardian, "Global Covid Vaccine Rollout Threatened by Shortage of Vital Components," April 10, 2021.
[26] WTO, "Developing & Delivering COVID-19 Vaccines around the World: a Checklist of Issues with Trade Impact," December 22, 2020.

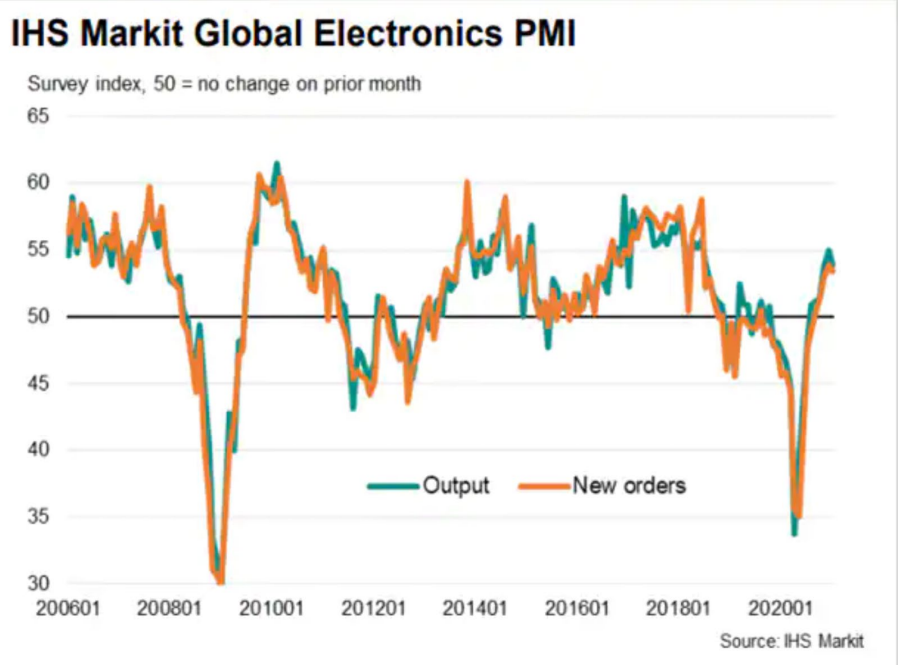
accessories, home appliances, and wearable tech (smart, virtual reality, and augmented reality gear).[27] The global electronics market had grown at a compound annual growth rate of 4.6 percent since 2015, reaching nearly $1.098 billion in 2019.[28] Due to the pandemic, the global electronics market is estimated to have declined by 5 percent to $1.043 billion in 2020 and then rebounded to $1.078 billion in 2021.[29] The largest markets for electronic products include China, the United States, Japan, South Korea, and Germany. Asian markets are expected to experience the most growth through 2022.[30]

Manufacturing of electronics products has largely shifted to Asia during the past two decades, facilitated by deep regional production integration. Countries in the Asian region such as China, Taiwan, Vietnam, South Korea, and India, have driven the electronics industry growth in recent years.[31] They have been leveraging their comparative advantage in tasks from simple assembly to component design and R&D, capitalizing on the highly modular nature of the electronics value chain.[32] In terms of revenue, 9 of the world's 10-largest electronics manufacturers in 2021 are located in Asia, including Samsung (South Korea), Hon Hai Technology Group (also known as Foxconn, Taiwan), Hitachi (Japan), Sony (Japan), and Panasonic (Japan).[33] Given the high concentration of manufacturing activity in Asia, the initial emergence of COVID-19 in this region had a severe impact. The output plunged in the first two quarters of 2020, though a quick recovery followed during the second half of 2020 and early 2021 (figure 8). Since April 2021, several East Asian economies with large electronic manufacturing industries were hit by escalating waves of the COVID-19 Delta variant, which led to new lockdown measures and sporadic production disruptions. The situation improved gradually in the summer of 2021.[34]

Global demand for electronic products—especially personal computing devices including traditional personal desktop and laptop computers, notebooks, and tablets—rose notably during the pandemic, as people spent more time in their home due to government-mandated lockdowns and social distancing.[35] The strong demand boosted global trade of electronics, rising from $5.3 trillion in 2019 to $5.4 trillion in 2020.[36] East Asian electronics exports were led by China, the largest manufacturer of electronics, rising sharply in late 2020 and early 2021.[37]

[27] Nayak et al., "An Impact Study of COVID-19 on Six Different Industries: Automobile, Energy and Power, Agriculture, Education, Travel and Tourism and Consumer Electronics," February 11, 2021.
[28] Business Wire, "COVID-19 Impact and Recovery to 2030," August 12, 2021.
[29] Business Wire, "COVID-19 Impact and Recovery to 2030," August 12, 2021.
[30] Statista, "Electronics," 2021; Statista, "Estimated Growth Rates for the Global Electronics Industry From 2020 to 2022, By Region," October 13, 2021.
[31] Euromoniter International, "Top 10 Countries to Drive Global Electronics Production Over 2017–2025," January 2018.
[32] Business Wire, "Electrical and Electronics Industry Is One of the Most Internationally and Regionally Integrated Industries in ASEAN," April 20, 2021. Abdul-Aziz and Zulkifli, "International Production Networks in East Asia's Electronics Industry," January 2017.
[33] Firmsworld, "Top 10 Electronics Companies in World 2021 Best," December 26, 2021.
[34] IHS Markit, "Global Electronics Industry Faces Continuing Supply Disruptions," July 26, 2021.
[35] Business Wire, "COVID-19 Impact and Recovery to 2030," August 12, 2021.
[36] IHS Markit, Global Trade Atlas database, exports, HS Chapter 85, accessed January 11, 2022.
[37] IHS Markit, "Global Electronics Upturn Boosts APAC Manufacturing Exports," accessed January 11, 2022.

Figure 8 Global Electronics Purchasing Managers' Index (PMI), output and new orders, 2006–21

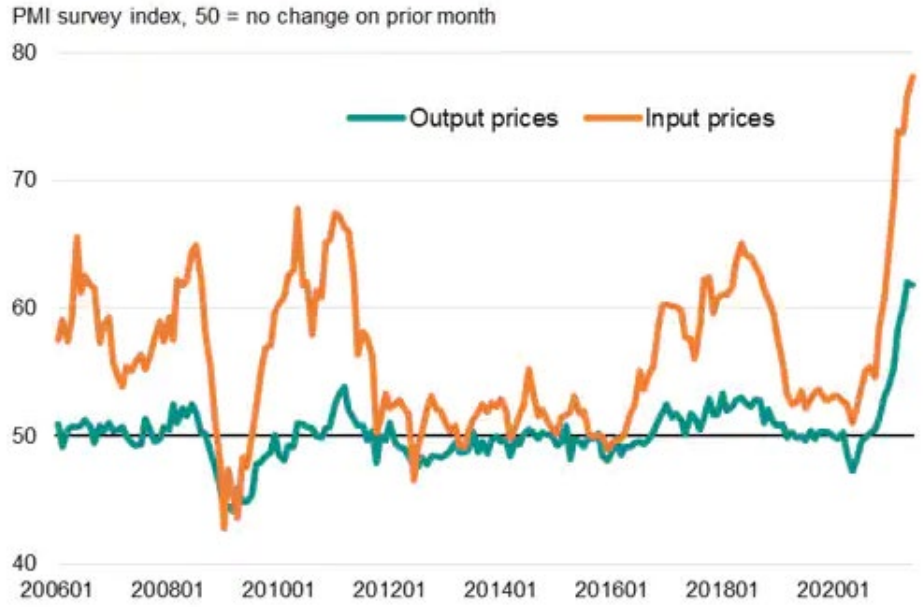


Source: IHS Markit, "Global Electronics Upturn Boosts APAC Manufacturing Exports," accessed January 11, 2022.

The rapid expansion of electronics production in early 2021 triggered several supply-chain issues. Among them were the rising input prices; the shortage of raw materials and key components such as semiconductors (box 1); and the longer supplier lead time. IHS Markit, an information provider, reported that since it began to measure input price inflation in January 1998, input prices experienced the highest rate of inflation during the second quarter of 2021 (figure 9). Supply shortage of raw materials and key components put upward pressure on input prices. For instance, the world's largest chip manufacturer, Taiwan Semiconductor Manufacturing Co. (TSMC), was reported to respond to the shortage of semiconductors with price hikes of up to 20 percent in order to curb demand while generating additional income for production capacity expansion.[38] Meanwhile, lead times for electronic components were reported at record highs, going from an average of 16 weeks to more than 52 weeks, according to the Institute for Supply Management survey.[39] These supply chain woes caused major disruptions in downstream electronics production, leading to a shortage of electronics goods and a long waiting time for consumers.

[38] Jie, "World's Largest Chip Maker to Raise Prices," *WSJ,* August 26, 2021.
[39] Kapadia, "Lead Times at Record Highs and 'Still Accelerating': ISM," *Supplychaindive,* July 7, 2021.

Figure 9 Global Electronics Purchasing Managers' Index (PMI), prices, 2006–20



Source: IHS Markit, "Global Electronics Industry Faces Continuing Supply Disruptions," July 26, 2021.

Personal Computing Devices

As the pandemic forced the closure of public and private spaces such as schools, offices, and indoor recreational facilities, many turned to personal computing devices (PCDs), transforming their homes into hybrid environments in which to learn, work, and play. According to industry market research firms including Deloitte and the International Data Corporation (IDC), global PC sales registered the largest growth since 2010, increasing by 11 percent in 2020.[40] Within the PC "ecosystem," this temporary surge in demand also translated into increases in sales of "computer peripherals," such as monitors, printers, storage devices, and accompanying software.[41]

The pandemic drove up global demand in the PCD industry throughout 2020, despite long-term declines in the traditional PC segment (including desktop, notebook, and workstation), due to the growing competition from alternative mobile devices like tablets and smartphones. Globally, the PCD market grew by 3.3 percent in 2020, with shipment volumes reaching 425.7 million units.[42] The traditional PC segment accounted for the most significant growth in this market, with shipments increasing by 13.1 percent in 2020.[43] The sudden transition to remote work and learning pitted individual consumers against businesses while institutions scrambled to buy devices to avoid work and school stoppages, resulting in a collective estimated shortage of about 5 million laptops in the United States alone by August 2020.[44] In 2021, the

[40] Warren, "The PC Market Just Had Its First Big Growth in 10 Years," *The Verge,* January 11, 2021.
[41] Deloitte, "The Computer Comeback: PCs Surge Due to COVID-19," 2020; IBIS World, *Global Computer Hardware Manufacturing Industry Report*, Report No. C2523-GL, October 2021, 18.
[42] IDC, "IDC Forecasts PC and Tablet Shipments to Grow 3.3% in 2020 Before Resuming Long-Term Decline in 2021," September 1, 2020.
[43] IDC, "PC Sales Remain on Fire as Fourth Quarter Shipments Grow 26.1% Over the Previous Year," January 11, 2021.
[44] Hruska, "A Massive Laptop Shortage Has Hit the United States," August 26, 2020.

IDC expected the PC shipments to grow by 18.1 percent,[45] with the surge in demand for PCs ultimately peaking in the first quarter of 2021 at 55.9 percent.[46] This growth was the highest in the consumer segments of the Asia and Pacific, North America, Europe, and the Middle East regions.[47] India's traditional PC market in particular reported all-time high shipments with 30 percent year-on-year growth in Q3 2021, exceeding even pre-pandemic levels.[48]

Despite the surging demand, global PC exports experienced only a modest 1.2 percent increase in 2020.[49] The PC industry grappled with supply shortages due to pandemic-induced factory closures in the Asia Pacific region, which delayed the procurement of vital computer hardware inputs as well as the production of final products.[50] PCs have a composition similar to that of tablets and smartphones in that they rely on semiconductors as the "brain" for central processors and graphics processors. Although semiconductor producers ramped up production to meet the surge in demand, the priority was placed on the needs of the largest business segment, which was for leading-edge nodes instead of the 40 nanometer or older nodes—more mature technology that is most common in the PC market.[51] The de-prioritization of PC-specific semiconductor inputs—in addition to existing backlogs and widespread logistical bottlenecks—led industry analysts to predict a delay in upstream supply rebalance until at least the first half of 2022.[52] Facing combined shortages in semiconductors and lower-priced components like notebook panel driver integrated circuits (ICs), audio codecs, sensors, and power management ICs (PMICs), preliminary data suggest that shipments intended to fill existing backlogs will continue into 2022.[53]

Concerted efforts throughout 2021 to ramp up production of key inputs—such as semiconductor chips—combined with shifts in consumer spending priorities led investors to predict an impending end to the supply-demand imbalance within the PC industries.[54] Historically, given the durability of these products, surges in the computer and related electronics industries are followed by multiple quarters, if not years, of declining demand.[55] While this trend is anticipated to continue over the next five years, the consumer refresh cycle is expected to be slightly shorter, given that the pandemic has reinvigorated consumer interest in PC gaming and content consumption.[56] The deceleration in shipment growth of PCs began in

[45] IDC, "The PC Market Continues to Surge with Expected Growth of 18.1% in 2021," May 25, 2021.
[46] IDC, "PC Demand Remained Strong in the Second Quarter," July 21, 2021; IBIS World, *Global Computer Hardware Manufacturing Industry Report*, Report No. C2523-GL, October 2021, 9.
[47] Heading into the second half of 2021, shipments began favoring the commercial segment alongside trends in the reopening of offices after the shutdown. IDC, "Traditional PC Shipments Continue to Grow," July 9, 2020; IDC, "EMEA PC Market Maintains Growth in 2021Q3," October 26, 2021.
[48] IDC, "India PC Market Ships 4.5 Million Units in 3Q21," November 18, 2021.
[49] IBIS World, *Global Computer Hardware Manufacturing Industry Report*, Report No. C2523-GL, October 2021, 38.
[50] IBIS World, *Global Computer Hardware Manufacturing Industry Report*, Report No. C2523-GL, October 2021, 38.
[51] IDC, "The PC Market Continues to Surge with Expected Growth of 18.1% in 2021," May 25, 2021.
[52] IDC, "The PC Shipment Wave Continues," March 10, 2021; IDC, "The PC Market Continues to Surge with Expected Growth of 18.1% in 2021," May 25, 2021.
[53] IDC, "PC Shipments Show Continued Strength in Q1 2021," April 9, 2021; IDC, "The PC Market Continues to Surge with Expected Growth of 18.1% in 2021," May 25, 2021.
[54] IDC, "PC Demand Remained Strong in the Second Quarter," July 21, 2021.
[55] Bloomberg, "The Pandemic PC Boom is Over, New Signs Suggest," August 18, 2021.
[56] Global shipments in the market of gaming PCs and monitors grew 26.8 percent in 2020 and continued to exhibit growth of 19.3 percent in Q2 2021. IDC, "The PC Market Continues to Surge with Expected Growth of 18.1% in 2021," May 25, 2021; IDC, "Global Gaming PC and Monitor Market Hit New Record High in 2020," March 29, 2021; IDC, "The Surge in Gaming PC and Monitors Expected to Remain Strong Through 2025," September 30, 2021.

the second quarter of 2021 (13.2 percent year-on-year) and was also felt in related industries including printers, webcams and routers, as well as the global smartphone market.[57]

[57] IDC, "PC Demand Remained Strong in the Second Quarter," July 21, 2021; IDC, "The Global Smartphone Market Grew 13.2% in the Second Quarter," July 29, 2021.

Box 1. Semiconductor Shortage

Semiconductors have been critical to the pandemic response and global economic recovery. They are critical inputs for a host of products from electronics to automobiles, providing essential functions such as display, wireless connectivity, processing, storage, and power management. Throughout the pandemic, semiconductors have underpinned economic solutions such as the IT systems that support remote work and school, or online shopping and delivery services, as well as public health responses such as public testing and contact tracing. Several factors underlie the prolonged semiconductor shortage during the pandemic:

Concentration of semiconductor production: Through the fabless-foundry model, semiconductor supply chains have become increasingly segmented. The United States, once a dominant semiconductor producer, now is specialized primarily in upstream activities such as R&D and chip design, and outsources most production to manufacturers located in the Asia-Pacific region. According to Taipei-based research firm TrendForce, Taiwan, South Korea, and China were the top semiconductor producers in the world in 2020. Taiwan, home to the world's largest foundry—Taiwan Semiconductor Manufacturing Company (TSMC), dominates the foundry market and the outsourcing of semiconductor manufacturing. In 2020, it accounted for 63 percent of global foundry revenue. South Korea, led by Samsung Electronics, accounted for 18 percent, and China was a distant third with a market share of 6 percent. The concentration of semiconductor production in the Asia-Pacific region makes it vulnerable to the regional shocks, such as the initial outbreak of the COVID-19 pandemic in early 2020 and the surging spread of Delta variant in the summer of 2021.

Surging demand for semiconductors: Semiconductors are the "smart brains" used in many modern products including computers, home appliances, cars, and equipment. A Deloitte report estimated about 34 percent of semiconductor sales revenue is generated from data processing electronics (e.g., storage and cloud computing), 30 percent from communication electronics (e.g., wireless), 13 percent from industrial electronics, 12 percent from automotive electronics, 9 percent from consumer electronics, and 1 percent from military and civil aerospace electronics. Automotive electronics and industrial electronics are expected to be the fastest-growing markets in the semiconductor industry.

During the pandemic, there was surging global demand for semiconductors to be used in devices and equipment that support remote healthcare, work at home, and virtual learning. The stronger-than-expected economic recovery in late 2020 and early 2021, as well as pent-up consumer spending, further fueled the demand for products using semiconductors. Although many fabrication factories boosted production and exceeded normal utilization levels of 80 percent, the supply still failed to meet the swelling demand. The shortage of semiconductors in turn affected a range of downstream industries including automotive, consumer electronics, home appliance, and industrial robotics.

Source: Semiconductor Industry Association, *2021 State of the U.S. Semiconductor Industry*, September 2021. OECD, Global Value Chains: Efficiency and risks in the Context of COVID-19, February 11, 2021. Jones et al., "The Rising Role of Re-exporting Hubs in Global Value Chains," April 2020. TrendForce, "Progress in Importation of US Equipment Dispels Doubts on SMIC's Capacity Expansion for Mature Nodes for Now, Says TrendForce," March 5, 2021. Deloitte, *Semiconductors- the Next Wave: Opportunities and Winning Strategies for Semiconductor Companies*, April 2019. Varas et.al, *Government Incentives and U.S. Competitiveness in Semiconductor Manufacturing*, September 2020, Boston Consulting Group and Semiconductor Industry Association. IHS Markit, "APAC electronics sector closes 2020 with strong rebound," December 11, 2020. Wayland, "How Covid Led to a $60 Billion Global Chip Shortage for the Auto Industry," February 11, 2021. Semiconductor Industry Association, "Semiconductor Shortage Highlights Need to Strengthen U.S. Chip Manufacturing, Research," February 4, 2021.

Transport Equipment

Transport equipment is a broad category covering subsectors such as motor vehicles, aircraft, railway equipment, and ships and boats. It was among one of the hardest-hit manufacturing industries in 2020. The industry experienced a strong rebound in demand during the first two quarters of 2021. However, several constraints, including global supply chain disruptions, continued to hinder a fast, full recovery.

Motor Vehicles

After national lockdown was implemented in many countries during the early phase of the pandemic, global demand for motor vehicles declined sharply. According to the International Organization of Motor Vehicle Manufacturers (OICA), global motor vehicle sales fell by 13.8 percent in 2020, with the greatest decline during the first half of 2020. This was a steeper drop than what experienced during the global financial crisis of 2007–08 when global vehicle sales declined by 8 percent.

Responding to the pandemic, the global motor vehicle industry also implemented public-health-related measures which affected the production adversely, such as closing factories to curtail outbreaks and reducing the workforce to maintain social distancing. Global motor vehicle production fell by 15.8 percent between 2019 and 2020. Developing regions such as Africa and South America suffered the largest declines of over 30 percent in motor vehicle production (table 2).[58]

A study by the International Labour Organization (ILO) suggests that in 2020, automotive factory closures in Europe and North America as a response to the pandemic resulted in some 2.5 million passenger vehicles to be removed from production schedules, with an estimate of $77.7 billion in lost revenue for automotive and parts manufacturing companies.[59] In addition, given that the automotive industry is highly dependent on global and regional supply chains, factory closures in one region could have affected key production countries in other regions. For instance, UNCTAD estimates that a 2 percent reduction in China's exports of parts and other intermediate inputs to automotive manufacturers in the EU, North America, Japan, South Korea and other major automotive producing economies could lead to a $7 billion reduction in automotive exports from these economies to the rest of the world.[60]

Table 2 World motor vehicle production (all types), by region, 2019–20

Region	2019	2020	Percentage change in 2019–20 (%)
Europe	21,579,464	16,921,311	−21.6
North America (inc. Mexico)	16,822,606	13,375,622	−20.5
South America	3,326,243	2,314,593	−30.4
Asia and Oceania	49,333,841	44,289,900	−10.2
Africa	1,113,651	720,156	−35.3
World	92,175,805	77,621,582	−15.8

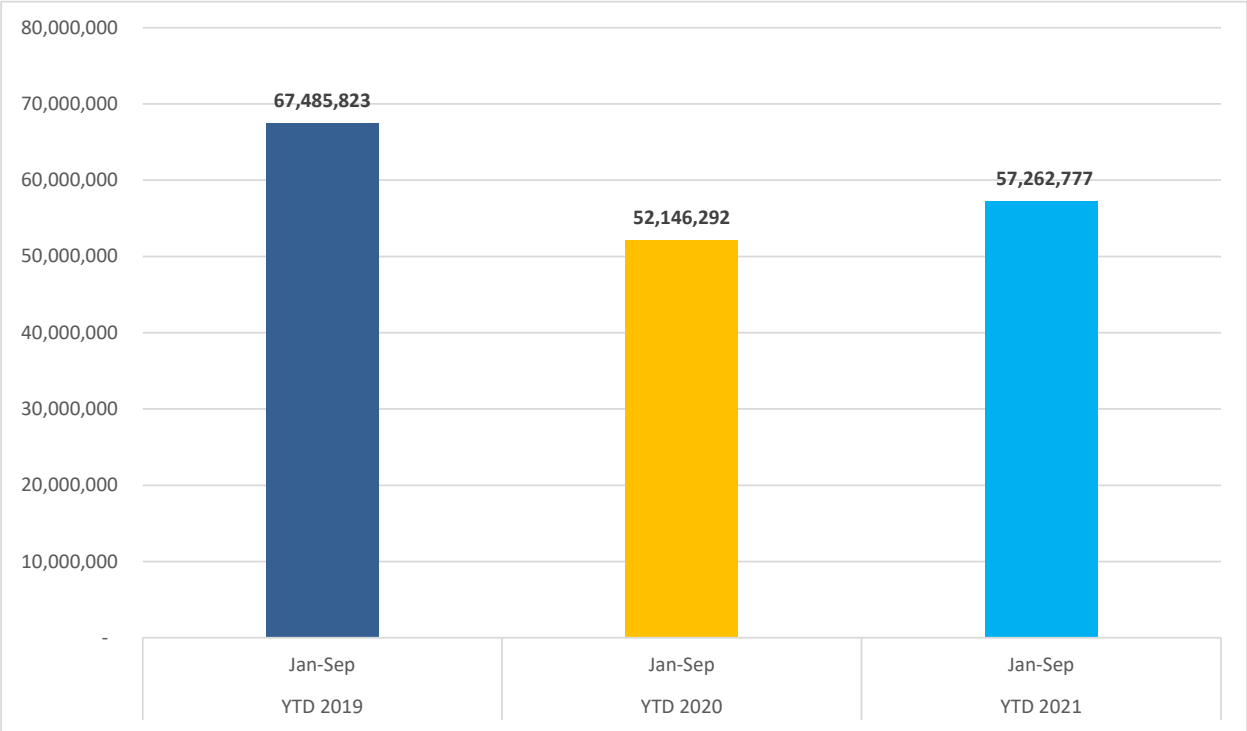
Source: OICA, "World Motor Vehicle Production Statistics," 2019 and 2020, accessed October 12, 2021.

According to the OICA, global motor vehicle production experienced a strong rebound in the first three quarters of 2021, rising nearly 10 percent from the same period of 2020, though still below the 2019 level

[58] OICA, "Sales of New Vehicles 2019–20," accessed August 30, 2021.
[59] ILO, *COVID-19 and the Automotive Industry*, April 8, 2020, 1.
[60] ILO, *COVID-19 and the Automotive Industry*, April 8, 2020, 2; UNCTAD, *Global Trade Impact of the Coronavirus (COVID-19) Epidemic*, March 4, 2020.

(figure 10). Although the demand for new vehicles in 2021 has recovered more strongly than initially expected, the full recovery of automotive industry has been constrained by supply chain disruptions. The shortage of semiconductors resulted in a dwindling supply of automotive microcontroller units (MCUs),[61] which are used in electronic control units throughout vehicles from the engine and transmission to the airbags and doors of modern cars.[62] Since many automotive MCU manufacturers outsource large parts of their manufacturing to original equipment manufacturers such as Taiwan Semiconductor Manufacturing Company, they compete against other technology companies for supplies for the same products, such as manufacturers of smartphones, computers, and other electronic products. The pandemic-induced lockdown and the shift to remote work and school ignited an unusually high demand for these products as well as key inputs such as semiconductors, which in turn led to semiconductor shortage (see box 1 for more information on semiconductors shortage).[63]

Figure 10 World motor vehicle production (all types), January–September of 2019–21



Source: OICA, "World Motor Vehicle Production Statistics," 2021, accessed January 12, 2021.

Research firm IHS Markit estimated 672,000 fewer vehicles will be produced in the first quarter of 2021 due to the semiconductor shortage, including 250,000 units in the world's largest vehicle market, China. Facing the limited supply of MCUs, car manufacturers had to adjust production of particular product lines depending on the availability of appropriate inputs. Consulting firm AlixPartners estimated the semiconductor shortage would reduce the global automotive industry revenue by $60.6 billion in 2021.[64]

[61] Microcontroller is a type of processor on a single integrated circuit, containing memory, processor, and input/output peripheral. BISinfotech, "BIS Chart-Busters: Top 10 Microcontrollers (MCU) Manufacturers for 2020," January 23, 2020.
[62] Leonard, "Why the Automotive Supply Chain is in a Semiconductor Jam," February 23, 2021.
[63] Leonard, "Why the Automotive Supply Chain is in a Semiconductor Jam," February 23, 2021.
[64] Wayland, "How Covid Led to a $60 Billion Global Chip Shortage for the Auto Industry," February 11, 2021.

Aircraft

Due to the COVID-19 pandemic, global demand for aircraft fell due to the reduction in air traffic (see the section on air transport services below for more information). According to the consulting firm, Oliver Wyman, the global fleet had about 27,884 aircraft in service in 2019; at its nadir of the pandemic, it had only about 13,000 aircraft in service, less than half the number flying in January 2020 before the pandemic was declared. It is estimated that the 2021 fleet rose to more than 23,700 aircraft, though still below the 2019 level.[65] Consequently, the reduced number of aircraft in service led to cancellations of orders by airlines, the biggest buyers of airplanes.[66]

Responding to the adverse effects of the pandemic on demand, the aerospace industry implemented significant business restructuring, such as downsizing, closing plants, and divestitures.[67] According to the General Aviation Manufacturers Association (GAMA), in 2020, the global shipment of airplanes declined by 9.4 percent, while the global shipment of helicopters declined by 19.2 percent. The global shipment of business jets had the largest decrease of over 20 percent in 2020. The total airplane billing dropped by 14.8 percent from $23.5 billion in 2019 to $20 billion in 2020, while the total helicopter billing decreased by 11.2 percent from $3.8 billion in 2019 to $3.4 billion in 2020 (table 3). Most declines incurred in the first half of 2020.

Table 3 Aircraft shipments, by type, 2019–2020

Product	2019	2020	Percentage change in 2019–20 (%)
Piston airplanes	1,324	1,321	−0.2
Turboprop airplanes	252	443	−15.6
Business jets	809	644	−20.4
Total airplane shipments	2,658	2,408	−9.4
Total airplane billings	$23.5 billion	$20.0 billion	−14.8
Piston helicopters	179	142	−20.7
Turbine helicopters	698	567	−18.8
Total helicopter shipments	877	709	−19.2
Total helicopter billings	$3.8 billion	$3.4 billion	−11.2

Source: GAMA, "Aircraft Shipment Reports," accessed October 12, 2021.

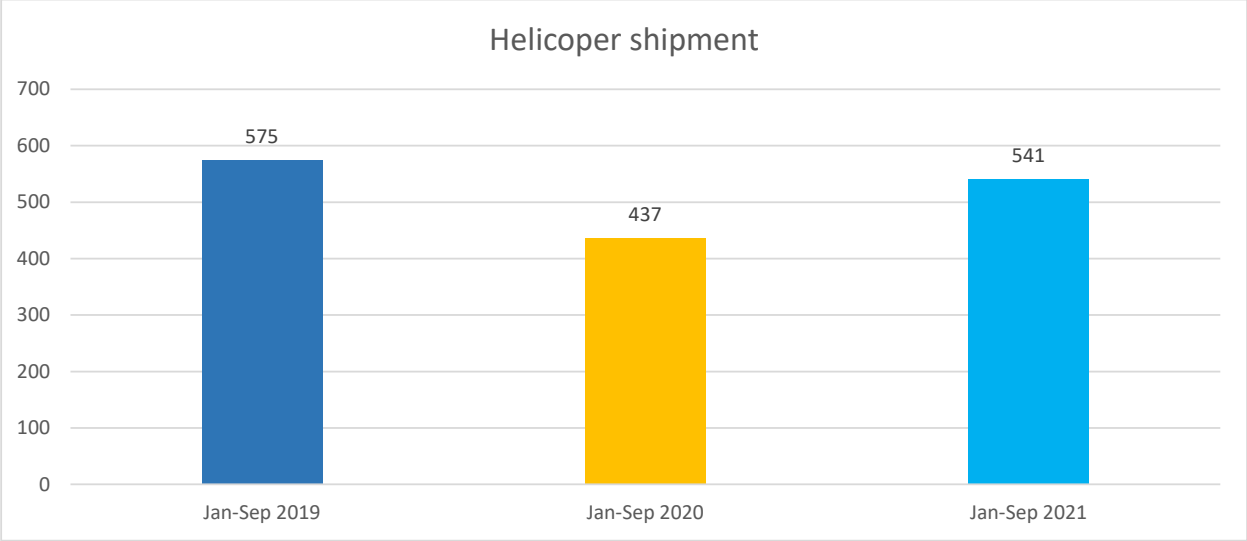
As countries around the world slowly eased restrictions on air travel, the aviation industry began to recover during the third quarter of 2020. By the third quarter of 2021, the global airplane shipment increased by more than 10 percent from 2020, and the global helicopter shipment increased by nearly 24 percent from 2020, though both still below the 2019 level (figure 11 and 11.5).[68]

[65] Oliver Wyman, *Global Fleet and MRO Market Forecast 2021–2031*, January 28, 2021.
[66] Akinola, *The Impact of COVID-19 on the Aviation Industry*, September 2020, 7–8.
[67] Krutz, "Avoiding Mass Disruption in the Aerospace Supply Chain," December 17, 2020.
[68] GAMA, "Aircraft Shipment Reports," accessed October 12, 2021.

Figure 11 Airplane shipments, January–September of 2019–21

Source: GAMA, "Aircraft Shipment Reports," accessed October 12, 2021.

Figure 11.5 Helicopter shipments, January–September of 2019–21



Source: GAMA, "Aircraft Shipment Reports," accessed October 12, 2021.

Easing travel restrictions led to a sharp increase in business jet traffic as well as demand for business jets. However, it also triggered a squeeze on the whole aviation supply chain. Similar to other manufacturing industries discussed above, the aviation industry also has been facing multiple supply chain constraints, including a shortage of plane parts for maintenance and replacement, substantial increase in costs for raw materials (estimated by 27–44 percent), a lack of skilled workers to ramp up production, and shipment delays.[69] These disruptions not only make it challenging for the aviation industry to meet resurgent demand, but also erode profit margins and increase the risks of slowing down the recovery. Airbus chief executive Guillaume Faury said, "the supply chain management for the next 12 to 18 months will be the most difficult part of what we have to achieve to really recover."[70]

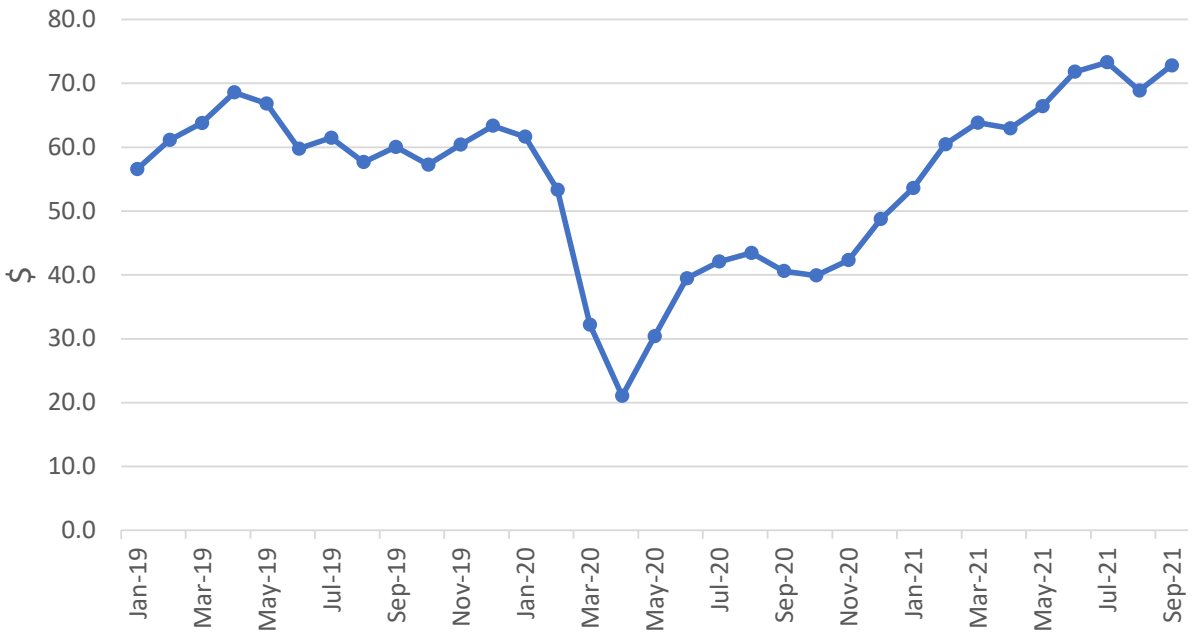
[69] Lampert, "Aviation Supply Chain Faces Mounting Strain as Demand Picks Up," October 15, 2021.
[70] Reuters, "Airbus CEO Says Supply Chain is in 'Difficult Spot'," September 14, 2021.

Petroleum Industry

As the data in figure 12 show, during the pandemic, the global oil industry experienced significant volatility. It was first marked by the collapse of crude oil prices, a sharp decline in global trade of petroleum products, and a steep drop in global oil demand. Those events were followed by a swift rebound, an unprecedent supply cut, and the ensuing global energy shortage. The turmoil in the global oil industry was largely due to the misalignment between global demand and supply, which swung sharply throughout the pandemic.

The price of crude petroleum dropped sharply from $63 per barrel in December of 2019 to $21 per barrel in April of 2020, a low level last seen in 2002.[71] The benchmark of U.S. crude oil, West Texas Intermediate, briefly fell into negative territory for the first time ever in late April 2020.[72] This sharp decline in the price of oil resulted from the outbreak of the COVID-19 pandemic, which triggered a global demand shock in the oil industry. The containment measures and the reduced economic activity led to a dramatic reduction of global oil demand, which in turn resulted in an oversupply with a massive buildup in petroleum inventory and limited capacity of storage. Amid this turmoil in the oil industry, the oil price war between Saudi Arabia and Russia, erupted on March 8, 2020, after these two countries failed to agree on oil production levels, putting even more downward pressure on the price of oil.[73] However, crude oil prices did recover to nearly $50 per barrel by the end of 2020, and by September 2021 had surpassed $72 per barrel, higher than pre-pandemic level (figure 12).[74]

Figure 12 Monthly crude oil price, January 2019–September 2021, in dollars



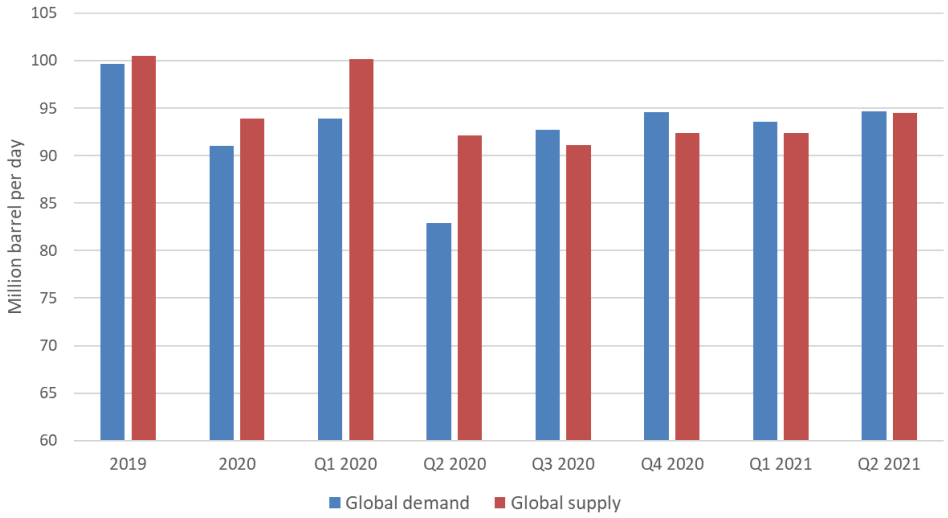
Source: IndexMundi, "Crude Oil (petroleum) Monthly Price," accessed January 12, 2022.
Note: Based on the average spot price of Brent, Dubai, and West Texas Intermediate, equally weighed.

[71] IndexMundi, "Crude Oil (petroleum) Monthly Price," accessed January 12, 2022.
[72] OECD, *The Impact of Coronavirus (COVID-19) and the Global Oil Price Shock on the Fiscal Position of Oil-Exporting Developing Countries*, September 30, 2020.
[73] Ruchuan Ma, et al., "The Russia-Saudi Arabia Oil Price War During the COVID-19 Pandemic," October 2021.
[74] IndexMundi, "Crude Oil (petroleum) Monthly Price," accessed January 12, 2022.

The value of global trade of crude and refined petroleum products in 2020 registered over 33 percent decline—among the sharpest of all goods—from the 2019 level, due to the decreases in price as well as quantity.[75] Based on available data, top oil exporting countries such as Brazil, Canada, China, Russia, and the United States, all reported a double-digit percentage decrease in their 2020 petroleum exports (Russia, −36 percent; China, −31 percent; Canada, −30 percent; the United States, −24 percent, and Brazil, −18 percent).[76]

In 2020, global oil demand fell by 8.7 percent from the 2019 level,[77] the largest drop since 1980.[78] The deepest decline took place during the second quarter of 2020, during which most countries were deep in strict lockdown. It was followed by a swift rebound in the third and fourth quarters of 2020. During the first half year of 2021, global oil demand was stabilized at about 94–95 million barrels per day (bpd), though still slightly below the 2019 level of 99.7 million bpd (figure 13).

Figure 13 Global oil demand and supply, 2019–Q2 20221, in millions of barrels per day (bpd)



Source: Data compiled from several IEA's Oil Market Reports.

In 2020, global oil production fell by over 6 percent from the 2019 level.[79] Responding to the decline in global oil demand and anticipating a weak economic outlook, the energy alliance—the Organization of Petroleum Exporting Countries (OPEC) and its non-OPEC allies (OPEC+)—agreed to a record supply cut of 9.7 million bpd, about 10 percent of global oil production, starting on May 1, 2020. Since then, the supply cut was scaled back to about 5.8 million bpd.[80] Of the top 10 oil producers in the world, Iraq, Iran, Kuwait, Russia, and United Arab Emirates (UAE) registered the largest percentage declines in their oil production in 2020 (table 4).

[75] Based on available data from 97 economies. IHS Markit, Global Trade Atlas database, chapter 27, accessed December 16, 2021. The trade data exclude five of the top oil producers including Iran, Iraq, Saudi Arabia, Kuwait, and UAE.
[76] Based on available data from 97 economies. IHS Markit, Global Trade Atlas database, Chapter 27, accessed December 16, 2021.
[77] IEA, *Oil Market Report (April 2021)*, April 2021.
[78] USEIA, "EIA Estimates Global Petroleum Liquids Consumption Dropped 9% in 2020," January 29, 2021.
[79] IEA, *Oil Market Report (April 2021)*, April 2021.
[80] Meredith, "OPEC Cuts 2020 Oil Demand Forecast Again on Rising COVID Cases," November 11, 2020.

Table 4 Global oil production, by the global top ten producers, 2018–20
In millions of barrels per day (mbpd) and in percentages.

Region	2018 (mbpd)	2019 (mbpd)	2020 (mbpd)	Percentage change 2019–20 (%)
United States	17,910	19,471	18,609	−4.4
Saudi Arabia	12,114	11,467	10,815	−5.7
Russia	11,385	11,474	10,496	−8.5
Canada	5,348	5,478	5,235	−4.4
China	4,753	4,863	4,863	0.0
Iraq	4,619	4,802	4,163	−13.3
UAE	3,786	4,130	3,780	−8.5
Brazil	3,413	3,659	3,769	3.0
Iran	4,601	3,321	3,012	−9.3
Kuwait	3,059	3,017	2,747	−9.0
Rest of World	29,431	28,653	26,372	−8.0
World	100,419	100,334	93,861	−6.5

Source: USEIA, Annual Petroleum and Other Liquids Production Database, accessed December 21, 2021.

The petroleum industry suffered the real-time misalignment between demand and supply more so than other industries throughout the pandemic. Production tends to take a longer time to respond and therefore often lags during the quick swings of global demand. During the third quarter of 2020, while the world began to experience a strong economic recovery, global oil production was reduced to about 91 million bpd, the lowest point during the pandemic. It slowly rose to over 92 million bpd in the fourth quarter of 2020 and the first quarter of 2021, and over 94 million bpd in the second quarter of 2021. Global oil demand exceeded global oil supply during this period, leading to low oil stocks and high oil prices. The imbalance of global oil supply and demand contributed to the 2021 energy crisis, in which countries such as the United Kingdom and China experienced energy shortages resulting in spikes in energy prices.[81] In turn, this added to inflationary pressure. In addition, with the later waves caused by the new virus variants such as Delta and Omicron, the uncertainty associated with the pandemic and the economic outlook continues to complicate the recovery of petroleum industry.

Services

The pandemic has left a strong, adverse impact on the services sector. With physical distancing and the reduction of nonessential operations and travel, the COVID-19 pandemic posed particularly large challenges for services industries that had heretofore relied heavily on in-person interaction. The latter includes a wide range of industries—from education, healthcare, and professional services to transportation and tourism services.[82] As a result, the share of services in global gross domestic product (GDP) declined from 64.3 percent in 2019 to 59.9 percent in 2020.[83] This section focuses on the effects of (and related challenges imposed by) the COVID-19 pandemic on transport and travel services, as pandemic-related impacts on these services were especially pronounced.

In order to mitigate the challenges of the loss of in-person services during the pandemic, a range of services firms pivoted to virtual provision, digitizing activities as substitutes for those that had been supplied through face-to-face interaction. Among the affected industries, for example, were professional

[81] Helman, "Energy Crisis 2021," October 19, 2021.
[82] McKinsey Insights, "Coronavirus' Impact on Service Organizations," April 29, 2020.
[83] World Bank, "Services, Value Added (% of GDP)," accessed January 6, 2022.

services such as accounting, legal, and management consulting services, as well as education and certain healthcare services.[84] Transportation services also benefited from access to and use of digital networks to schedule and monitor the flow of goods, particularly via containers (box 2). The availability of robust telecommunications services became an important issue within and among countries and also highlighted the negative consequences of unequal access to such networks among different demographic groups.[85]

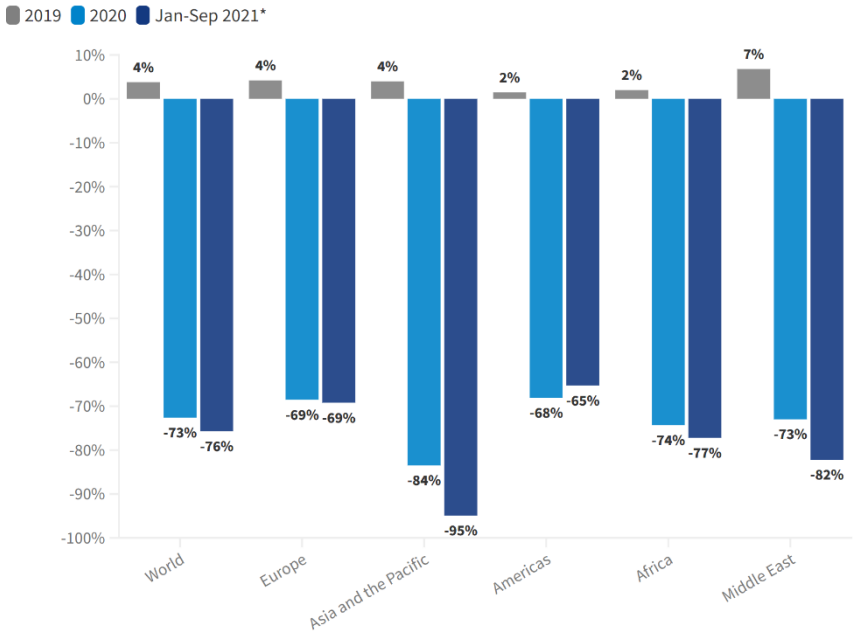
Travel and Tourism Services

Travel and tourism services were among the hardest hit sectors by the pandemic in 2020. In 2019, travel and tourism services accounted for $9.2 trillion, or 10.4 percent of global GDP, but fell to $4.7 trillion in 2020 (a 49.1 percent decrease).[86] Although industry experts state that the rebound of travel and tourism activity in 2021 is important to global economic recovery, expenditures related to business and international travel have continued to significantly lag pre-pandemic levels. In 2020, expenditures on business travel decreased by 61.0 percent compared to 2019, international travel by 69.4 percent, and leisure travel by 49.4 percent.[87] Employment losses in the travel and tourism sector were also large during the pandemic. The number of travel and tourism jobs worldwide decreased from 334 million in 2019 to 272 million in 2020, a decline of 18.6 percent.[88]

According to a report by the UN World Tourism Organization (UNWTO), as of November 2020, more than half of countries worldwide had established partial restrictions on foreign visitors due to the COVID-19 pandemic, with 27 countries in the Asia Pacific region prohibiting foreign entry.[89] As a result, international tourist arrivals decreased by 73 percent in 2020 compared to 2019, with the largest aggregate decline experienced by countries in Asia and the Pacific, followed by Africa and the Middle East, Europe, and the Americas (figure 14).[90] Within Asia, the largest decreases in international tourist arrivals between January and December 2020 occurred in Northeast Asia (−88 percent), Southeast Asia (−82 percent), Oceania (−79 percent), and South Asia (−78 percent). North Africa (−78 percent) and Northern Europe (−74 percent) also registered large declines in international tourist arrivals in 2020.[91]

[84] For more information, see USITC, *Recent Trends in U.S. Services Trade: 2021 Annual Report*, April 2021.
[85] WTO, "Trade in Services in the Context of COVID-19," May 28, 2020.
[86] World Travel and Tourism Council, "Travel and Tourism: Economic Impact 2021," June 2021.
[87] World Travel and Tourism Council, "Travel and Tourism: Economic Impact 2021," June 2021.
[88] World Travel and Tourism Council, "Travel and Tourism: Economic Impact 2021," June 2021. According to the World Travel and Tourism Council, the travel and tourism sector accounted for 1 of every 4 net new jobs between 2014 and 2019 and, in 2019, represented 10.6 percent of total employment and 54.0 percent of female employment.
[89] UNWTO, "International Tourism and Covid-19," accessed March 8, 2021. UNWTO, "70% of Destinations Have Lifted Travel Restrictions, but Global Gap Emerging," December 2, 2020.
[90] UNWTO, "Global Tourism Sees Upturn in Q3 But Recovery Remains Fragile," November 28, 2021.
[91] UNWTO, "UNWTO Tourism Data Dashboard," accessed July 29, 2021.

Figure 14 Change of international tourist arrivals, in percentages, 2019–21
2019 change is over 2018; 2020 and 2021 changes are over 2019.



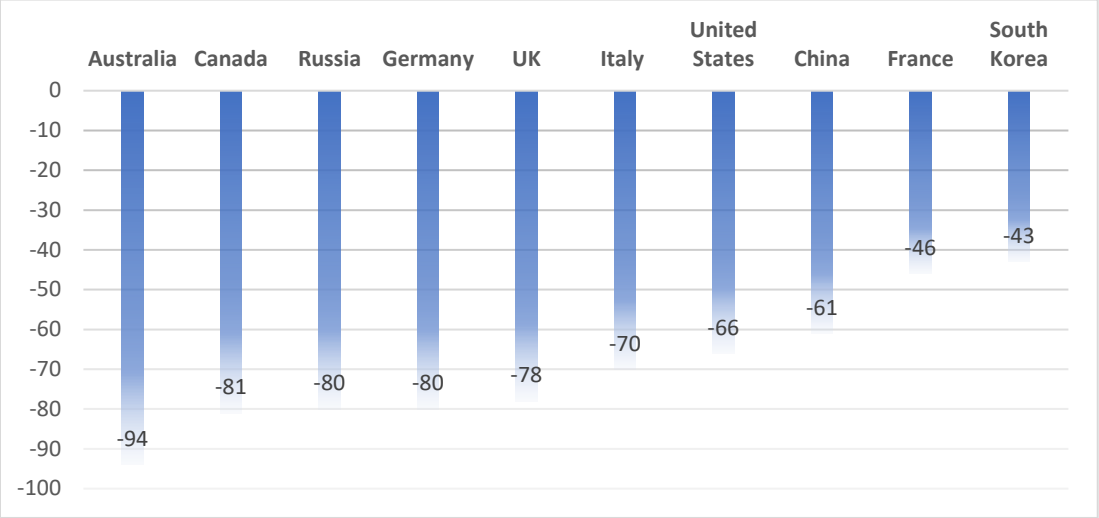
Source: UNWTO, "Global Tourism Sees Upturn in Q3 But Recovery Remains Fragile," November 28, 2021.

In 2021, although the rollout of COVID-19 vaccines brought hope that international travel restrictions would be lifted soon, the new waves caused by the Delta and Omicron variants forced countries to tighten their borders once again. According to the latest World Tourism Barometer, released by the UNWTO on November 28, 2021, international tourist arrivals in 2021 is estimated to be over 75 percent lower than in 2019, worse than in 2020. Receipts from tourism were forecasted to reach $700 to $800 billion, a small improvement from 2020 but remaining far below $1.7 trillion recorded in 2019.[92] The Asia and Pacific region is among the worst-performing regions, as many destinations remained closed to nonessential travel. As a result, 2021 international tourist arrivals in the region decreased by 95 percent from 2019, compared to a decline of 84 percent in 2020 (figure 16).[93]

Data from the UNWTO indicate that the top 10 source countries for international tourist arrivals continued to show a significant decline in such arrivals in 2021 compared to 2019 (figure 15). By the spring of 2021, tourist arrivals in Australia had fallen by 94 percent compared to the same period in 2019, and by approximately 80 percent each in Canada, Germany, and Russia.[94] Although tourism rebounded slightly in the summer of 2021, January–September 2021 international tourism arrivals remained 76 percent lower than in the same period during 2019.[95]

[92] Economist, "This Year May Prove Even Worse for the Tourism Industry Than 2020," December 1, 2021.
[93] UNWTO, "Global Tourism Sees Upturn in Q3 But Recovery Remains Fragile," November 28, 2021.
[94] UNWTO, "UNWTO World Tourism Barometer," accessed July 29, 2021.
[95] UNWTO, "Latest Tourism Data: World Tourism Barometer," accessed January 7, 2022.

Figure 15 Percentage change in international tourist arrivals by top 10 source countries, 2021 vs. 2019



Source: UNWTO, "UNWTO Tourism Dashboard," accessed July 29, 2021.
Note: Data for Canada, China, Russia, and the UK are from March 2021. Data for Italy are from April 2021. Data for France, South Korea, and the United States are from May 2021.

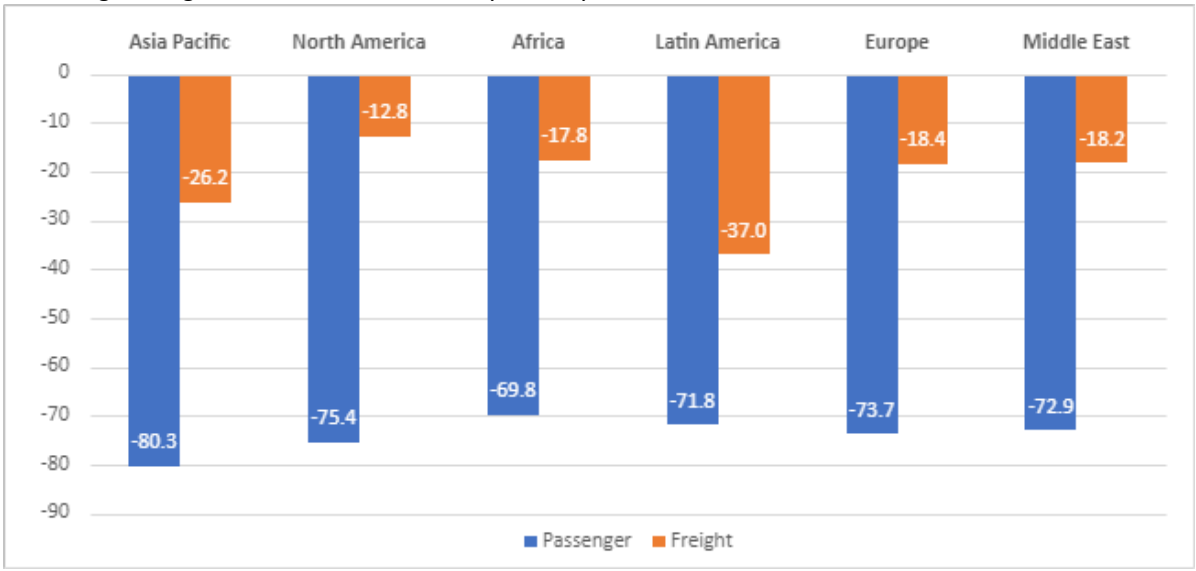
Transport Services

Air Transport Services

As noted earlier, restrictions on foreign travel caused a sharp decrease in air traffic in 2020. Available data indicate that both air passenger and air freight traffic fell precipitously in 2020 compared to 2019, with the most pronounced decreases experienced in air passenger transport (figure 16).[96] By region, the highest decreases in air passenger traffic in 2020 occurred among countries in the Asia Pacific (−80 percent), followed by North America (−75 percent) and Europe (−74 percent). At the same time, air freight traffic declined by the greatest amount in Latin America (−37 percent), followed by the Asia Pacific (−27 percent), and Europe (−20 percent).[97]

[96] IATA, "January Air Cargo Demand Recovers to Pre-COVID Levels," March 2, 2021.
[97] IATA, "2020 Worst Year in History for Air Travel Demand," February 3, 2021.

Figure 16 Percentage change in air freight and air passenger traffic, by region, 2019–20
Percentage changes are calculated based on year-on-year data for December 2019 and December 2020.



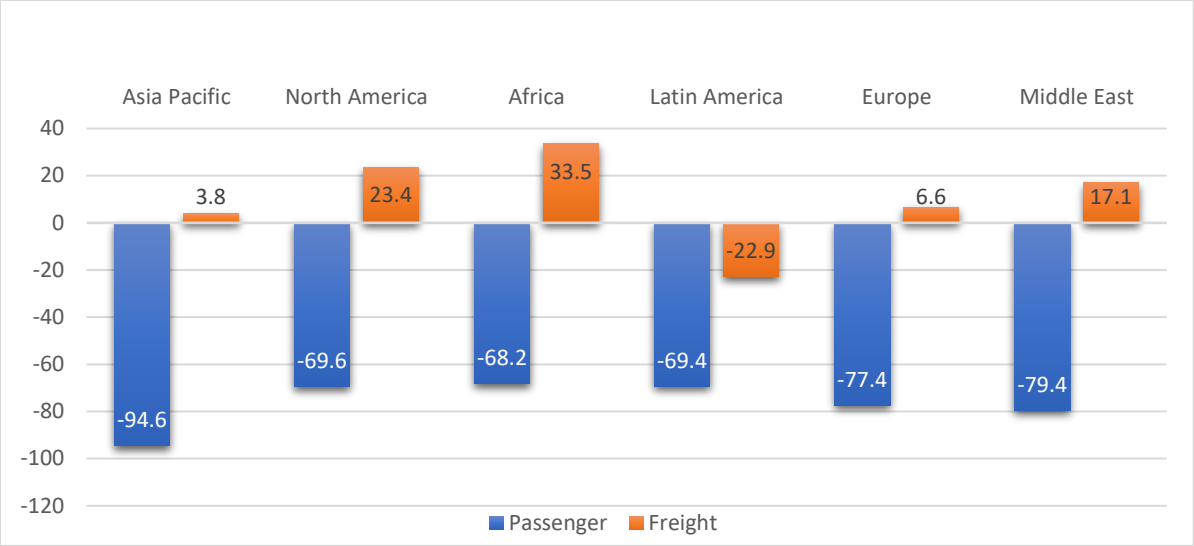
Source: IATA, "January Air Cargo Demand Recovers to Pre-COVID Levels," March 2, 2021; IATA, "2020 Worst Year in History for Air Travel Demand," February 3, 2021.

The drop in airline traffic, also diminished the availability of "belly" cargo, or cargo transported in the holds of passenger aircraft.[98] During the pandemic, however, some airlines removed seats from passenger aircraft to convert them into cargo carriers, thereby returning some air freight capacity to the market.[99] For example, in August 2020, American Airlines announced plans to add 1,000 all-cargo flights (using passenger aircraft) covering 32 cities to its scheduled services.[100] However, by the summer of 2021, major U.S. airlines began canceling cargo-only services, as the demand for passenger transport recovered.[101]

Available data for 2021 from the International Air Transport Association (IATA) indicate a continued shortfall in the demand for airline travel compared to 2019. Data from June 2021 show that air passenger traffic was significantly below that of June 2019, with decreases across all major regions (figure 17). By contrast, the demand for air cargo increased above 2019 levels in Africa (33.5 percent), North America (23.4 percent), the Middle East (17.1 percent), Europe (6.6 percent), and the Asia Pacific (3.8 percent).[102]

[98] IATA, "2020 Worst Year in History for Air Travel Demand," February 3, 2021.
[99] Atlas Logistics Network, "US Airlines Transform Passenger Aircraft into Cargo Carriers," accessed March 12, 2021.
[100] Kulisch, "American Airlines Doubles Down on Cargo-Only Flights," August 18, 2020.
[101] Kulisch, "United Airlines Ditches Cargo-Only Flights as Passengers Return," July 22, 2021.
[102] IATA, "Air Cargo Posts Strongest First Half-Year Growth Since 2017," July 28, 2021.

Figure 17 Percentage change in air freight and air passenger traffic, by region, 2019–21
Percentage changes are calculated based on year-on-year data for June 2019 and June 2021.



Source: IATA, "June Air Travel Recovery Continues to Disappoint," July 28, 2021; IATA, "Air Cargo Posts Strongest First Half-Year Growth Since 2017," July 28, 2021.

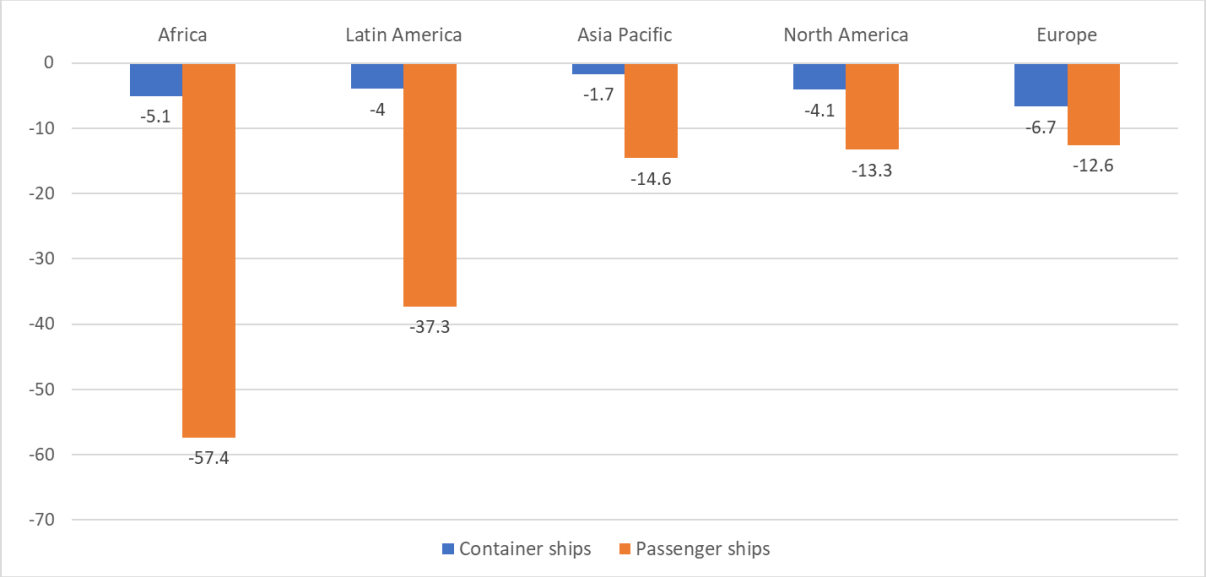
Although, due to the availability of COVID-19 vaccines in early 2021, air travel demand was forecast to increase throughout the remainder of the year, the spread of the Delta (and, beginning at the end of 2021, the Omicron) variants slowed an anticipated rebound. Especially hard-hit were international travel, with several countries maintaining restrictions on foreign visitors, and corporate travel, as some businesses remain closed to in-person activity.[103] Forecasts estimated that air travel would not return to pre-pandemic levels until at least 2023. While near-term recovery in short-haul (domestic) travel is evident, long-haul travel will continue to be affected by global disparities in vaccine distribution and ongoing concerns that travel contributes to the spread of COVID-19.[104] As such, sectors that depend on international tourism, as well as services industries that require the temporary movement of persons (i.e., specialists, managers, and other executives that travel to or work in the foreign affiliates of host countries), may experience the knock-on effects of pandemic-related travel restrictions. Such effects may, in turn, have implications for global value chains that rely on access to both overseas consumers and personnel.[105]

Maritime Transport Services

UNCTAD's port call and performance statistics database indicates that global ship traffic fell by 10.4 percent between 2019 and 2020. Container ship traffic declined by over 3 percent, while passenger ship traffic decreased by almost 14 percent.[106] Europe had the largest percentage decline in container ship traffic, while Africa suffered the largest percentage decrease in passenger ship traffic (figure 18).

[103] Evers-Hillstrom, "Airlines Warn of Delta Variant's Impact on Travel," September 9, 2021; U.S. Travel Association, "U.S. Travel Reacts to Lifting of Travel Restrictions," September 20, 2021.
[104] WiT, "Return to Normal of Travel Unlikely Until 2023," July 15, 2021.
[105] Frederick and Daly, "Global Value Chain Lens Can Inform Responses," October 20, 2020.
[106] UNCTAD, Maritime Transport, port call and performance statistics, semi-annual, accessed July 1, 2021.

Figure 18 Percentage change in number of port calls, by region, 2019–21



Source: UNCTAD, Maritime Transport, port call and performance statistics, semi-annual, accessed August 31, 2021.

During the second half of 2020, container ship traffic rose above levels in the first half of the year[107] due to an increase in demand for goods, including that generated by a spike in online retail sales, or e-commerce.[108] The increase in the demand for containerized goods in the second half of 2020 precipitated a cascade of capacity shortages in maritime container transport, and associated port services and trucking services, continuing into 2021.[109] Exacerbating high container processing times at ports were delays and congestion associated with the inland transport of containers by truck and rail (partly due to fewer personnel), and a lack of adequate warehousing capacity.[110] Warehousing space was allocated early in the pandemic to store containerized goods that retailers held at U.S. ports because these goods were not expected to sell during an economic downturn. When the economy improved in the latter half of 2020, such space was at premium due to an influx of U.S. containerized imports stemming from e-commerce.[111]

Capacity shortages in the maritime sector led to a jump in container freight rates, as shipping lines exhausted available capacity and awaited the delivery of new container ships.[112] The uneven distribution of shipping containers—many of which were circulated in high-volume trade lanes between China and the U.S. West Coast—also created capacity shortages on certain maritime routes.[113] Illustratively, by 2021, the spot price for shipping a 40 foot-equivalent unit (FEU) container from Shanghai to New York had increased fourfold, from $2,500 in 2019 to $10,000.[114] For standard-size 20-foot equivalent units (TEUs),

[107] UNCTAD, Maritime Transport, port call and performance statistics, semi-annual, accessed July 1, 2021.
[108] Knowler, "E-Tailers Tap Expedited Ocean Services as Air Cargo Rates Soar," September 4, 2020; King, "Ocean Freight Market Far Stronger than in Last Global Recession," March 17, 2021.
[109] Friesen, "No End in Sight," September 3, 2021.
[110] Tirschwell, "U.S. Port Congestion Solutions Bump Into Third Rail of Labor," April 13, 2021.
[111] Journal of Commerce, "COVID-19: Pile up of Non-Essential Cargo at US ports Raises Alarms," March 27, 2020.
[112] Paris, "Tight Capacity on Shipping Lines Brings Record Rates, Delays," June 30, 2021.
[113] Friesen, "No End in Sight," September 3, 2021.
[114] Economist, "A Perfect Storm for Container Shipping," September 16, 2021.

purchase prices also doubled to $3,695 from mid-2019 to mid-2021. As such, China, the largest global manufacturer of shipping containers, had increased its production of shipping containers to meet demand.[115]

U.S. port congestion was exacerbated by a significant shortage in truck drivers, leading to further delays in the transport of containerized cargo to and from ports.[116] Although a U.S. truck driver shortage existed prior to the pandemic,[117] this shortage deepened over the last 18 months due to COVID-related illness.[118] Other factors contributing to a declining workforce in the U.S. trucking industry include drug testing mandates leading to driver attrition, and retirement.[119] The U.S. truck driver shortage has also affected the delivery of goods within and between U.S. markets, contributing to the higher prices of raw materials, such as fuel and lumber, and increasing the downstream costs of consumer goods.[120] As such, the U.S. government has considered efforts to expand the driver workforce, such as lowering minimum age requirements for new truck drivers from 21 to 18 and modifying visa requirements to permit the hiring of foreign truck drivers.[121] In addition, some U.S. companies have increased starting salaries for new drivers and added signing bonuses and other benefits to entice applicants. The competition for long-haul truck drivers has grown especially fierce during the current pandemic phase.[122]

The United Kingdom (UK) also has been experiencing a truck driver shortage, largely driven by factors similar to those in the United States, such as illness, attrition, and early retirement.[123] Although, in October 2021, the UK extended temporary visas to foreign truck drivers to help fill the employment gap over the 2021 holiday season, the truck driver shortage was expected to persist through at least the first quarter of 2022.[124] In addition, industry sources suggest that the total shortfall of truck drivers across the Europe surpassed 400,000 in 2021, led by the UK, Germany, and Poland.[125]

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[115] Dempsey and Hale, "Record Freight Container Production Fails," September 15, 2021.
[116] Palmeri, "Port-Crisis Plan Seeks Inland U.S. Terminals, More Truckers," October 14, 2021.
[117] USDOL, BLS, "Is the U.S. Market for Truck Drivers Broken?" March 2019.
[118] Journal of Commerce, "The Driver Shortage," accessed October 27, 2021; and Cassidy, "Trucking Recruiters Face Long Haul in Hunt for Drivers," April 5, 2021.
[119] Dean, "U.S. Trucking Industry is Short by a Record 80,000 Drivers," October 20, 2021. The long-haul trucking industry typically exhibits high turnover due to -drivers' long working hours and time away from home.
[120] Hawkins, "A Trucking Crisis Has the U.S. Looking for More Drivers Abroad," August 2, 2021.
[121] Hawkins, "A Trucking Crisis Has the U.S. Looking for More Drivers Abroad," August 2, 2021.
[122] Cassidy, "Yellow Revs Up Recruitment," February 22, 2021.
[123] Meyer, "The UK Desperately Needs European Truck Drivers," October 5, 2021.
[124] Pylas, "UK Extends Truck Driver Visa Program," October 2, 2021. UK truck driver shortages have been exacerbated by Brexit, as truck drivers from EU countries are now required to have visas to provide service to and from the UK. To mitigate a shortage of drivers, the UK government has offered three-month temporary visas to EU truck drivers serving the UK market. However, the UK is now competing with EU countries for such drivers, some of whom may prefer to remain in the EU for a variety of reasons, including proximity to their home countries. Khan, "UK Aims to Ease Trucker Shortage with Visas Into 2022," updated October 13, 2021; and Segal, "As U.K. Beckons Truck Drivers, Many in Poland Say 'No Thanks'," November 28, 2021.
[125] Ellyatt, "After Causing Chaos in the UK," updated October 4, 2021.

Box 2 Ports and Maritime Firms Advance the Use of Digital Technologies to Improve Supply Chain Resilience and Maritime Safety

In recent years, both maritime firms and port operators have employed digital technologies to monitor and facilitate the movement of cargo. These efforts have often lagged those in the air freight industry due to the disparate and complex nature of maritime supply chains. However, during the pandemic, the use of digital technologies in the maritime sector grew in urgency, not only to track cargo and improve port efficiency but to ensure the safety of vessels and maritime personnel. Digitization and a complementary effort towards automation decrease bureaucratic delays associated with the processing of cargo at ports and reduces delays in vessel and container movement. In particular, the use of digital technology enables the paperless exchange of customs and other information on cargo between port authorities, ocean carriers, and shippers, while automation facilitates the loading and unloading of containers from ships, and from vessels to warehouses or intermodal transport with few or no workers. Such outcomes have improved the resiliency of maritime supply chains during the pandemic and, importantly, offered a way to mitigate the spread of the COVID-19 among port workers.

Going forward, additional efforts to incorporate digital technologies in the maritime sector will likely focus on the ship-to-shore exchange of information on vessels, cargo, and crew in transit. Specifically, digital platforms would enable shippers, logistics firms, and maritime personnel to view real-time data on the movement of ships at sea, the location of cargo, and the capacity of nearby ports to accommodate vessels. Further initiatives by the International Maritime Organization (IMO) are underway to study how the automation of ships can reduce the effects of human error, protect the safety of crew, and enable increasingly large container ships to be operated by fewer personnel.

Sources: Industry representative, interview by USITC staff, May 25, 2021; UNCTAD, *Review of Maritime Transport 2020*, 2020, XV, and 61–62; Hellenic Shipping News Worldwide, "COVID-19 Accelerates Drive for Digitization of Shipping," December 30, 2020; XChange (blog), "Container Terminal Automation and Its Benefits Explained," August 1, 2019; IMO and MPA, "Future of Shipping: Digitalization." October 8, 2020; Powell, "The Digital Exchange of Shipping is Here," May 23, 2019; Homeland Security Today, "Autonomous Ships: Regulatory Scoping Exercise Completed," May 27, 2021; Port Technology International, "Digitalization Needed to Save Maritime Industry According to IMO and MPA," July 31, 2020.

Conclusion

The year 2022 has marked the third year of the COVID-19 pandemic. At the time of this writing, many countries are coping with another wave of a pandemic surge caused by the highly contagious Omicron variant, which has added more uncertainty to the global economic outlook and anticipated recovery. This is the great challenge we faced in our attempt to analyze the economic impact of the pandemic, as many data and estimates continued to be revised, and/or will be revised to reflect the reality more accurately. Regardless of the data limitation, this paper provides a collection of industry-based analyses. It complements another paper authored by Erika Bethmann, Emma Blair, Chang Hong, Lin Jones, Chris Montgomery, Huyen Nguyen— "Regional Macroeconomic and Trade Trends During the COVID-19 Pandemic," which provides a collection of region-based macroeconomic and trade analyses. Together, these two papers aim to provide a comprehensive set of background information and data for future work on the impact of the COVID-19 pandemic on global value chains.

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