4

KEY PERFORMANCE INDICATORS FOR PORTS AND THE SHIPPING FLEET

This chapter reports on key performance indicators based on a growing wealth of data derived from satellite tracking of vessels, shipping schedules, and port information platforms. For improving the efficiency and resilience of international maritime transport, this year's analysis draws lessons from the COVID-19 experience. The chapter has the following sections.

A – Port calls and turnaround times – The number of port calls rebounded in 2021, supported by the recovery in seaborne trade volume, though container ships have been hindered by heavy port congestion, with impacts that cascaded to Sub-Saharan Africa and Oceania.

B – Port wating time and cargo handling – During the pandemic, waiting times in container and dry bulk ports increased significantly, though the impact has been alleviated by upgrading port infrastructure. Port cargo handling shows increasing returns to scale.

C – Port authority performance – Higher shipping rates and the increase in revenue enabled a strong recovery in 2021. Since 2020, training costs have remained low, and there is scope to invest in employees for digitalization and decarbonization. The port industry is still dominated by men.

D – Liner connectivity – China widened its lead as the most-connected economy, while other economies lost connectivity. During the pandemic, States in Africa and Latin America and the Caribbean lost more than 10 per cent of direct shipping connections, but there were new links between India and other Asian economies.

E – Impact of the war in Ukraine – Liner shipping connection to Ukraine was completely cut off. The Russian Federation also suffered losses in the Black Sea, the Baltic Sea and the Far East, as European countries significantly reduced their connections.

F – Fleet productivity – World fleet productivity has declined steadily due to oversupply of vessel capacity and sluggish growth in demand. Despite a strong rebound in demand, this trend continues.

G – Fleet greenhouse gas emissions – Fleet carbon intensity had been declining but has levelled off. There is significant variation across carriers. From 2023, new IMO regulations will encourage further speed reductions, as well as energy saving technologies and retrofitting.

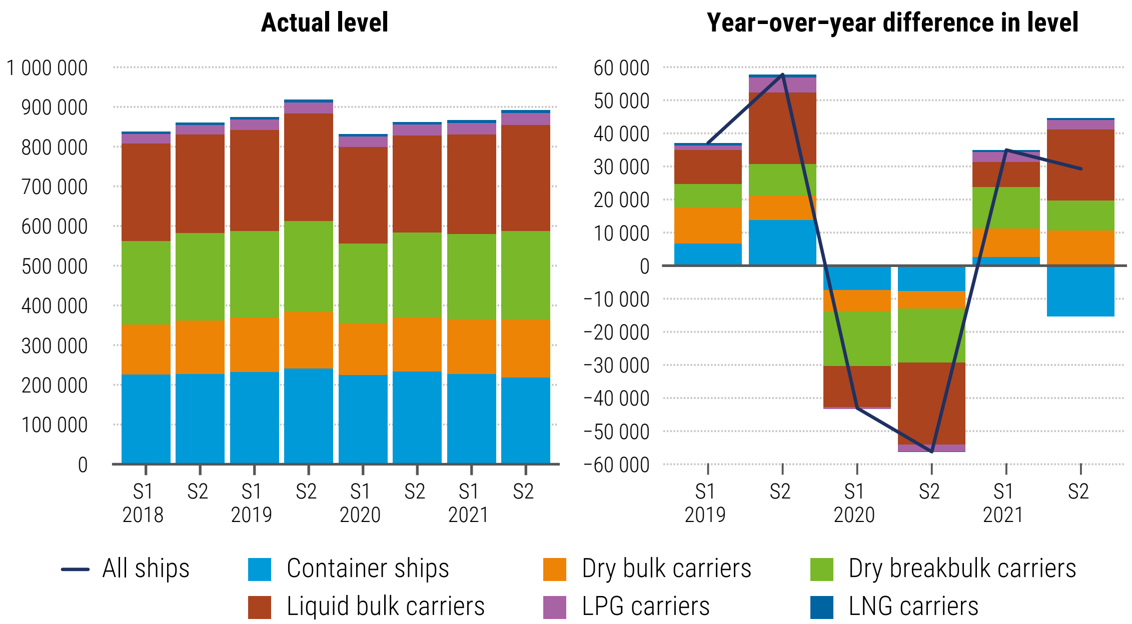
A. PORT CALLS AND TURNAROUND TIMES

1. More trade, but congestion reduces port calls

In line with the broader upturn in the global economy, the world's cargo-carrying ships made more port calls during the first six months of 2021 compared with the corresponding period in 2020 (figure 4.1). The recovery was more robust in dry bulk carriers, dry breakbulk carriers, and liquid bulk carriers. For dry bulk carriers there was a 6.6 per cent increase. For container ships, however, the increase was only 1.1 per cent, due to global container shortages and heavy port congestion. Port calls decreased by 1.9 per cent in Eastern Asia and by 1.2 per cent in Northern America.

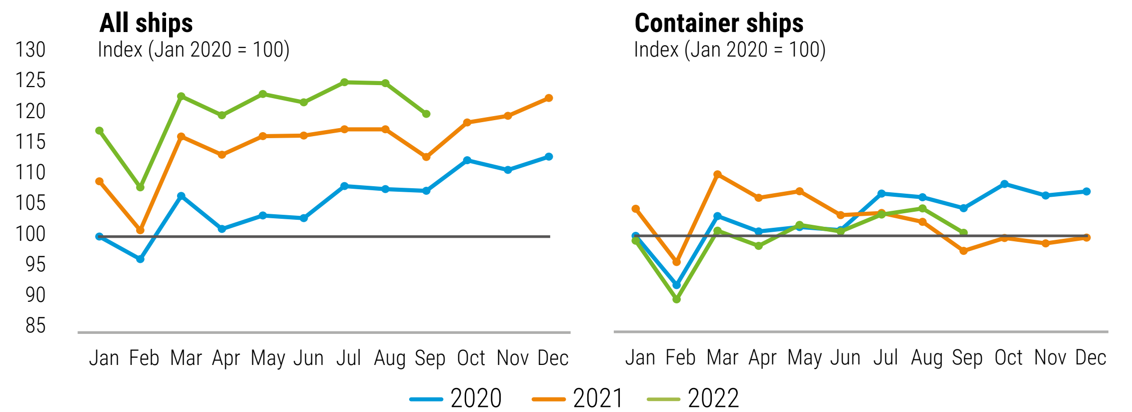
The second half of 2021 saw a rebound in port calls, which continued in the first nine months of 2022 in all segments except container ships which faced continuing congestion (figure 4.1 and figure 4.2). According to Clarksons Research, the proportion of container ships in port, taken as a proxy of port congestion, increased from 31.7 per cent 2019 to 34.2 per cent in 2020, 34.9 per cent in 2021, and 35.7 per cent in the first nine months of 2022.[1] Calls were reduced by lockdowns in major Chinese cities and the impact of the war in Ukraine which entailed increased customs checks.[2]

Figure 4.1 Port calls per half year, world total, 2018–2021



Source: UNCTAD, based on data provided by MarineTraffic (https://www.marinetraffic.com).
Note: Ships of 1,000GT and above. Not including passenger ships and Ro/Ro vessels.

Figure 4.2 Monthly port calls, world total, January 2020–September 2022



Source: UNCTAD, based on data provided by Clarksons Research.
Note: All ships do not include passenger ships and Ro/Ro vessels.

Between 2020 and 2021, there was a 14 per cent increase in median vessel turnaround time for container ships (table 4.1). This reflected increasing demand, with supply constrained by workforces reduced to limit social contact, spillovers from disruptions in hinterland transport, and some temporary port closures as in China.[3] Pandemic-related disruptions increased time in port by 2.3 per cent for dry bulk carriers and by 2.1 per cent for dry breakbulk carriers. This was partly because some dry breakbulk carriers started carrying container-related cargoes, and dry bulk vessels took minor bulk cargoes usually carried by container or dry breakbulk carriers.[4]

Table 4.1 Time in port, vessel age and size, by vessels type, 2021, world total

Vessel type	Median time in port (days)	Median time in port, annual change (%)	Average age of vessels	Average size (GT) of vessels	Maximum size (GT) of vessels	Average cargo carrying capacity (dwt) per vessel	Maximum cargo carrying capacity (dwt) of vessels	Average container carrying capacity (TEU) per container ship
Container ships	0.80	13.7	14	37 223	237 200			3 431
Dry breakbulk carriers	1.17	2.1	21	5 463	91 784	7 427	116 173	
Dry bulk carriers	2.11	2.3	14	32 011	204 014	57 268	404 389	
LNG carriers	1.13	0.9	11	95 356	168 189	74 522	155 159	
LPG carriers	1.03	-1.5	15	10 541	61 000	11 799	64 220	
Liquid bulk carriers	0.98	1.3	14	15 739	170 618	27 275	323 183	
All ships	**1.05**	**4.8**	**16**	**21 732**	**237 200**	**26 997**	**404 389**	**3 431**

Source: UNCTAD, based on data provided by MarineTraffic (https://www.marinetraffic.com).

Note: Ships of 1,000GT and above. Not including passenger ships and Ro/Ro vessels.

Table 4.2 Port calls and median time spent in port, container ships, 2021, top 25 economies

Country	Number of arrivals	Number of arrivals, annual change (%)	Median time in port (days)	Median time in port, annual change (%)	Average age of vessels	Average container carrying capacity (TEU) per container ship	Maximum container carrying capacity (TEU) of container ships
China	70 506	-5.3	0.73	17.2	13	4 401	23 992
Japan	35 526	-6.4	0.36	7.4	13	1 541	21 237
Republic of Korea	20 652	-3.8	0.72	11.7	14	2 958	23 992
United States of America	18 816	-6.1	1.25	20.8	15	5 417	21 237
Indonesia	15 648	4.2	1.06	7.6	15	1 218	6 921
Taiwan Province of China	14 909	-10.3	0.57	27.2	14	2 644	23 992
Spain	14 705	2.7	0.65	-1.8	15	3 029	23 964
Malaysia	14 577	-8.2	1.00	24.5	14	3 649	23 992
Singapore	13 408	-10.3	1.03	29.1	13	5 421	23 964
Türkiye	12 171	5.0	0.63	2.8	17	2 969	23 756
Netherlands	11 516	-0.7	0.89	10.8	15	2 819	23 992
Viet Nam	11 367	18.6	0.83	-7.8	14	2 229	19 273
China, Hong Kong SAR	10 435	-12.9	0.65	24.8	14	3 395	23 964
India	8 983	14.2	0.93	1.1	16	4 017	15 000
Thailand	8 321	2.6	0.75	11.6	12	2 059	19 630
Italy	7 746	-2.3	0.96	4.7	16	3 642	23 964
United Kingdom	7 513	-4.1	0.83	12.7	16	3 114	23 992
Brazil	7 284	-4.3	0.85	11.2	11	5 799	12 690
United Arab Emirates	7 228	-5.0	1.00	4.7	17	4 026	23 964
Germany	7 082	-0.8	1.13	14.9	13	4 497	23 992
Philippines	5 816	12.3	0.94	6.2	16	1 673	6 258
Panama	5 444	21.9	0.88	27.4	13	4 630	15 000
Belgium	4 960	-5.3	1.20	15.4	15	4 760	23 964
Morocco	4 541	5.2	0.76	3.3	15	4 210	23 964
France	4 521	-2.8	0.96	22.3	14	5 105	23 964
Subtotal, top 25	**343 675**	**-2.7**			**14**	**3 477**	**23 992**
World total	***446 589***	***-2.8***	***0.80***	***13.7***	***14***	***3 431***	***23 992***

Source: UNCTAD, based on data provided by MarineTraffic (https://www.marinetraffic.com).

Note: Ships of 1,000GT and above. Ranked by number of port calls. For the complete table of all countries, see http://stats.unctad.org/portcalls_number_a and http://stats.unctad.org/portcalls_detail_a.

Figure 4.3 Proportion of container ships fully laden, world total, 2018–2022

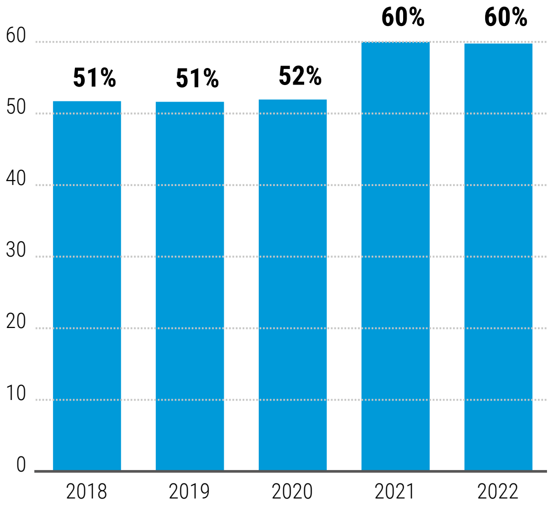
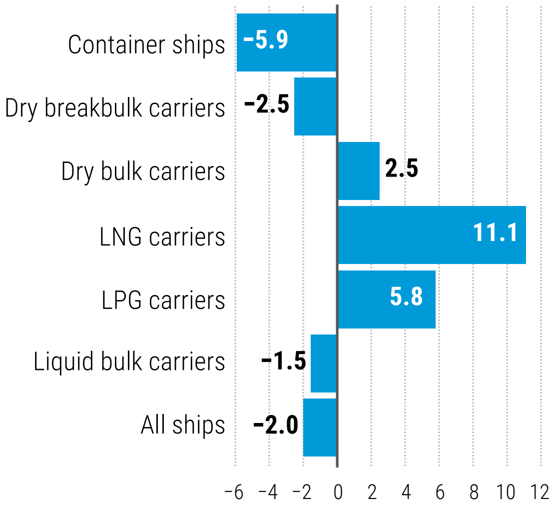


Figure 4.4 Change in port calls from 2019 to 2021, world total, percentage



Source: UNCTAD, based on data provided by Sea/ (www.sea.live, left-hand side) and MarineTraffic (https://www.marinetraffic.com, right-hand side).

Note: Fully laden, partially laden, and ballast status is estimated by Sea/ based on historical draft messages transmitted by each vessel. Data for 2022 is up to 12 October 2022 (left-hand side). All ships do not include passenger ships and Ro/Ro vessels (right-hand side).

In 2021, among the 25 economies with the most container ship arrivals, 23 recorded increases in median turnaround time, and 15 economies faced double-digit increases (table 4.2). The largest increase was in Singapore at 29 per cent, followed by Panama, Taiwan Province of China, Hong Kong China, Malaysia, France, the United States, and China. Some freight was sent to Singapore without on-time connecting vessels to load the containers – disrupting shipping schedules and resulting in container shortages in other Asian economies.[5] Table 4.2 includes large vessels operated by international shipping lines as well as small feeder vessels deployed for domestic and regional shipping.

Longer times in port reduced efficiency, and shipping lines tried to avoid some congested ports. Some container ships for the China-EU trade lane have bypassed the refuelling hub in Singapore and bunkered in China to save time.[6]

In contrast, the number of arrivals in Panama increased by 22 per cent, as more container ships transited through the Panama Canal to avoid congestion in the US West Coast ports, increasing port calls, bunkering and requiring crew changes in Panama.[7] Growth here was supported by stable provision of port services and crews.[8] India had double-digit growth in port calls, partly supported by increased regional connectivity (see section D.3).

Viet Nam and Philippines recorded similar increases in the number of port calls, driven by strong growth of exports, mainly of electronic products,[9] despite a temporary economic downturn during the third quarter of 2021 due to the spread of the COVID-19 Delta strain.[10] Viet Nam's export volume increased by 15.6 per cent in 2021,[11] with mobile phones, computers and electronics accounting for a third of total exports.[12] Philippines export volume increase by 5.3 per cent, with electronic products forming two-thirds of the total.

Despite fewer container port calls, global containerized trade volume and port throughput increased, a result partly of higher tonnage per call and better use of vessel capacity. Between 2020 and 2021, the proportion of container ships that were fully laden increased from 52 to 60 per cent (figure 4.3). Also, shipping lines started skipping some ports such as Singapore. On the US West Coast routes, some shipping services eliminated dual calls – loading and discharging in two ports.[13]

2. Cascading effects of COVID-19 in Sub-Saharan Africa and Oceania

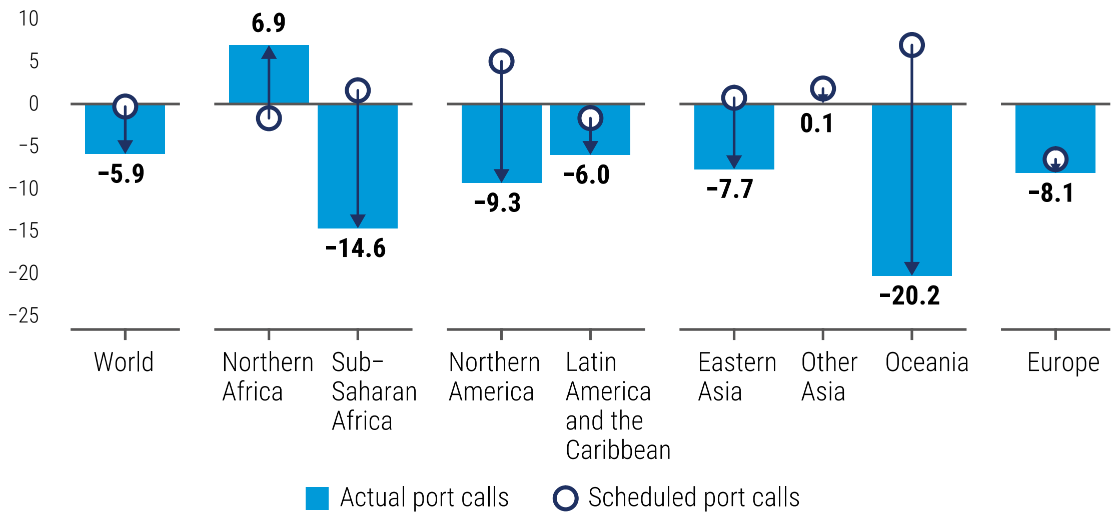
Container ships were the worst affected by the cascading effects of the pandemic, with a decline in port calls between 2019 and 2021 of 5.9 per cent, followed by dry breakbulk and liquid bulk carriers (figure 4.4). On the other hand, there was strong growth in port calls for gas carriers , driven by expansion of US export capacity and firm demand from Asia.[14] For dry bulk carriers, there was a rebound in demand for grains and industrial materials.

In Sub-Saharan Africa and Oceania, port calls for container ships fell steeply (figure 4.5). This was partly a knock-on effect of port congestion in main trading lanes – through late arrivals of vessels and container shortages, combined with COVID-related restrictions on workforces.[15] In addition, carriers removed some shipping capacity in order to service routes in Eastern Asia and Northern America (see section D).

The first two years of the pandemic saw declines in port calls in Northern America, Eastern Asia, and Europe. Scheduled port calls increased in Northern America and Eastern Asia to meet increased container shipping demand, but actual port calls declined due to serious port congestion and container shortages.

Despite a six-day blockade of the Suez Canal in March 2021, Northern Africa recorded stable growth in container ship port calls, supported by ongoing development and upgrading of ports, including Tanger Med in Morocco and Ain Sokhna in Egypt. Between 2019 and 2021, container ship port calls in Tanger-Med increased from 2,652 to 3,195, and in Ain Sokhna from 59 to 217. On the other hand port calls in Port Said – the largest port in the region – decreased from 3,516 to 3,393.[16]

Figure 4.5 Changes in actual and scheduled port calls of container ships from 2019 to 2021, per cent



Source: UNCTAD, based on data provided by MarineTraffic (https://www.marinetraffic.com, for actual port calls) and MDS Transmodal (https://www.mdst.co.uk/, for scheduled port calls).

B. PORT WAITING TIME AND CARGO HANDLING PERFORMANCE

1. Remarkable improvement of Middle East and Mediterranean port performance

The World Bank and S&P Global produce a container port performance index that assesses turnaround time by vessel size and port call size. For 2021, the highest-ranked ports were in the Middle East and Mediterranean, and East Asia (table 4.3). Among the 25 highest-ranked ports, ten were in the Middle East and Mediterranean, up from four in 2020. For East Asia, reflecting congestion, the number of ports in the top 25 decreased from 15 to 8.

The strong performance of the ports in the Middle East and Mediterranean and East Asia is indicated in a global heatmap (figure 4.6). In Europe, south-western ports were ranked higher than the ports in Northwest Europe. The latter required more time for terminal operations caused mainly by a surge in average cargo exchange volume as carriers, aiming to mitigate volatile demand and the risk of congestion, consolidated some of their port calls. In the US West Coast ports, much of the time was spent waiting.[17]

In South Asia, the highest-performing port was Colombo in Sri Lanka. However, almost all these performed better than the global average. In North and Central America, ports in the US West Coast suffered from long-term underinvestment in infrastructure. In 2021, Long Beach and Los Angeles were the two-lowest ranked ports in the world.[18] Ports in the US East Coast and Mexico performed better.

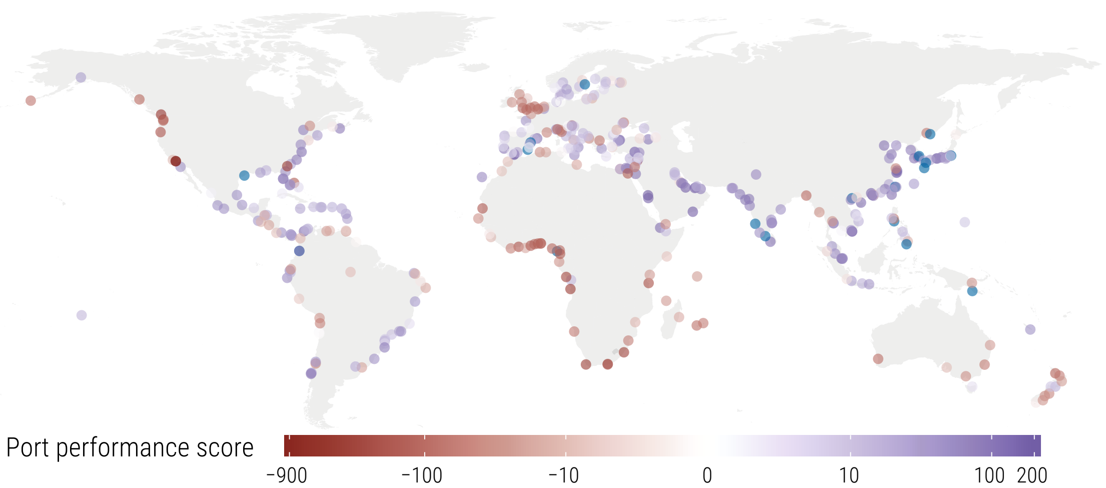
Table 4.3 Top 25 ports under the Container Port Performance Index 2022

Port name	Economy	Rank in 2021	Rank in 2020
King Abdullah port	Saudi Arabia	1	2
Salalah	Oman	2	9
Hamad port	Qatar	3	38
Yangshan	China	4	10
Khalifa port	United Arab Emirates	5	22
Tanger-Med	Morocco	6	15
Ningbo	China	7	13
Jeddah	Saudi Arabia	8	42
Guangzhou	China	9	6
Yokohama	Japan	10	1
Algeciras	Spain	11	32
Cartagena	Colombia	12	34
Cai Mep	Viet Nam	13	18
Dammam	Saudi Arabia	14	92
Port Said	Egypt	15	70
Shekou	China	16	5
Chiwan	China	17	27
Tanjung Pelepas	Malaysia	18	11
Djibouti	Djibouti	19	93
Buenaventura	Colombia	20	71
Kaohsiung	Taiwan Province of China	21	4
Barcelona	Spain	22	46
Port of Virginia	United States	23	110
Colombo	Sri Lanka	24	33
Busan	Republic of Korea	25	36

Source: World Bank and S&P Global Port Performance Program.

Note: Ranked by the Administrative Approach scores.

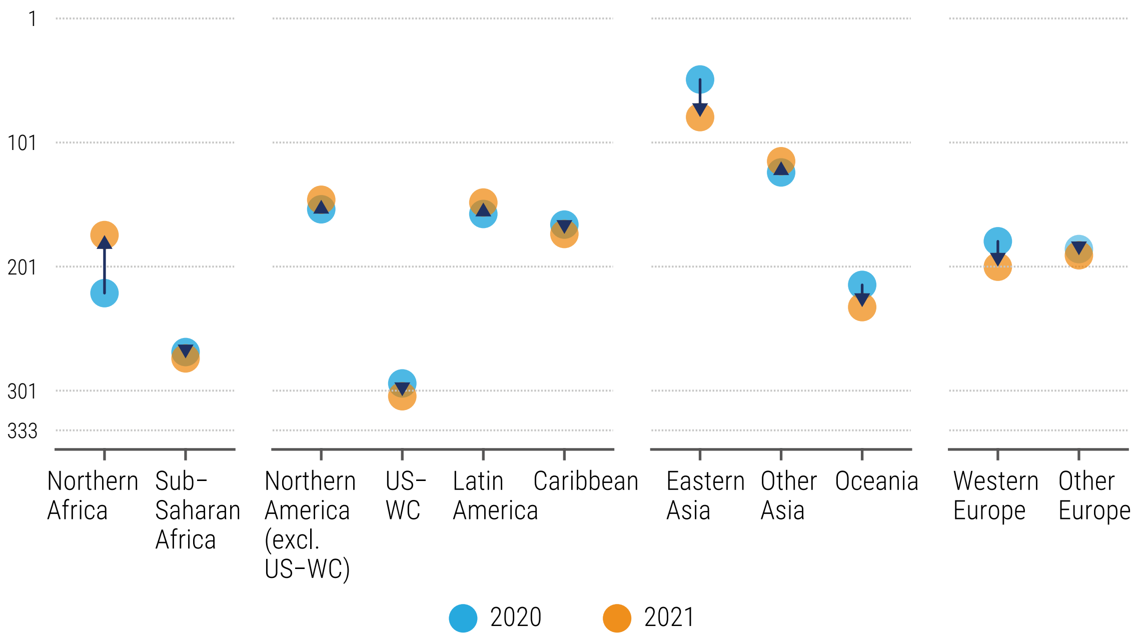
Figure 4.6 Global heatmap for the Container Port Performance Index 2022



Source: UNCTAD, based on data provided by the World Bank and S&P Global Port Performance Program.

Note: The heatmap is based on the Administrative Approach score.

Figure 4.7 Average rank of container port performance, by region, 2020 and 2021



Source: UNCTAD, based on data provided by the World Bank and S&P Global Port Performance Program.

Note: The average rank is based on the Administrative Approach score. The rank is recalculated by UNCTAD across 333 ports, for which port performance scores are available in 2020 and 2021.

The results for South American ports were mixed: two-thirds of the ports had better than global average performance, led by Cartagena and Buenaventura in Colombia, with the lowest ranking for San Antonio in Chile. Overall, however the regions with the lowest rankings were Sub-Saharan Africa and Oceania.

Between 2020 and 2021, in East Asia, due to heavy congestion many ports dropped from the top 25, while the average rank of container ports worsened. But as indicated in figure 4.7 their average was higher than that of other regions. Western Europe ports and US West Coast ports suffered from logistics disruptions that depressed their averages.

Sub-Saharan Africa and Oceania faced further deterioration, with the biggest drop for the Port of Auckland in New Zealand – from 118 to 351 – partly due to a massive backlog of freight caused by serious shortages of skilled port operators.[19]

In contrast, there were improvements for Northern Africa, Latin America, Northern America (excluding the US West Coast) and Other Asia – which all improved their rankings. The greatest advance was for Northern Africa, driven by Damietta Port in Egypt, whose ranking jumped from 297 to 58 due to a new multi-purpose terminal installed in 2019 that reduced vessel waiting time.[20]

2. Longer dry bulk waiting times due to disruption in ports and supply chains

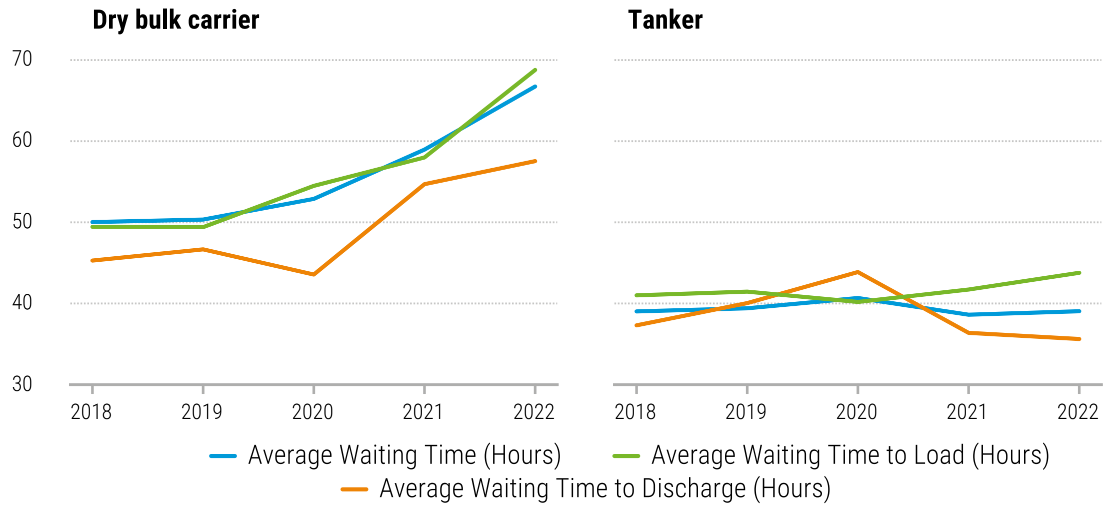
Waiting time in port

The COVID-19 pandemic caused serious port congestion and increased waiting times for dry bulk vessels. Between 2019 and the first half of 2022, the average waiting time across 30 major dry bulk handling economies increased from 50 to 67 hours (figure 4.8).[21] This was primarily caused by stringent COVID-19 related protocols, including mandatory quarantine periods and negative PCR tests for seafarers.[22] Among the top 30 economies, 12 recorded more than 50 per cent increases in waiting time for loading, with the highest increases in Colombia, Oman and Norway (table 4.4). In Colombia, COVID-19-related restrictions disrupted not only port operation but also coal mining and rail transportation.[23]

In Europe in 2022, congestion in dry bulk ports has been exacerbated by the knock-on effects from the war in Ukraine, and the wider global energy crisis, which have increased coal imports, particularly from South Africa. In Rotterdam, the region's main coal terminal, between 9 May and 29 June the waiting time for dry bulk carriers increased from 48 to 186 hours.[24]

For tankers on the other hand, average waiting time is largely unchanged because of weak demand for oil products, particularly for gasoline and jet fuel (figure 4.8).

Figure 4.8 Average waiting time across 30 major dry bulk/ tanker handling economies, 2018–2022, hours



Source: UNCTAD, based on data provided by VesselsValue (https://www.vesselsvalue.com/).

Note: The 30 major dry bulk/ tanker handling economies are listed in table 4.4 and table 4.5. The data for 2022 is the average from 1 January 2022 to 30 May 2022.

Table 4.4 Waiting time to load and discharge for dry bulk carriers, top 30 economies by vessel arrivals, average values for first half of 2022 and changes from 2019

	Average waiting time to load (hours)		Average waiting time to discharge (hours)	
	2022	%-change from 2019 to 2022	2022	%-change from 2019 to 2022
China	78.8	67.1	38.9	7.7
Australia	132.6	47.6	54.5	44.9
United States of America	88.0	48.7	30.2	102.4
Brazil	184.7	41.2	181.6	36.0
Russian Federation	43.8	-1.6	63.0	-4.9
Canada	102.3	37.3	24.2	143.4
Argentina	43.3	1.5	12.4	-52.4
South Africa	146.3	51.4	91.2	146.9
Japan	27.6	-22.3	40.8	-2.4
India	57.7	-3.2	32.3	-36.2
Ukraine	41.5	-4.6	17.3	9.2
United Arab Emirates	47.8	34.6	31.4	109.7
Indonesia	19.9	54.9	43.5	5.5
Republic of Korea	22.3	-13.7	52.4	-3.9
New Zealand	43.0	-14.8	21.8	-12.0
Chile	107.7	61.2	172.6	142.7
Türkiye	57.8	91.2	72.3	134.0
Viet Nam	22.7	24.7	25.9	18.2
Colombia	57.7	208.3	25.7	3.8
Malaysia	50.6	62.8	75.9	41.2
Mexico	57.0	26.2	52.2	13.7
Taiwan Province of China	29.7	60.7	41.6	6.0
Peru	86.4	11.5	110.1	159.5
Oman	65.8	196.8	19.8	-56.0
Norway	38.4	107.5	6.8	-76.0
France	18.1	21.8	40.3	-19.6
Saudi Arabia	57.9	49.8	39.7	-12.6
Morocco	125.7	56.6	101.7	-29.6
Romania	71.4	-1.6	78.1	521.5
Mozambique	137.0	70.3	128.3	-7.9

Source: UNCTAD, based on data provided by VesselsValue (https://www.vesselsvalue.com/).

Note: Ranked by number of dry bulk carrier arrivals for loading. The data for 2022 is the average from 1 January 2022 to 30 May 2022.

Table 4.5 Waiting time to load and discharge for tankers, top 30 economies by vessel arrivals, average values for first half of 2022 and changes from 2019

	Average Waiting Time to Load (hours)		Average Waiting Time to Discharge (hours)	
	2022	%-change from 2019 to 2022	2022	%-change from 2019 to 2022
United States of America	39.3	-9.3	30.7	-23.2
Russian Federation	39.9	-1.1	12.6	21.6
China	39.7	10.1	54.4	24.8
Brazil	43.8	0.8	50.2	-4.8
Saudi Arabia	36.2	6.1	34.5	-12.4
United Arab Emirates	43.6	4.0	55.1	-2.5
Republic of Korea	64.7	11.4	37.1	-4.7
Singapore	52.3	-18.0	47.8	17.2
India	48.9	-13.0	41.7	-24.4
Malaysia	35.8	17.7	29.0	-16.4
Netherlands	57.6	-0.5	33.8	-9.8
Indonesia	40.9	-15.8	40.9	-8.0
Italy	57.1	18.6	37.4	-11.8
Mexico	95.4	22.6	70.5	-25.7
Nigeria	19.3	31.6	59.0	-68.0
Kuwait	53.7	94.6	115.0	213.8
Iraq	22.8	-34.3	0.1	69.0
Canada	20.4	-17.4	26.1	60.8
Spain	43.4	14.1	36.2	37.8
Qatar	19.9	-1.0	11.3	-68.7
Japan	25.3	3.0	16.3	13.1
United Kingdom	36.5	9.3	39.6	29.5
Türkiye	38.9	38.9	35.5	39.9
Norway	13.3	-30.1	19.5	-21.3
Angola	19.2	-34.3	17.1	-46.9
Belgium	81.8	44.4	56.6	36.3
Bolivarian Republic of Venezuela	66.8	-4.8	7.3	-78.2
Taiwan Province of China	65.6	27.9	32.6	23.5
Argentina	40.4	-15.3	5.0	-66.8
Greece	50.9	16.2	15.7	-40.5

Source: UNCTAD, based on data provided by VesselsValue (https://www.vesselsvalue.com/).
Note: Ranked by number of tanker arrivals for loading. The data for 2022 is the average from 1 January 2022 to 30 May 2022.

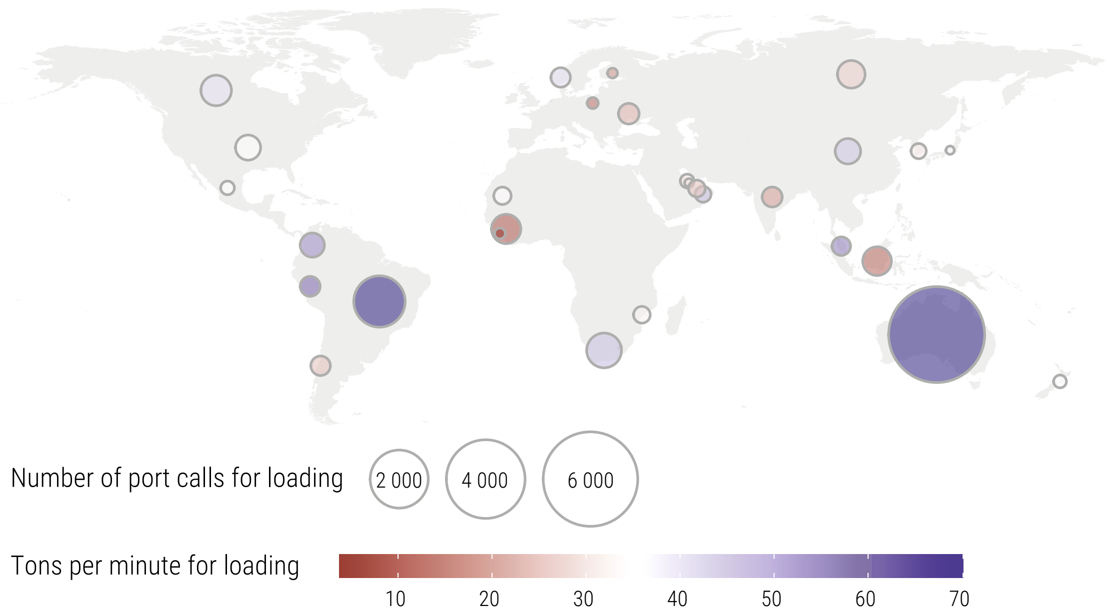
Cargo handling

Cargo handling performance is assessed in tons per minute and increases with ship size since large vessels can be handled by large cranes, conveyer belts and other equipment. In 2021, the global average for loading Capesize dry bulk vessels was 34.9 tons per minute, but for handysize vessels was only 6.3 tons per minute.[25]

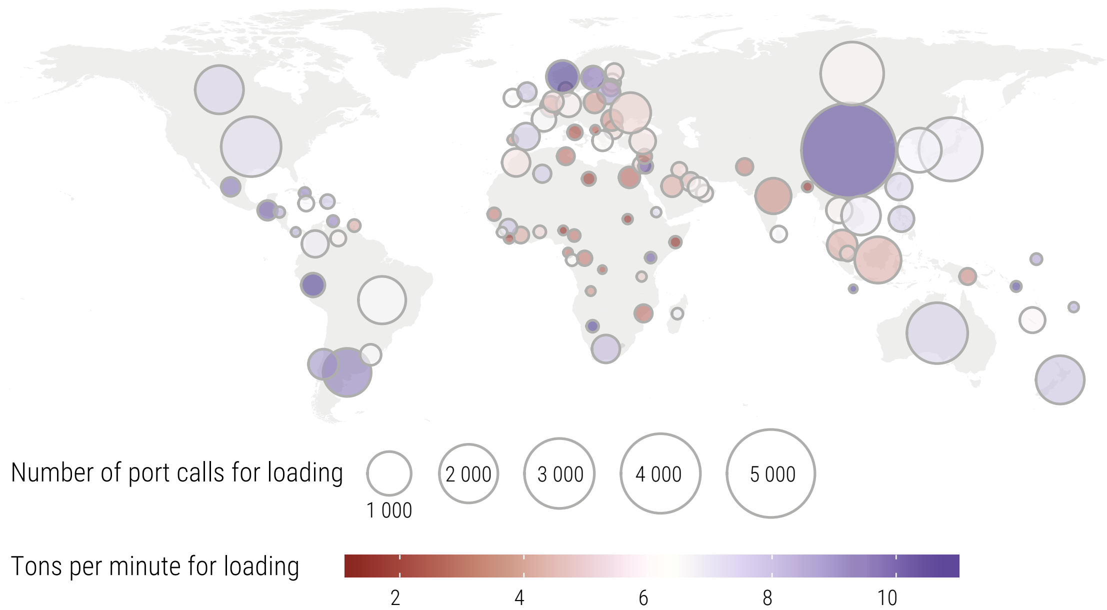
For Capesize dry bulk carriers, countries in Eastern Europe (Ukraine and Poland), South Asia (India), the Middle East (Qatar, Bahrain, and United Arab Emirates), and West Africa (Guinea and Siera Leone) had performances lower than the global average (figure 4.9).

Figure 4.9 Port cargo handling performance for dry bulk carriers, tons per minute and number of port calls for loading, 2021

Capesize



Handysize



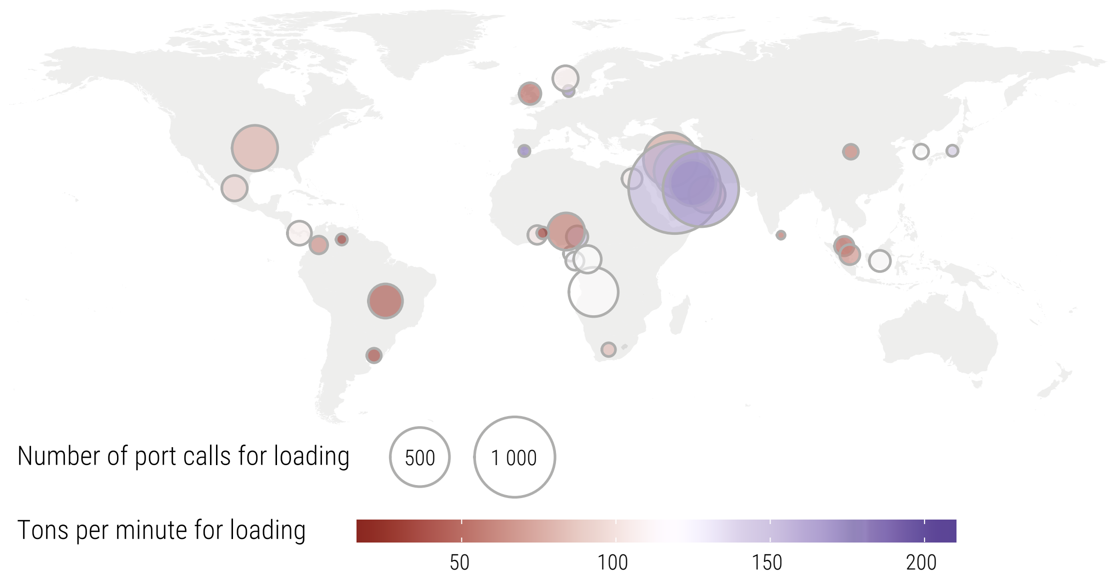
Source: UNCTAD, based on data provided by Sea/ (www.sea.live).

Note: Countries with five or more arrivals for loading. The white color indicates global average (i.e., 34.9 tons per minute for capesize and 6.3 tons per minute for handysize). Blue color means higher than average tons per minute, and red means lower than average. Bubble size indicates number of port calls for loading.

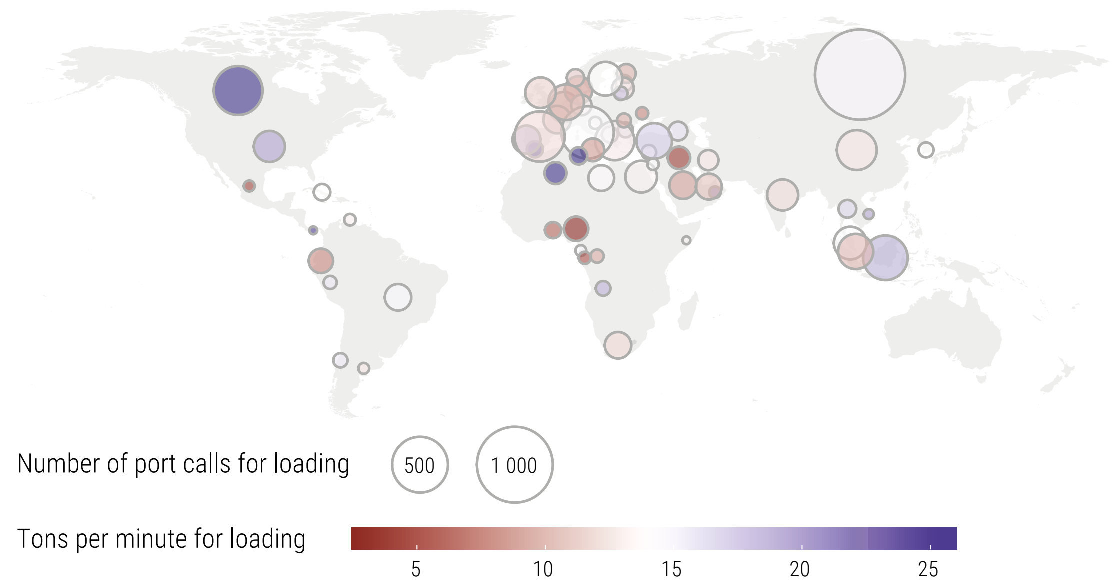
A similar geographical pattern was found for Handysize dry bulk carriers, even though more economies have been handling Handysize vessels than Capesize vessels (figure 4.9). Eight of the top 10 port call economies, including China, Japan, Australia and the United States, had average or higher cargo handling productivity. Exceptions were the Russian Federation and Indonesia. Also, some economies in North Europe and South America – Norway, Sweden, Peru, Guatemala, and Chile – recorded high cargo handling performance even though they had fewer port calls.

Figure 4.10 Port cargo handling performance for tankers, tons per minute and number of port calls for loading, 2021

VLCC



Handysize



Source: UNCTAD, based on data provided by Sea/ (www.sea.live).

Note: Countries with five or more arrivals for loading. The white color indicates global average (i.e., 116.3 tons per minute for VLCC and 14.1 tons per minute for handysize). Blue color means higher than average tons per minute, and red means lower than average. Bubble size indicates number of port calls for loading.

VLCC tankers showed different patterns. The highest-performing economies were in the Middle East – Qatar, United Arab Emirates, Kuwait, and Saudi Arabia – although Oman and Iraq had lower than average performances (figure 4.10). Also, some Western African economies like Angola, Cameroun, Gabon, and Equitorial Guinea, showed average or higher performances, while others – Nigeria and Ghana – had low performances. Performance was also low for economies on the American continent.

For Handysize tankers, the situation was significantly different. Economies in North America and North Africa (Canada, the United States, Tunisia, and Algeria) performed well, while most economies in Europe (Romania, Malta, Denmark, and Ukraine), the Middle East (Saudi Arabia and Iraq) and West Africa (Republic of the Congo, Gabon, Togo, and Nigeria) showed low performance (second map of figure 4.10).

Table 4.6 Port cargo handling performance for dry bulk carriers and tankers by ship size, top 10 economies by vessel arrivals for loading and global average, tons per minute for loading, 2021

Dry bulk carriers				Tankers			
Cape size		Handysize		VLCC		Handysize	
Country	Tons/minute	Country	Tons/minute	Country	Tons/minute	Country	Tons/minute
Australia	71.2	China	10.8	Saudi Arabia	156.6	Russian Federation	14.9
Brazil	77.9	Japan	7.0	United Arab Emirates	168.6	Italy	14.3
South Africa	46.5	Russian Federation	5.9	Kuwait	159.7	Spain	11.8
Canada	41.4	Australia	7.6	Iraq	71.5	Canada	26.1
Guinea	10.3	United States	7.3	Angola	115.0	Indonesia	19.2
Indonesia	12.3	Canada	7.5	Qatar	259.3	China	12.4
Russian Federation	26.3	New Zealand	8.0	United States	74.0	Greece	12.7
China	45.3	Argentina	9.7	Nigeria	51.1	Netherlands	10.1
United States	34.3	Brazil	6.1	Oman	79.8	Türkiye	17.3
Colombia	54.0	Indonesia	4.2	Brazil	34.3	Singapore	10.0
Global average	***34.9***	***Global average***	***6.3***	***Global average***	***116.3***	***Global average***	***14.1***

Source: UNCTAD, based on data provided by Sea/ (www.sea.live).

Note: Ranked by number of arrivals for loading. Global average is a simple average across all countries with five or more arrivals for loading.

C. LESSONS FROM THE TRAINFORTRADE PORT MANAGEMENT PROGRAMME

The UNCTAD TRAINFORTRADE Port Management Programme helps ports deliver more efficient and competitive services. The programme creates networks through which port operators can share knowledge and expertise and strengthen talent management and human resources development.

Over the past 20 years the Modern Port Management elite course has been adopted by over 250 member ports. In response to the COVID-19 pandemic, the programme offered a special interactive online course, Building Port Resilience Against Pandemics, in French, English and Spanish. At the time of publication, this had trained over 2,800 participants from 138 countries.

Since 2012, TRAINFORTRADE's network members have completed an annual survey which collects data in a secure and confidential manner to produce a port performance scorecard (PPS) that enables port managers to benchmark their performances and provide evidence for policy analysis at global, regional and state levels.[26]

1. PPS as a strategic port management tool

The PPS has been used in various ways in different countries:

- **Ireland, for a new port** – For a proposed new port development – Bremore – the PPS network supported detailed revenue and profitability forecasting, as well as data for employee metrics. The indicators on operations will be of value in tendering for concessions and for other investment partners.
- **Philippines, for concession agreements** – Concession agreements are challenging to construct and to manage. The Philippines Ports Authority is responsible for more than 400 trading ports and is offering concession opportunities supported by the global operational benchmarks available from the PPS.
- **Spain, for reporting** – Most ports in the network are owned, directly or indirectly, by governments, so have a range of reporting obligations. Valencia port has used the PPS to compare operational benchmarks for container handling, such as dwell time or handling rates, and to compare revenue profiles, profit levels and organizational structures.
- **Ireland, dealing with disruption** – Prior to Brexit, Ireland moved a large proportion of containers to hub ports on mainland Europe via the UK by ferry and road. Brexit required major changes with many shippers now moving cargo onto direct ferry services to mainland Europe. The indicators for the ports across the whole island of Ireland in 2021 showed mixed results, prompting further analysis of both the ports' own data and that in the PPS.

In 2021, 58 port entities contributed data from which the PPS derived 26 indicators under the following categories: finance, human resources, gender, vessel operations, cargo operations, and environment. Table 4.7 shows annual median values for the period 2016 to 2021.[27]

Port profiles

Most ports in the network have some degree of state control – typically through ownership of underlying assets such as quay walls and breakwaters. The private sector participates through concessions, though public authorities also maintain a high degree of control over pricing and over investment decisions for commercially funded port operating assets. Most ports have adopted environmental management systems and comply with ISO 14001 and national requirements, while monitoring air, waste, noise, and water quality.

Signs of post-COVID 19 recovery

In the period up to the pandemic, cargo throughput had grown annually by four to six per cent. The pandemic then caused a steep decline before a recovery in 2021 partly due to higher freight rates with some increase in capacity.

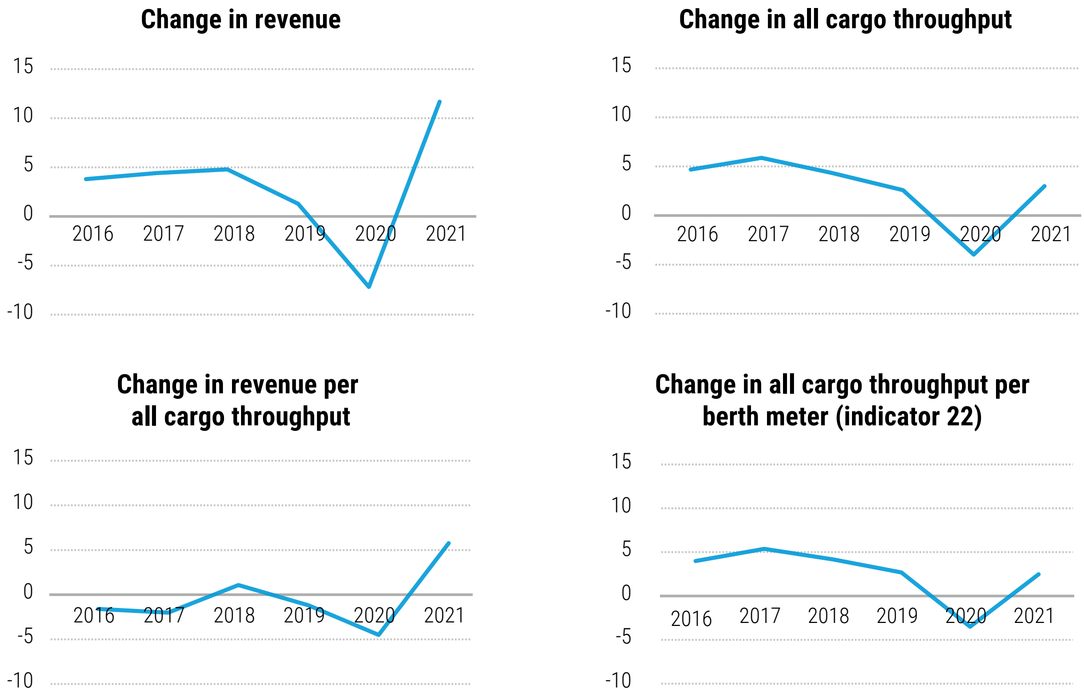
In March 2020, as a result of the pandemic the entire world cruise fleet stopped operating, with serious consequences for cruise companies, their crews and their management teams. However, over more than 50 years of history the cruise sector has proved very resilient and is expected to return to 2019 levels by the end of 2023.

Table 4.7 Port performance scorecard, 2016–2021

	Indicator number	Indicator	Median values					
			2016	2017	2018	2019	2020	2021
Finance	1	EBITDA/revenue (operating margin)	37.1%	40.1%	47.5%	43.6%	39.3%	42.8%
	2	Labour/revenue	14.9%	19.0%	17.6%	17.2%	18.9%	16.2%
	3	Vessel dues/revenue	15.4%	17.8%	17.8%	13.9%	14.3%	14.7%
	4	Cargo dues/revenue	36.3%	33.3%	28.4%	29.5%	35.2%	32.6%
	5	Concession fees/revenue	2.5%	6.5%	17.0%	14.0%	6.4%	5.6%
	6	Rents/Revenue	2.4%	2.5%	2.7%	3.2%	2.9%	2.2%
Human resources	7	Tonnes/employee	15 951 t	17 640 t	37 742 t	37 583 t	26 805 t	40 476 t
	8	Revenue/employee	$120 867	$113 378	$122 405	$243 932	$131 583	$268 501
	9	EBITDA/employee	$53 664	$45 524	$57 573	$66 115	$52 766	$61 898
	10	Labour cost/employee	$24 338	$20 697	$23 425	$21 220	$24 651	$23 370
	11	Training cost/wages	0.9%	1.0%	1.2%	0.7%	0.2%	0.2%
Gender	12	Female Participation Rate (All categories)	15.0%	15.6%	16.4%	16.8%	16.9%	17.1%
	12.1	Female Participation Rate (Management)	34.4%	35.0%	42.4%	44.3%	44.6%	42.3%
	12.2	Female Participation Rate (Operations)	8.6%	8.1%	7.0%	7.4%	6.2%	5.9%
	12.3	Female Participation Rate (Cargo Handling)	0.0%	4.4%	6.5%	5.8%	3.6%	7.5%
	12.4	Female Participation Rate (Other employees)	24.4%	21.0%	35.3%	32.2%	28.0%	26.3%
Vessel operations	13	Average waiting time	4 h	8 h	11 h	5 h	7 h	8 h
	14	Average gross tonnage per vessel	15 573 t	15 911 t	16 759 t	16 081 t	19 515 t	19 056 t
	15.1	Oil Tankers arrivals	3.4%	4.6%	6.9%	7.4%	5.9%	5.7%
	15.2	Bulk Carrier arrivals	5.4%	4.2%	5.0%	7.1%	5.9%	8.6%
	15.3	Container Ship arrivals	42.4%	42.0%	26.7%	25.0%	27.5%	18.5%
	15.4	Cruise Ship arrivals*	1.3%	2.2%	1.7%	1.4%	0.7%	0.3%
	15.5	General Cargo Ship arrivals	21.5%	17.2%	20.6%	22.1%	20.6%	25.7%
	15.6	Other Ship arrivals	13.0%	10.7%	12.9%	8.8%	15.0%	6.2%
Cargo operations	16	Average tonnage per arrival (all)	4 296 t	4 882 t	5 337 t	5 238 t	4 970 t	5 011 t
	17	Tonnes per working hour, dry or solid bulk	244 t	257 t	235 t	207 t	219 t	186 t
	18	Tonnes per hour, liquid bulk	736 t	222 t	175 t	171 t	157 t	124 t
	19	Containers Lift Per Ship Hour at Berth	22	32	18	20	27	27
	20	Average container dwell time in days	5	4	4	5	5	5
	21	Tonnes per hectare (all)	141 091 t	116 534 t	129 241 t	88 454 t	89 885 t	94 271 t
	22	Tonnes per berth meter (all)	3 071 t	3 043 t	3 010 t	2 889 t	2 833 t	2 888 t
	23	Total Passengers on Ferries*	817 727	1 222 436	1 006 742	1 141 094	321 023	410 578
	24	Total Passengers on Cruise*	65 538	55 968	118 606	146 953	17 085	14 146
Environment	25	Investment in Environmental Projects/Total CAPEX	0.0%	0.5%	0.6%	0.2%	0.0%	0.2%
	26	Environmental expenditures/Revenue	0.0%	0.2%	0.2%	0.9%	0.4%	0.2%

Source: UNCTAD Secretariat calculations, based on data from port entities reporting to the TRAINFORTRADE PPS platform.
Abbreviations: CAPEX, capital expenditure; EBITDA, earnings before interest, taxes, depreciation and amortization.

Figure 4.11 Revenue and cargo throughput, 2016–2021
(median year-to-year percentage change across all ports)

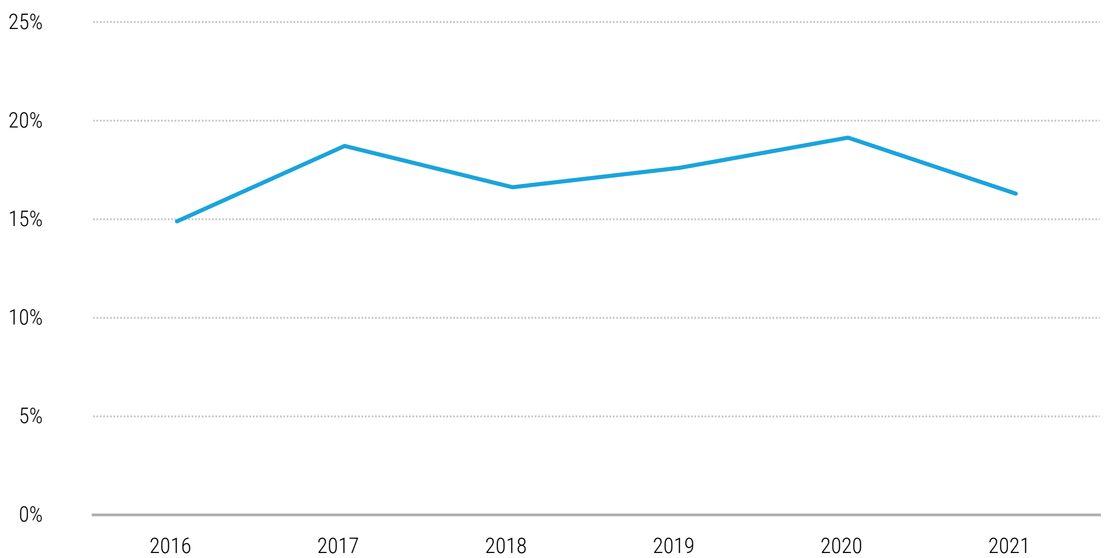


Source: UNCTAD Secretariat calculations, based on data from port entities reporting to the TRAINFORTRADE PPS platform.
Note: To minimize the bias due to data availability from reporting port entities. these charts look first at the dynamics of revenue and cargo throughput changes on every port and then at the median value across all ports.

Human resources

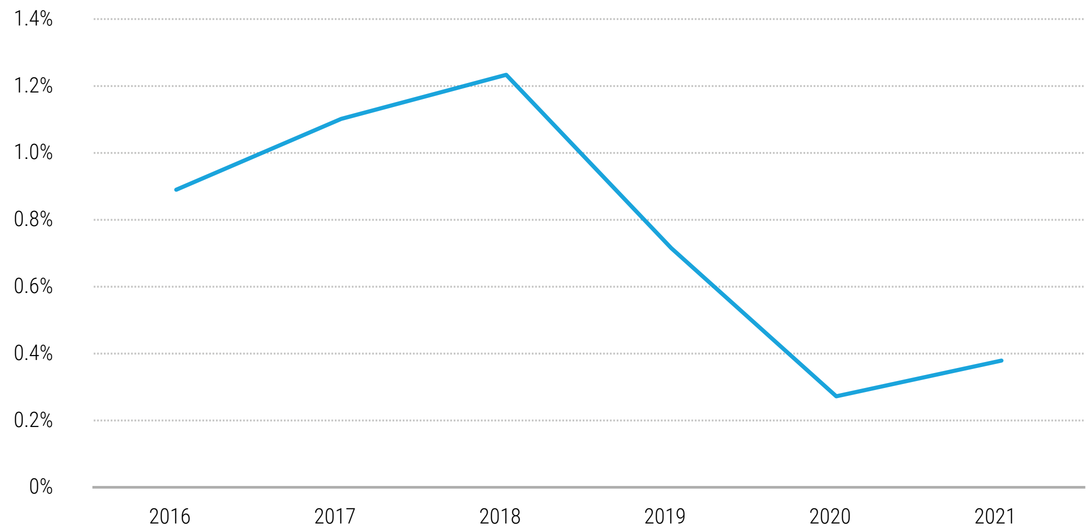
Figure 4.12 indicates that for contracted workers and port authority staff labour costs a proportion of revenue have been fairly consistent. But staff have been getting less training: since 2020, only a small proportion of labour costs have been for training (figure 4.13). The dip following the onset of the epidemic was partly due to fewer training programmes but also because most training went online thus reducing travel and logistical costs. This benchmark remains a valuable indicator as ports go through digitalization and decarbonization as it shows the scope for investing in employees.

Figure 4.12 Labour costs as a proportion of revenue, 2016–2021
(median across all ports)



Source: UNCTAD Secretariat calculations, based on data from port entities reporting to the TRAINFORTRADE PPS platform.

Figure 4.13 Training cost as a proportion of labour costs, 2016–2021 (median across all ports)

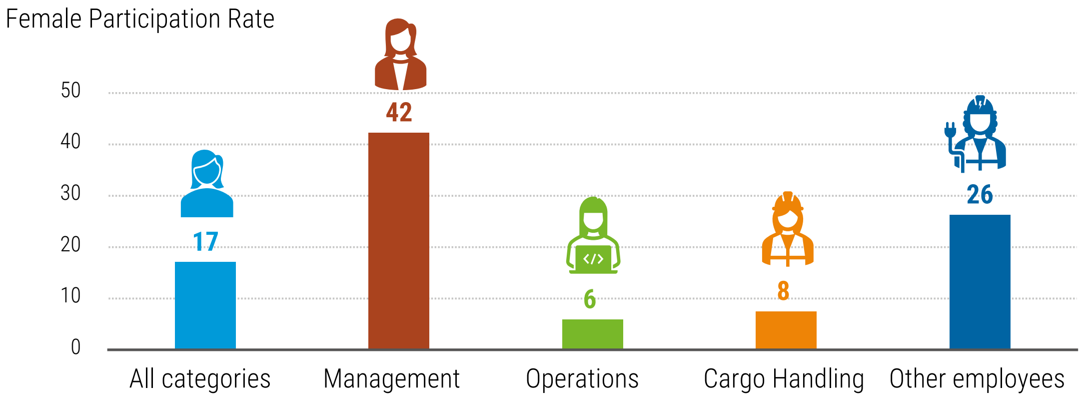


Source: UNCTAD Secretariat calculations, based on data from port entities reporting to the TRAINFORTRADE PPS platform.

Female participation in ports

The PPS disaggregates data by gender and shows that the port industry as a whole is still dominated by men. In 2021, the median value for female participation in port management was 42 per cent globally – and in Asia 60 per cent (indicator 12.1). However, women's participation rate in ports overall workforces remained low, at 17 per cent, and even lower for port operations at 6 per cent, and for cargo handing at 8 per cent.

Figure 4.14 Women's participation in port workforces, 2021 (median across all ports)



Source: UNCTAD Secretariat calculations, based on data from port entities reporting to the TRAINFORTRADE PPS platform.

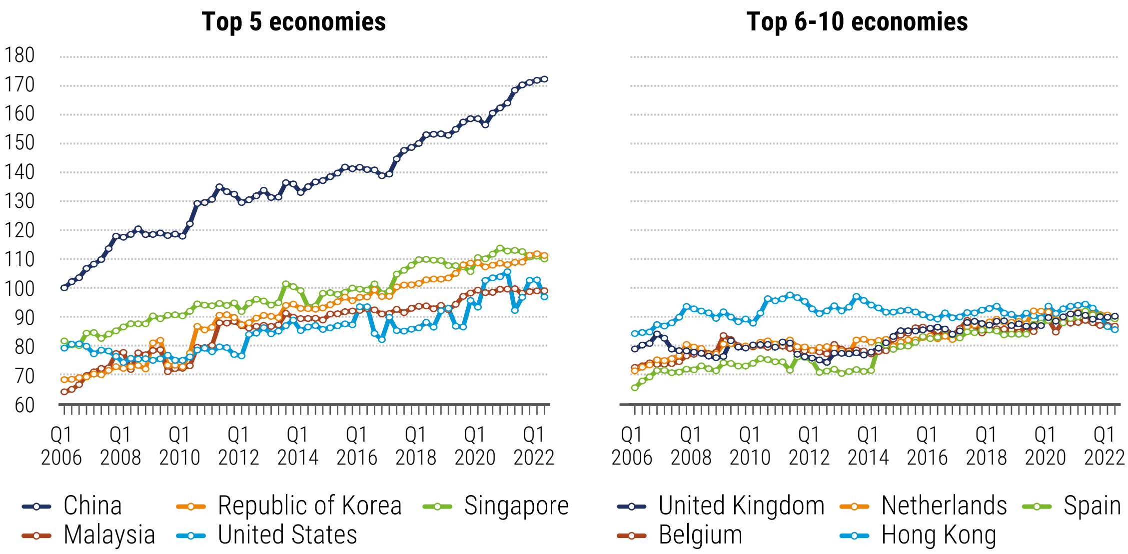
D. LINER SHIPPING CONNECTIVITY

This section focuses on port connectivity. In this regard, UNCTAD, in collaboration with MDS Transmodal, has prepared the liner shipping connectivity index (LSCI), which since 2020 has measured connectivity to the global liner shipping network at both port and country levels.[28]

1. China widened its lead while most other economies lost connectivity

In the second quarter of 2022, the four most-connected economies, with the highest LSCIs, were in Asia – China, Republic of Korea, Singapore, and Malaysia (figure 4.15). China widened its lead as it deployed more vessel capacity to the United States trade routes (figure 4.16). The United States, ranked fifth in the second quarter of 2022, had large fluctuations due to changes in maximum vessel size, but benefited from redeployment of vessels (figure 4.17).

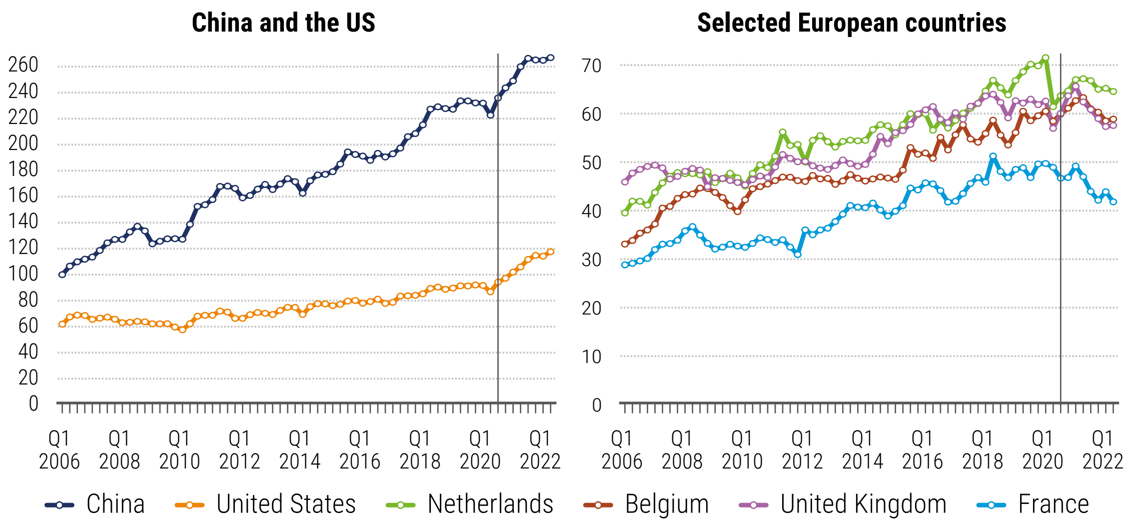
Figure 4.15 Liner shipping connectivity index, top 10 economies, 2006Q1–2022Q2



Source: UNCTAD, based on data provided by MDS Transmodal. For the complete data set for all countries, see http://stats.unctad.org/LSCI.

Note: Index is based on 2006Q1 = 100 in China. Top 10 economies as of the second quarter of 2022.

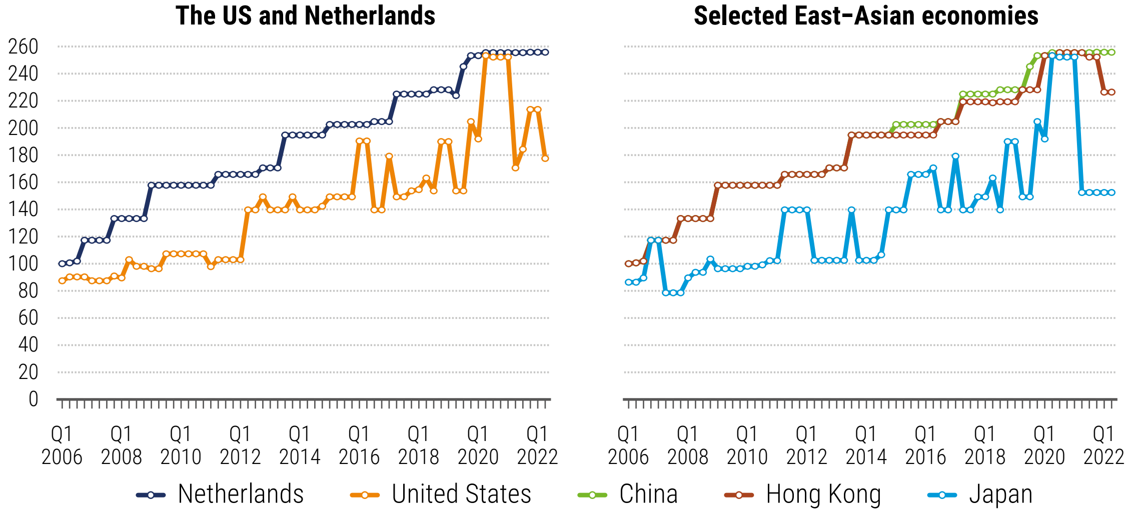
Figure 4.16 Deployed capacity of container ships, selected economies, from 2006Q1 to 2022Q2, index
(maximum value across countries in 2006Q1 = 100)



Source: UNCTAD, based on data provided by MDS Transmodal.

Note: Numbers are normalized by setting the maximum value across countries (i.e., value for China) as of the first quarter of 2006 to 100. Vertical lines in 2020 correspond to the worsening of port congestion.

Figure 4.17 Maximum capacity of container ships, selected economies, from 2006Q1 to 2022Q2, index
(maximum value across countries in 2006Q1 = 100)



Source: UNCTAD, based on data provided by MDS Transmodal.

Note: Numbers are normalized by setting the maximum value across countries (i.e., value for China) as of the first quarter of 2006 to 100.

Four European countries – United Kingdom, Netherlands, Spain, and Belgium – ranked sixth to ninth. Apart from Spain, they redeployed vessels to the China-US route (figure 4.16). France faced the same pressures. Although Spain increased capacity, it lost operators resulting in a decline in overall connectivity.

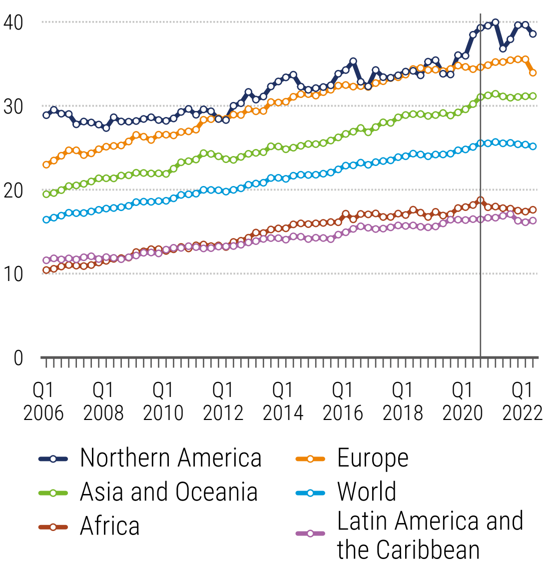
Hong Kong China dropped from fifth to tenth as large container vessels serving the China-EU route, started skipping this port (figure 4.17). Japan faced the same problem three quarters earlier; its rank dropped from 11th to 21st.

2. COVID-19 causes Sub-Saharan Africa and Latin America and the Caribbean to lose connections

The COVID-19 pandemic also reduced shipping connectivity even for some top performing countries. In the third quarter of 2020, worsening port congestion reduced the global average of the LSCI (figure 4.18). Europe continued improving until the first quarter of 2022, but it dropped steeply in the second quarter, mainly in Eastern and Southern Europe, due to the war in Ukraine (see section E). Northern America and Asia and Oceania, on the other hand continued their positive trends, led by China and the United States.

Connectivity also fell in Africa and in Latin America and the Caribbean. Between the third quarter of 2020 and the second quarter of 2022, the LSCI for Africa declined from 18.8 to 17.6 and for Latin America and the Caribbean from 16.5 to 16.3. In Africa, the average number of direct connections fell by 12.4 per cent, and in Latin America and the Caribbean by 13.5 per cent (figure 4.19). As shipping lines reassigned ships to the China-US routes, other States lost

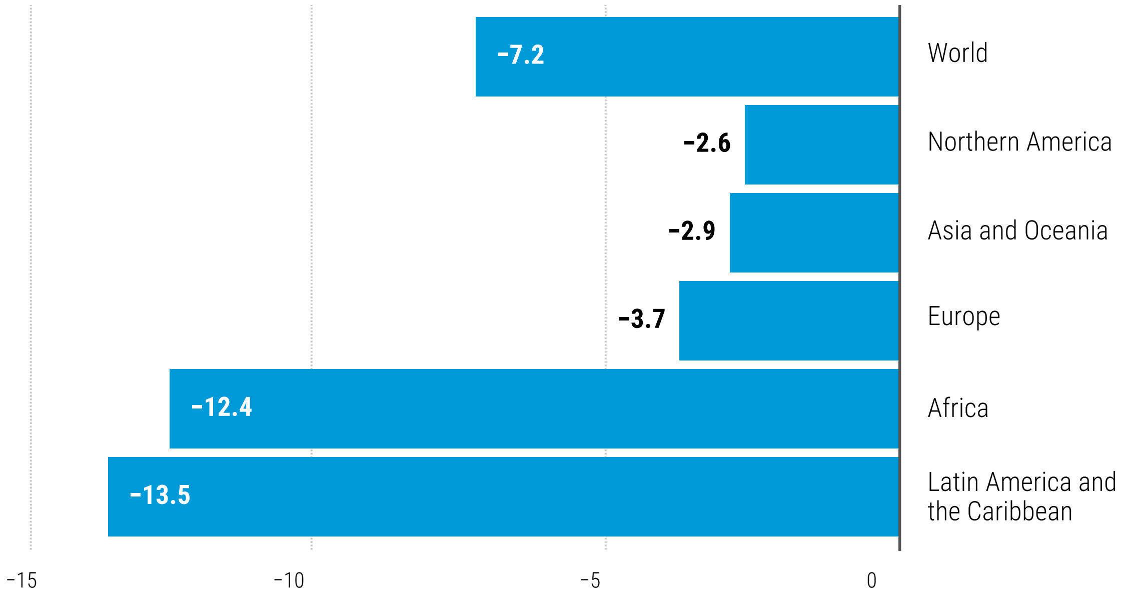
Figure 4.18 LSCI, world and regional average from 2006Q1 to 2022Q2



Source: UNCTAD, based on data provided by MDS Transmodal.

Note: Numbers are normalized by setting the maximum value across countries (i.e., value for China) as of the first quarter of 2006 to 100. For countries whose data are missing for a particular period due to a complete loss of liner shipping connections, such as Ukraine in the second quarter of 2022, their values are assumed to be zero.

Figure 4.19 Changes in direct calls by region, from 2020Q3 to 2022Q2, per cent



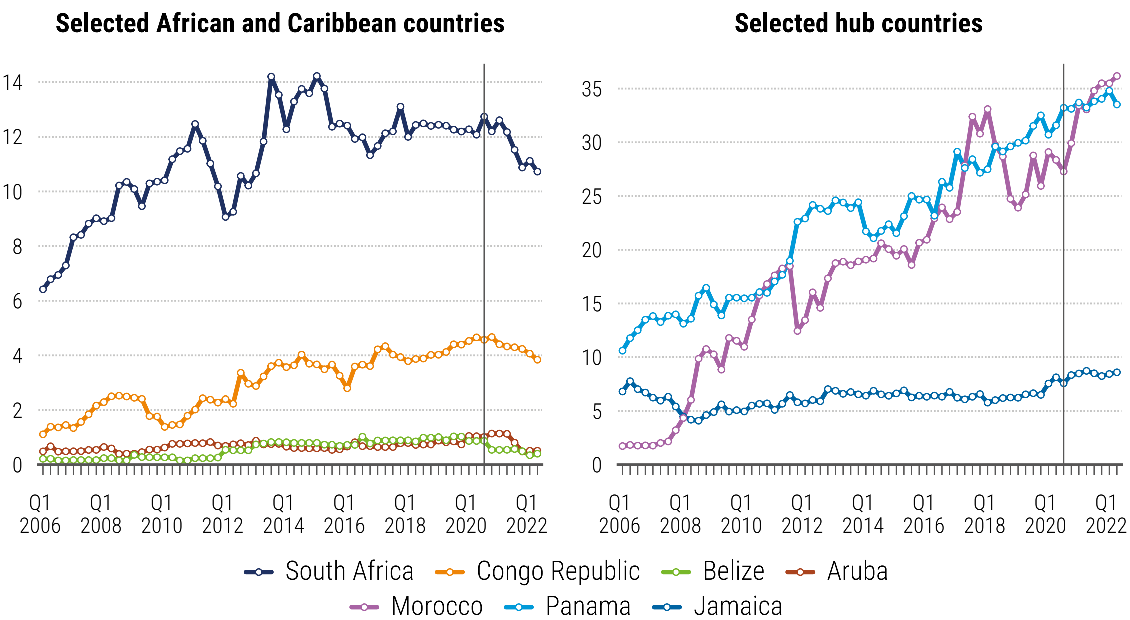
Source: UNCTAD, based on data provided by MDS Transmodal.

Note: Numbers are normalized by setting the maximum value across countries (i.e., value for China) as of the first quarter of 2006 to 100. For countries whose data are missing for a particular period due to a complete loss of liner shipping connections, such as Ukraine in the second quarter of 2022, their values are assumed to be zero.

connectivity: South Africa and Republic of the Congo recorded container carrying capacity decline by 16 per cent, Belize by 54 per cent, and Aruba by 50 per cent (left chart of figure 4.20).

However, even in Africa and Latin America and the Caribbean regions, some hub countries increased vessel capacity. Panama's increased by 0.9 per cent, and Jamaica by 13.5 per cent (figure 4.20). Capacity in Morocco increased by 32.5 per cent, mostly driven by ongoing development of Tanger Med.

Figure 4.20 Deployed capacity of container ships, selected developing economies, from 2006Q1 to 2022Q2



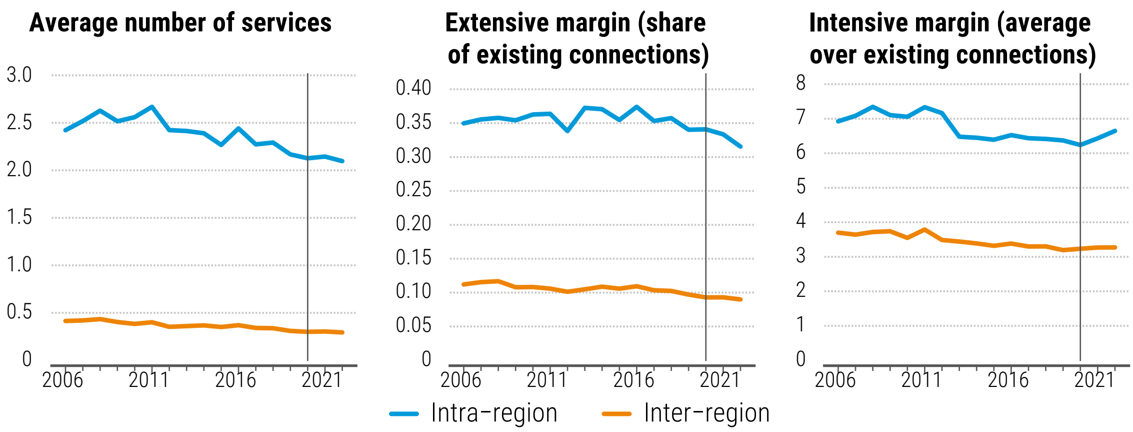
Source: UNCTAD, based on data provided by MDS Transmodal.

Note: Numbers are normalized by setting the maximum value across countries (i.e., value for China) as of the first quarter of 2006 to 100. For countries that suffered a complete loss of liner shipping connections, such as Ukraine in the second quarter of 2022, their values are assumed to be zero.

3. Most regions lose shipping connections

The pandemic may have shifted trade from global supply chains to regional ones. To examine this hypothesis UNCTAD has calculated the average number of liner shipping services across intra- and inter-regional country pairs. Overall, the average number of shipping services continued to decline both across intra- and inter-regional country pairs (left of figure 4.21). However, for intra-regional country pairs the loss was mostly for non-core pairs which suffered falls in their extensive margins (middle of figure 4.21). The extensive margin measures the share of connected intra-regional country pairs over all potential intra-regional country-pairs, and its decline indicates a complete loss of shipping services in thinly connected country pairs.

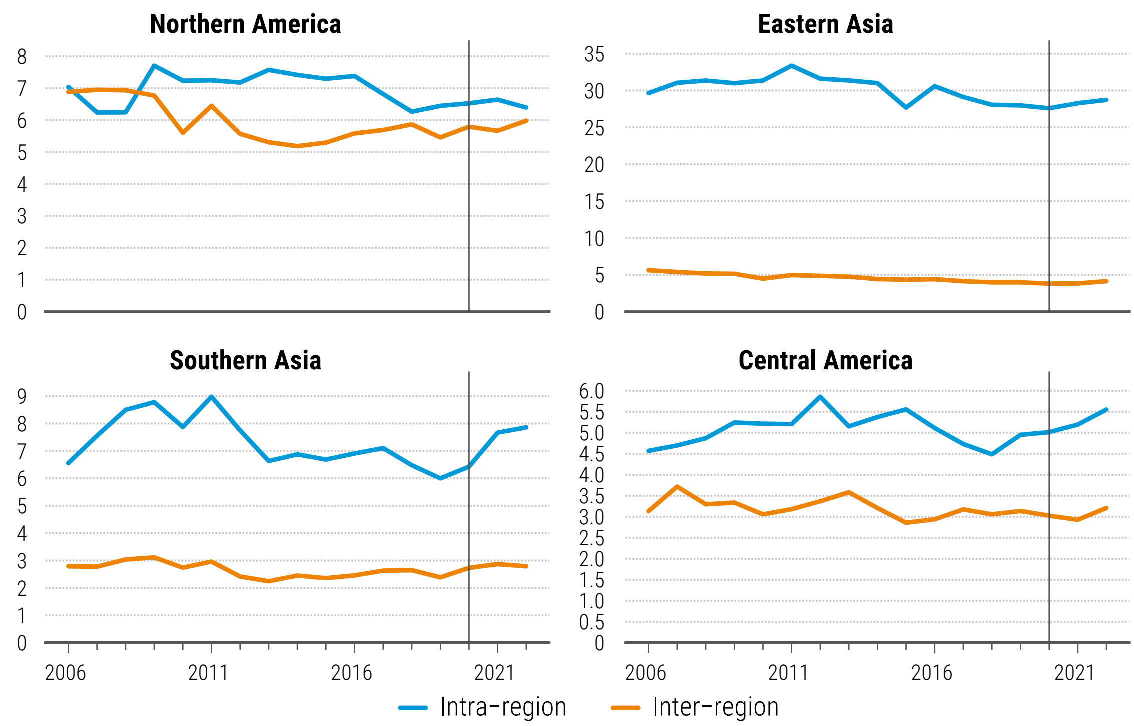
Figure 4.21 Average number of liner shipping services and its extensive and intensive margins, across intra- and inter-regional country pairs, global average, 2006 to 2022



Source: UNCTAD, based on data provided by MDS Transmodal.

Note: Annual data for the first quarter of each year. Intra-region is the average for trading partner countries within the same region, inter-region is the average for trading partners countries in other regions. The indicators are calculated for all countries and aggregated into global average.

Figure 4.22 Average number of liner shipping services over existing connections (intensive margin), by intra- and inter-region trade, selected regions, 2006 to 2022



Source: UNCTAD, based on data provided by MDS Transmodal.

Note: Annual data for the first quarter of each year. Intra-region is the average for trading partner countries within the same region, inter-region is the average for trading partners countries in other regions. The indicators are calculated for all countries and aggregated into regional average.

In contrast, shipping services have been strengthened for core trading country pairs, as indicated by an increase in their intensive margins (figure 4.21). The intensive margin measures the average number of shipping services between existing pairs, and an increase implies an improvement in existing connections.

Intra-regional shipping connections increased in Southern Asia – as India strengthened connections to Pakistan, Sri Lanka, China, the Republic of Korea, Malaysia, Saudi Arabia, United Arab Emirates and Singapore. Jawaharlal Nehru port and Mundra port in India secured several additional connections facilitated by port expansions and upgrades including the launch of dwarf-container train services.[29] Dwarf containers are lower by 660 millimetre than the normal containers, giving them a logistical edge. Connections have also been strengthened in Central America, mainly between Guatemala, Nicaragua, and Mexico.

Overall, however, between 2006 and 2021 the number of shipping services declined, partly due to consolidation of liner shipping companies and the trend towards larger container ships. This is posing a problem for developing economies, especially for those dependent on maritime transport such as small island developing States (SIDS) (box 4.1).

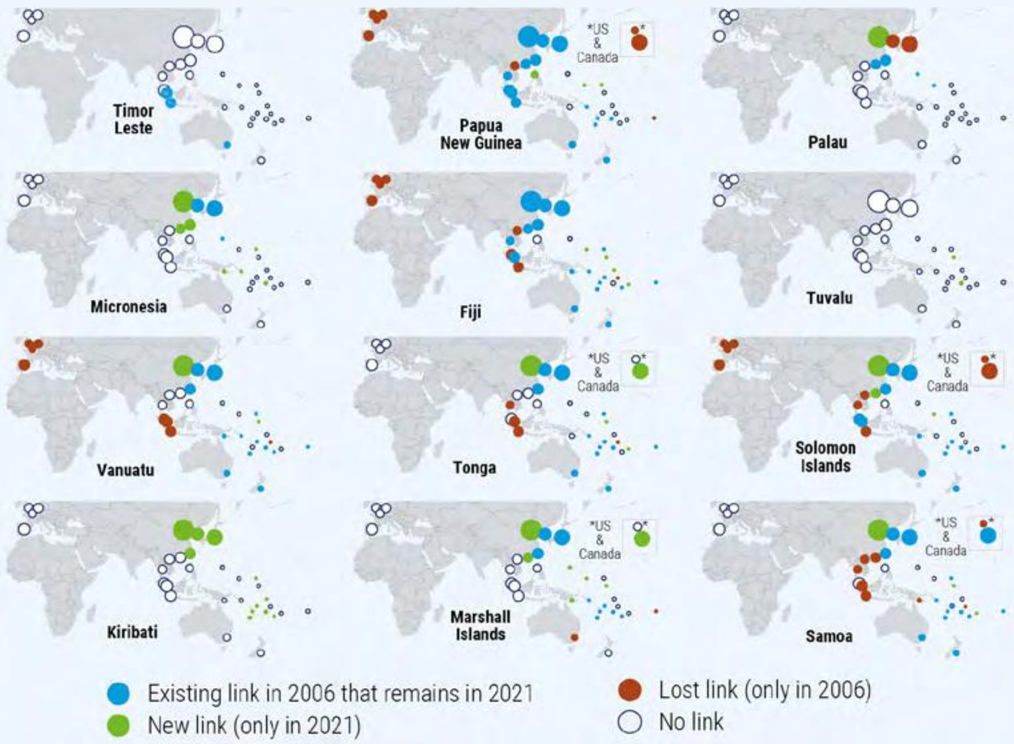
Box 4.1 Liner shipping connectivity in the Pacific SIDS

An UNCTAD-ESCAP study has assessed maritime connectivity in the Pacific SIDS – which have the world's lowest liner connectivity.[30] The best-connected States are the more populated ones with larger markets: Papua New Guinea, Fiji and Solomon Islands, which are regional transhipment bases. All the other States are among the world's least connected, with Kiribati, Tuvalu and Nauru in the bottom 10.

Pacific SIDS have direct connections with a few partners, mainly in Asia and the Pacific. In 2021, the best-connected State was Fiji, with 23 direct connections, followed by Solomon Islands (19), and Papua New Guinea, Tonga, Samoa, Marshall Islands (18), and Vanuatu (16). For the other States the number of direct connections varies between two (Tuvalu) and 12 (Micronesia and Kiribati). These direct connections are limited to the Asia-Pacific region, and mostly with other small States and territories.

A handful of States in Asia have direct connections with the Pacific SIDS: Japan, Republic of Korea, Taiwan Province of China, Hong Kong China, and China. Direct connections with ASEAN States are less common.

Direct links of selected Pacific SIDS. Circle size reflects number of calls (first half of 2021)
Direct* links between countries. Situation in 2021 and change with regard to 2006

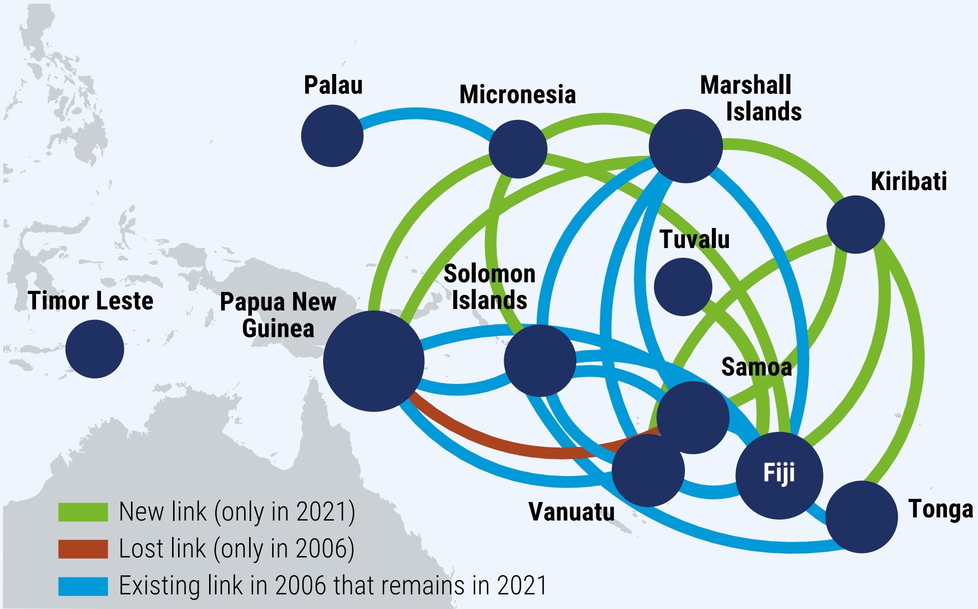


Circle size (number of vessel calls, 2021 S1) [MarineTraffic data].
* A direct link exists between two countries in a same vessel calls at ports in both countries. Based on MDST data.

China has recently become the main non-Pacific partner, with direct connections to ten Pacific SIDS. The States gaining new direct links between 2006 and 2021 were Kiribati, Micronesia and the Marshall Islands. Over the same period, Fiji, Solomon Islands, Papua New Guinea and Vanuatu lost their direct connections with Europe, and Samoa, Tonga and Vanuatu lost connections with South-East Asian countries.

Box 4.1 Liner shipping connectivity in the Pacific SIDS *(Cont.)*

Direct links between Pacific SIDS. Circle size reflects number of calls (first half of 2021)



Low connectivity results in high transport costs. On average, SIDS pay twice as much for international transport of their imports as do developed countries.

Another major challenge is to maintain frequent vessel connections. The Pacific SIDS attract very few container ship port calls, indicating a low frequency of shipping services. However, there are important intra-regional differences. During the period 2018–2021, for the first half-year, Papua New Guinea on average received 392 vessel calls and Fiji 165. At the other end of the scale, during the first six months of 2019, Kiribati received only 21 container ship port calls, fewer than a vessel per week. The other Pacific SIDS had similar numbers, ranging between 38 and 48.

When deciding how to deploy their ships, companies consider remoteness, the volumes of cargo and trade imbalances, port fees and infrastructure, and the level of transport facilitation. ESCAP and UNCTAD are helping countries to elaborate strategies for maritime connectivity, such as improving port infrastructure, and investing in port facilities, port efficiency and hinterland connections.

Contribution from ESCAP.

E. IMPACT OF THE WAR IN UKRAINE

The war in Ukraine has seriously affected shipping in the Black Sea region. This section quantifies these impacts based on port performance and connectivity.

1. Impact on port calls in the Black Sea region

After the onset of the war on 24 February 2022, weekly departures of ships from Ukraine's ports immediately dropped from 160 to around 10 (figure 4.23). They marginally recovered to about 30 by April and after the signing of the Black Sea Grain Initiative (BSGI) in July increased to around 100, but were still about 35 per cent below the pre-war period in September.[31]

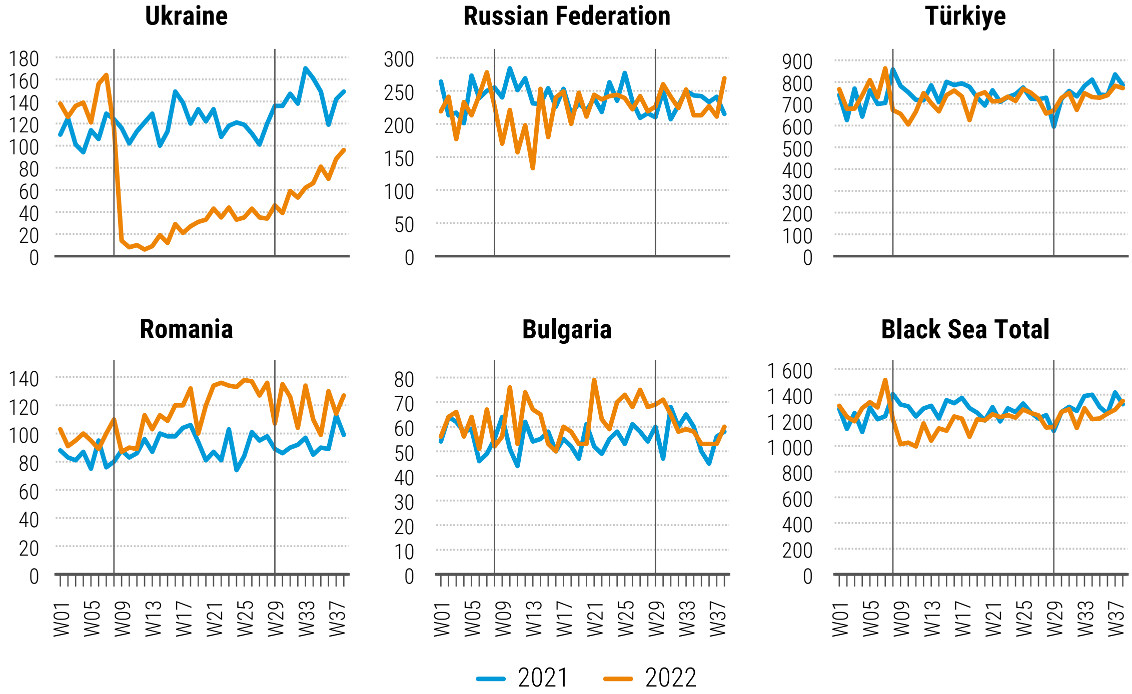
Departures from Black Sea ports in the Russian Federation also declined, from 280 to around 150, though by April had recovered to 250. Port calls in Türkiye dropped from 700–800 to 600, though by May had recovered to 700–800; since then for most weeks they have been around the corresponding week of 2021.

Some cargoes are transported from Ukraine to Romania by road, rail or barge, and then shipped from Romanian ports, particularly Constanta. As a result, Romania's port calls increased from around 100 to 120–140.[32] Given the ensuing congestion in Constanta, ports in Bulgaria have become a viable option for Ukrainian exporters and importers.[33]

Other Carriers from Ukraine turned to safer trade routes along the Danube River, departing from river ports such as Reni and Izmail, but since these cannot accommodate large dry bulk vessels generally carriers have been using small general cargo and multipurpose vessels (figure 4.24 and figure 4.25). Following the signing of the BSGI, more dry bulk carriers departed from major Black Sea ports – Chornomorsk, Odessa, and Pivdennyi/Yuzhny.

Figure 4.26 shows a typical shipping route from Ukraine for one general cargo ship, the Sparta. This vessel departed Reni on the Danube River on 3 July 2022[34] and used branch rivers to enter the Black Sea through Sulina in Romania. It visited Istanbul in Türkiye on 5 July 2022 and reached Abu Qir in Egypt on 8 July 2022.

Figure 4.23 Number of weekly departures of all cargo ships in the Black Sea region for international shipping, 1st week to 38th week in 2021 and 2022



Source: UNCTAD, based on data provided by Sea/ (www.sea.live).

Note: X-axis represents departure week. The Russian Federation includes only ports in Black Sea. Black Sea Total includes Georgia and Moldova. The vertical lines indicate the start of the war in Ukraine in the eighth week of 2022 and the signing of the BSGI in the 29th week.

Figure 4.24 Composition of port calls in Ukraine by port, departure before and after the war and the BSGI

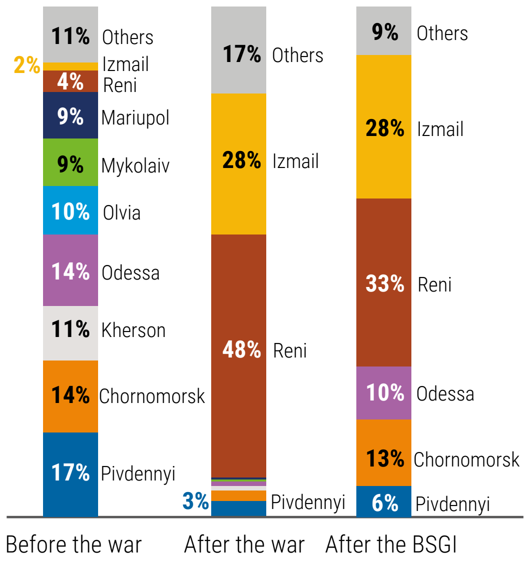
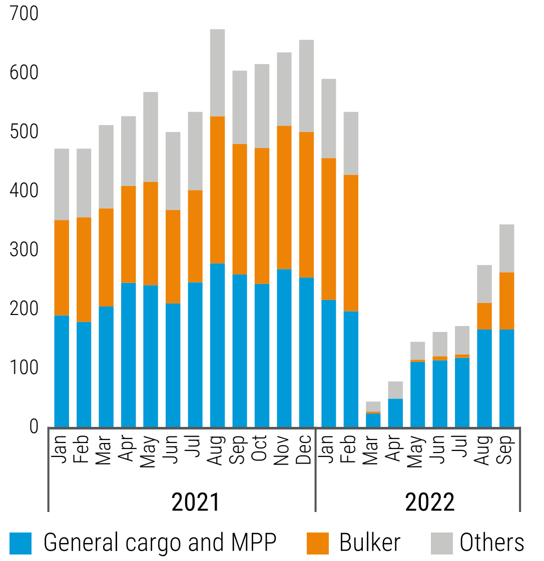


Figure 4.25 Monthly port calls in Ukraine by shipping sector, departure during January 2021 to September 2022



Source: UNCTAD, based on data provided by Sea/ (www.sea.live).

Note: The period "before the war" refers to 1 January 2021 – 23 February 2022, "after the war" refers to 24 February 2022 – 21 July 2022, and "after the BSGI" refers to 22 July 2022 – 16 October 2022.

Figure 4.26 Typical shipping route from Ukraine after the war

Source: Sea/ (www.sea.live) and Google Map.

Note: A voyage of Sparta from Reni in Ukraine to Abu Qir in Egypt from 3 July 2022 to 8 July 2022.

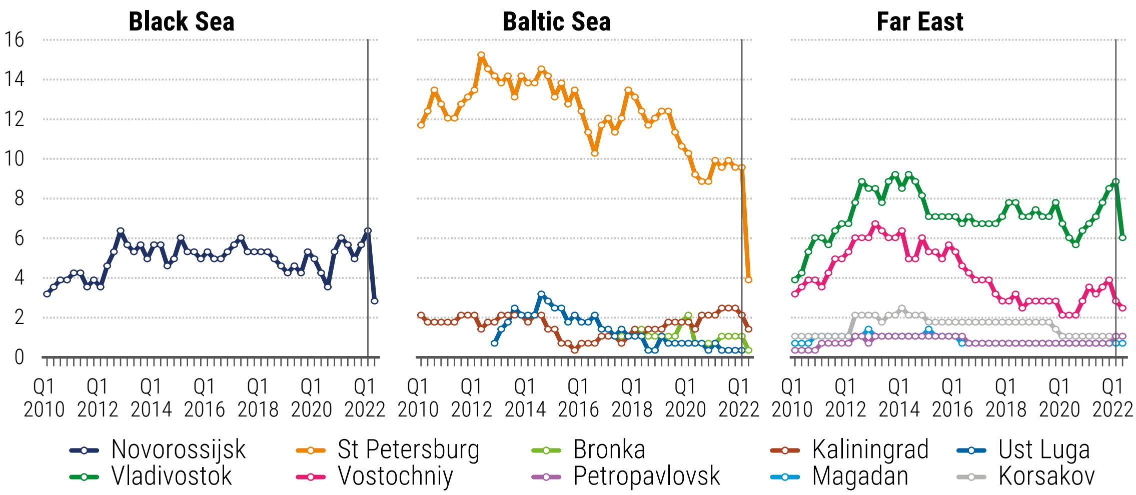
2. Impact on liner shipping connectivity in Ukraine and the Russian Federation

The war also reduced liner shipping connectivity in Ukraine and the Russian Federation. Due to safety concerns, Ukraine has been completely cut off, with the number of liner shipping services falling from 10 in the first quarter of 2022 to zero in the second quarter. Services for the Russian Federation have fallen by half.

As shipping companies limited their businesses in the area, the Russian Federation lost services not only in the Black Sea ports but also in Baltic Sea and Far East ports (figure 4.27). The number of liner services in St. Petersburg, the largest Russian port in the Baltic Sea, dropped by about 60 per cent, and those in Vladivostok in the Far East by about 30 per cent.

The decline in liner shipping connections with the Russian Federation was primarily with European countries (figure 4.28). Before the war, Germany was the largest partner country with a monthly average of 114 voyages, but that number fell to 32. For the Republic of Korea, the fall was from 96 to 73. On the other hand, Türkiye retained its monthly average at around 70 voyages, while China increased its average from 29 to 50.

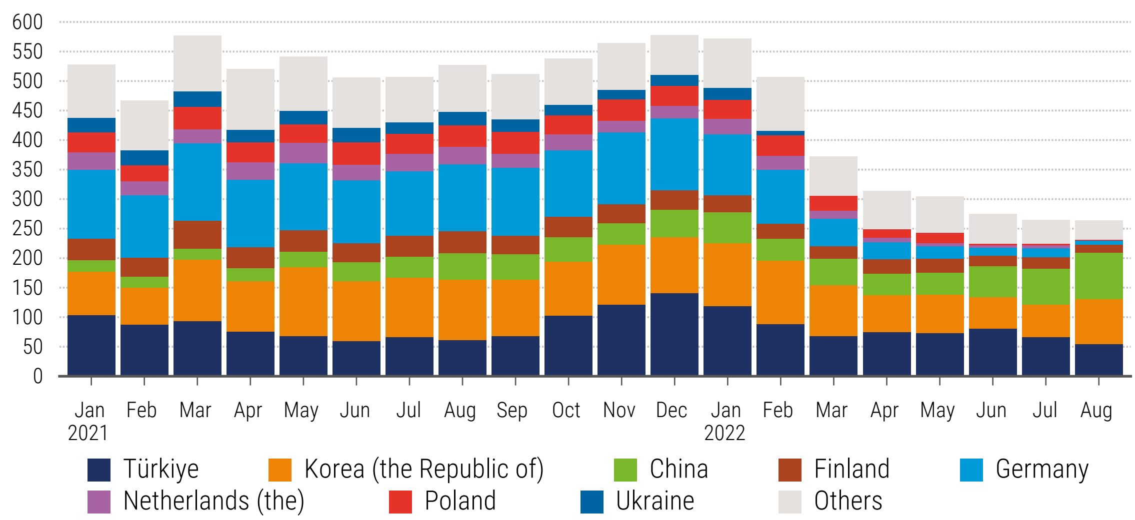
Figure 4.27 Number of liner shipping services, ports in the Russian Federation by region, index (maximum value across ports in 2006Q1 = 100)



Source: UNCTAD, based on data provided by MDS Transmodal.

Note: Excluding recently inactive ports and Northern ports.

Figure 4.28 Number of monthly voyages of container ships from and to the Russian Federation, by partner country



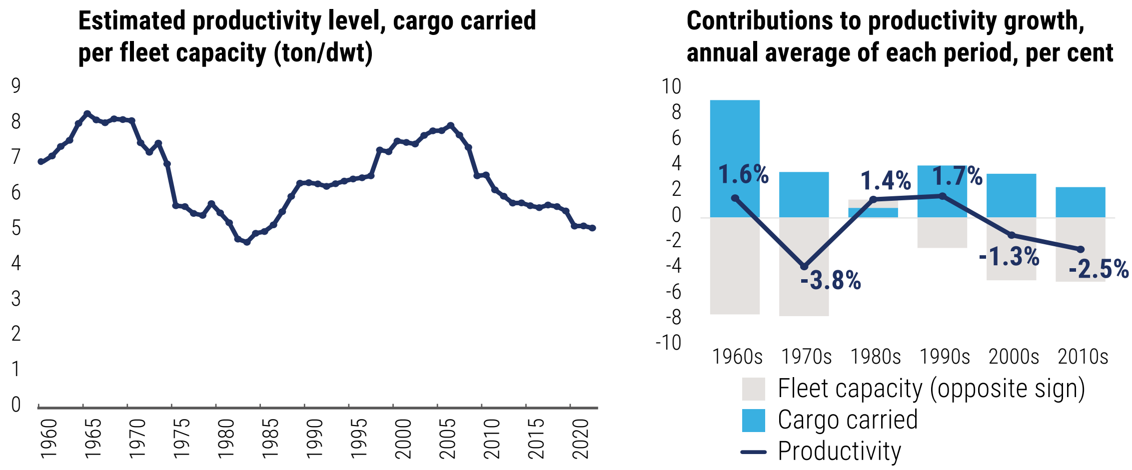
Source: UNCTAD, based on data provided by Sea/ (www.sea.live).

F. PRODUCTIVITY OF THE WORLD FLEET

UNCTAD has estimated the operational productivity of the world fleet, in terms of cargo carried per unit of fleet capacity for the period 1960 to 2022. During the 1970s and early 1980s, deep recessions, including oil shocks in 1973 and 1979, reduced shipping costs, while fleet productivity declined by over one-third to around five tons per dwt of capacity (figure 4.29).[35] Productivity revived during the 1990s and early 2000s, following export-led global growth in Asia, only to decline again following the global financial crisis.[36] It continued to fall in the 2010s as fleet supply increased per year by about five per cent, while demand increased only by two per cent.

As indicated in figure 4.30, this fall was evident in all three major shipping sectors – oil tankers, dry bulk carriers, and container ships – though smaller for container ships due to market consolidation which reduced oversupply.[37] The trends were similar for chemical tankers and gas carriers. But it was a different story for other dry carriers as the limited supply of new vessels reduced fleet capacity. Between 2009 and 2021, cargo carried increased from 678 million to 940 million tons but the fleet capacity declined from 95.5 million to 92.5 million dwt.

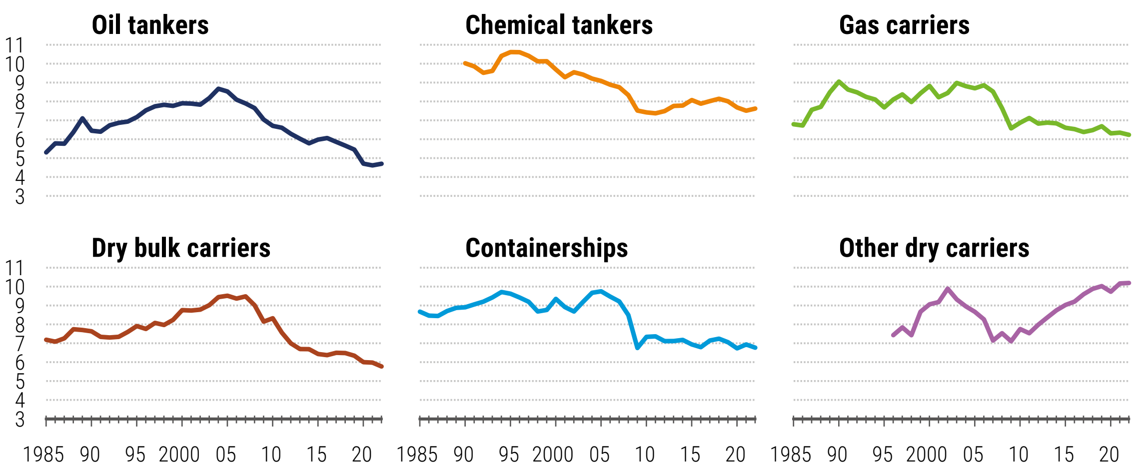
Figure 4.29 Operational productivity of the world fleet, all ships, 1960–2022



Source: UNCTADstat for fleet capacity for 1980-2022 and cargo carried for 1970–2022. Data before 1980 for fleet capacity and before 1970 for cargo carried are retrieved from earlier issues of *Review of Maritime Transport*.

Note: Fleet productivity (tonne per dwt) = cargo carried (tonne) / fleet capacity (dwt). Fleet capacity is in the opposite sign in the right-hand chart. Fleet capacity is as of 1 January of each year. Cargo carried in 2022 is forecast by UNCTAD.

Figure 4.30 Operational productivity of the world fleet, by fleet sector, available years for 1985–2022, cargo carried per fleet capacity (ton/dwt)



Source: UNCTAD, based on data provided by Clarkson Research Services (Shipping Intelligence Network and several issues of Shipping Review and Outlook).

Note: The estimated productivity level is slightly higher than the estimated productivity in figure 4.29 due to the difference in data sources. Cargo carried in 2022 is forecast by Clarkson Research Services.

With container ship capacity expected to grow by 7.9 per cent in 2023, productivity will decline further.[38] But for dry bulk carriers fleet growth in 2023 is projected at only 0.4 per cent so changes are likely to be marginal, with a similar outcome for oil tankers with fleet growth of less than 2 per cent.[39] For bulk and oil tankers, demand continues to recover which should boost productivity, but given the war in Ukraine the outlook is uncertain.

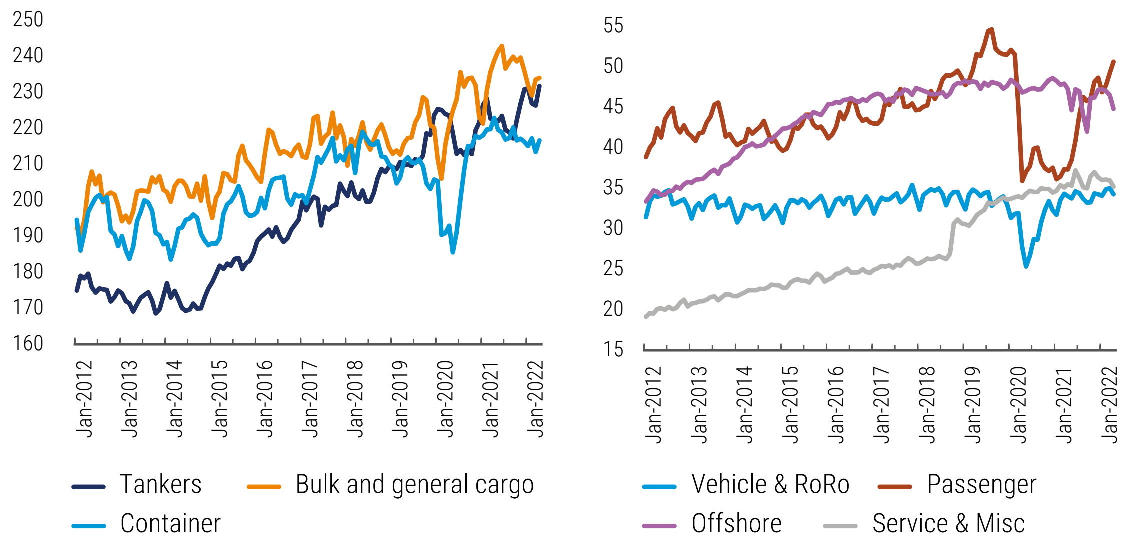
G. GREENHOUSE GAS EMISSIONS FROM THE WORLD FLEET

1. Pandemic stalls improvements in carbon intensity

Between 2020 and 2021, total emissions from the world fleet increased by 4.7 per cent, with most of the increases coming from container ships, dry bulk and general cargo vessels (figure 4.31). Emissions also increased from vehicle and Ro/Ro vessels and from passenger vessels. Increases were due primarily to a recovery in maritime transport work, with a 3.1 per cent increase in ton-mile seaborne trade in 2021, but emissions in grams of CO_2 per ton-mile – carbon intensity – also increased slightly.

During the previous decade there had been a steady reduction in carbon intensity (figure 4.32). Between 2012 and 2022, the carbon intensity of container ships fell by 21 per cent and that of bulk and general cargo vessels by 18 per cent. In contrast, for tankers the decline was only 1 per cent; tanker carbon intensity hit a bottom in August 2018 then peaked in October 2020.

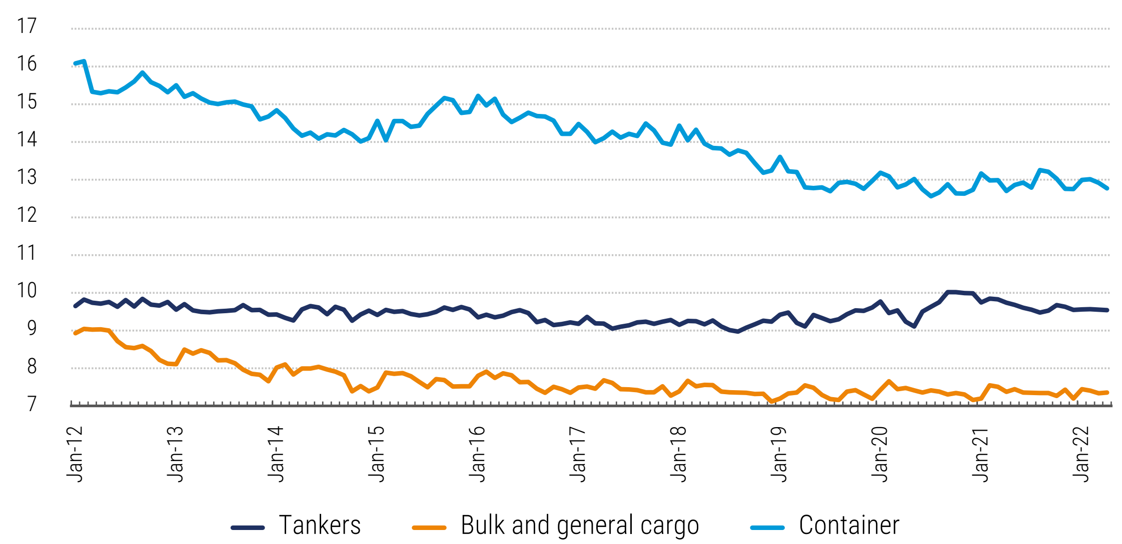
Figure 4.31 Total CO_2 emissions of world fleet by vessel type, annualized monthly, January 2012 to April 2022, million tons



Source: UNCTAD, based on data provided by Marine Benchmark.

Note: Service & Misc includes tug boats, fishing vessels and others. CO_2 emissions from vessel specific calculated bunker fuel from AIS.

Figure 4.32 CO_2 emission intensity by vessel type, monthly, gram per ton-mile



Source: UNCTAD, based on data provided by Marine Benchmark.

Note: CO_2 emissions from vessel specific calculated bunker fuel from AIS.

Larger ships consume less fuel per cargo volume and, having generally been built more recently, have more efficient designs (figure 4.33).[40] Over this period, carbon intensity of container ships decreased by 3.3 grams of CO_2 per ton-mile. UNCTAD estimates that around half of the reduction in intensity for container ships can be explained by their increasing size. In a counter-factual scenario, where carbon intensity is fixed for each ship size segment, and only ship size composition is assumed to change, the carbon intensity should have dropped by only 1.7 grams of CO_2 per ton-mile (figure 4.34). In the second half of 2020, as major shipping lines redeployed vessels to the US-China route, small shipping lines and shippers moved in, which produced a slight increase in carbon intensity.

Another factor for carbon intensity is slow steaming. During economic downturns, ships sail slower to save fuel, so the pattern is cyclical (figure 4.34). The association is higher for larger ships than smaller ones (figure 4.35). Between 2015 and 2016 however, the benefit of slow steaming for transport efficiency was outweighed by a slow growth in demand.

Figure 4.33 CO_2 emission intensity of container ships by ship size, grams per ton-mile, 2021

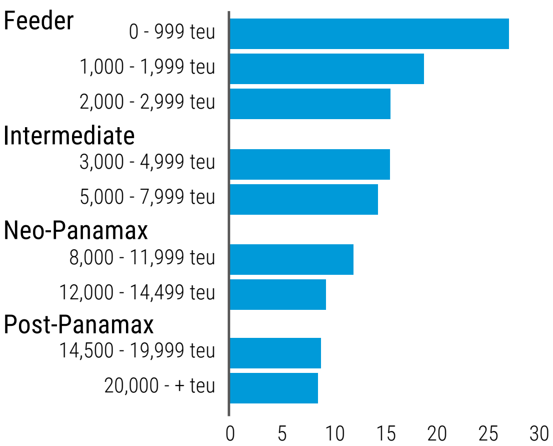
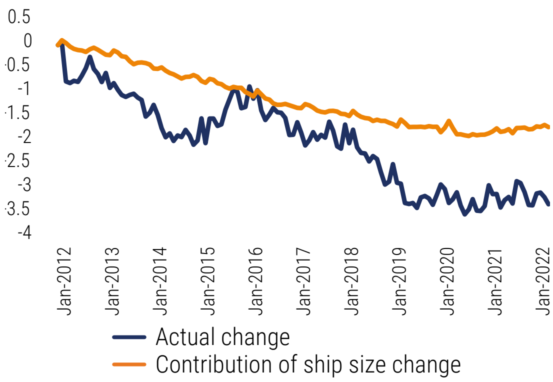


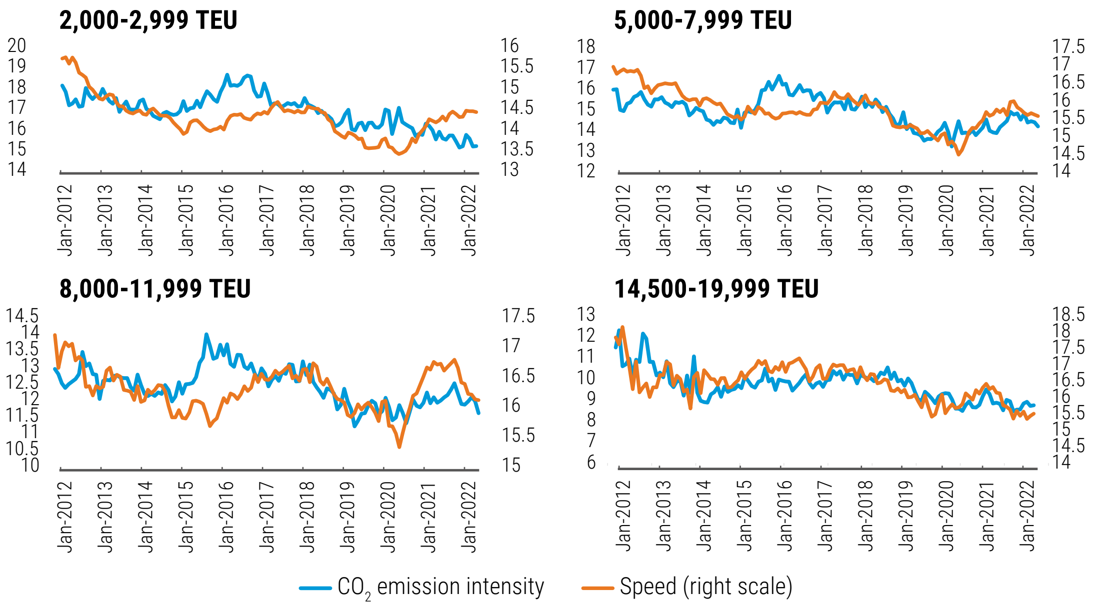
Figure 4.34 Cumulative change from January 2012 in CO_2 emission intensity, and contribution of ship size change of container ships, grams per ton-mile



Source: UNCTAD, based on data provided by Marine Benchmark.

Note: CO_2 emissions from vessel specific calculated bunker fuel from AIS. Right-hand chart is an actual cumulative change in CO_2 emission intensity from January 2012 and contribution of ship size change. The contribution of ship size change is calculated by fixing the CO_2 emission intensity in each ship size segment at the value in 2021 and only changing the ship size composition.

Figure 4.35 CO_2 emission intensity and steaming speed of container ships, selected ship sizes, monthly, grams per ton-mile and knot



Source: UNCTAD, based on data provided by Marine Benchmark.

Note: CO_2 emissions from vessel specific calculated bunker fuel from AIS. Steaming speed is average of voyages above 6 knots.

2. Flag State CO_2 emissions reflect fleet compositions

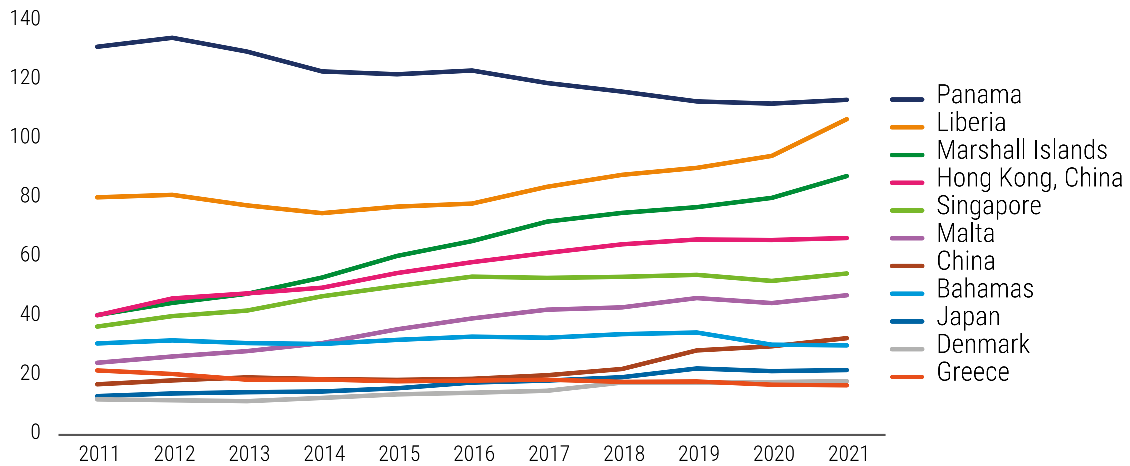
The International Maritime Organization target for 2050 is to reduce total annual 2008 GHG emissions by at least 50 per cent. The company Marine Benchmark has assigned total CO_2 by flag State based on the automatic identification system (AIS) tracking system. Over the past decade some of the largest increases, 33 per cent and 116 per cent, have been for Liberia and Marshall Islands due to their substantial increases in registered vessel capacities (figure 4.36). In contrast, emissions from Panama's flag ships have declined by 14 per cent because improvements in GHG efficiency outweighed the moderate increase in registered ship capacity.

In 2021, the flag States emitting the most CO_2 were Panama, Liberia, Marshall Islands, and Hong Kong China (figure 4.37). However, they had a smaller share of emissions than of capacity because they had a higher proportion of dry bulk vessels which tend to have lower emission intensities.[41] Japan's higher share in emissions is partly because it uses more general cargo vessels which generally have the highest emission intensities.[42] Similarly, Denmark has a high share of container ships which also have higher emission intensities.[43]

3. Carriers differ in their carbon intensities

Marine Benchmark and Xeneta have developed a global index system to assign CO_2 emissions per ton of cargo transported, by trade lane and by container carrier. This is based on real voyages using AIS data, including vessel dimensions and CO_2 emission per unit of fuel consumption, as well as the tonnage of cargo onboard, the speed, distance sailed, and port rotation. The results are shown in figure 4.38 for the major 10 carriers, anonymized as carriers A to J, for the Far East–North Europe trade lane. Over the last four years, the trend has been downwards, though with large differences between carriers. In the first quarter of 2022, the average carbon intensity for Carrier-J, for example, was about 30 per cent lower than that of Carrier-C.

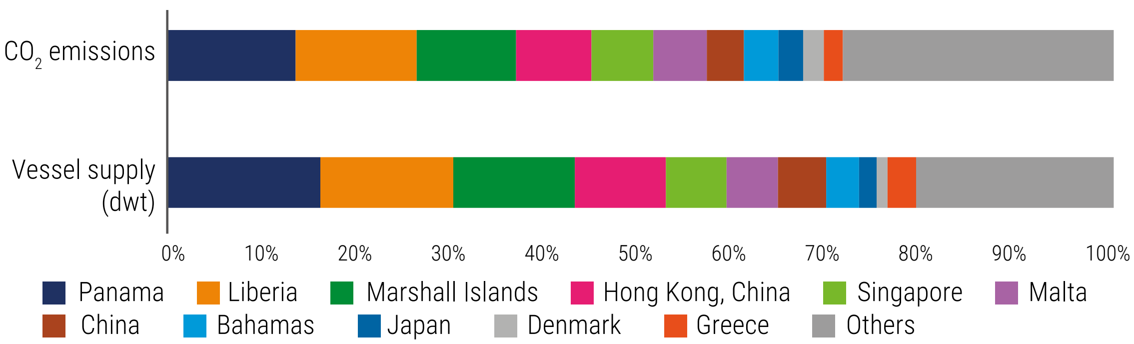
Figure 4.36 Total CO_2 emissions of the world fleet by flag state, annual, 2011 to 2021, million tons



Source: UNCTAD, based on data provided by Marine Benchmark.

Note: CO_2 emissions from vessel specific calculated bunker fuel from AIS.

Figure 4.37 Main flag states' shares in world fleet CO_2 emissions (million tons) and vessel supply (dwt), 2021, percentage



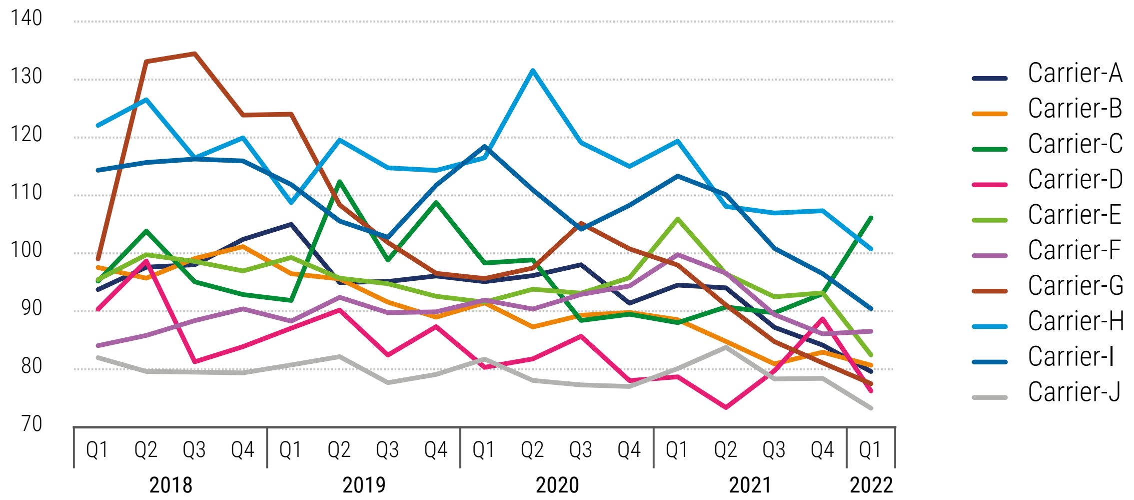
Source: UNCTAD, based on data provided by Marine Benchmark for CO_2 emissions and Clarksons Research for vessel supply.

Note: CO_2 emissions from vessel specific calculated bunker fuel from AIS.

Carriers have different intensities because of differences in vessel size and age (figure 4.39). Generally, the larger and younger the vessel, the lower the carbon intensity. Carrier-G had the youngest vessels, and 96 per cent of those had electronically controlled engines; also, 83 per cent could use alternative fuels including LNG.[44] In contrast, Carrier-E had the oldest vessels of which 82 per cent had electronically controlled engines and none could use alternative fuels.

Figure 4.39 also shows how deploying larger and younger vessels and slow steaming have helped reduce emissions. Carrier-G attained the largest reduction – increasing average vessel size by 210 per cent, decreasing average age by 86 per cent, and reducing average speed by 23 per cent. However, only a few carriers increased vessel sizes or reduced average age. As discussed in chapter 2, carriers have been reluctant to invest due to uncertainty about environmental regulations, fuel and carbon prices, and technological developments.

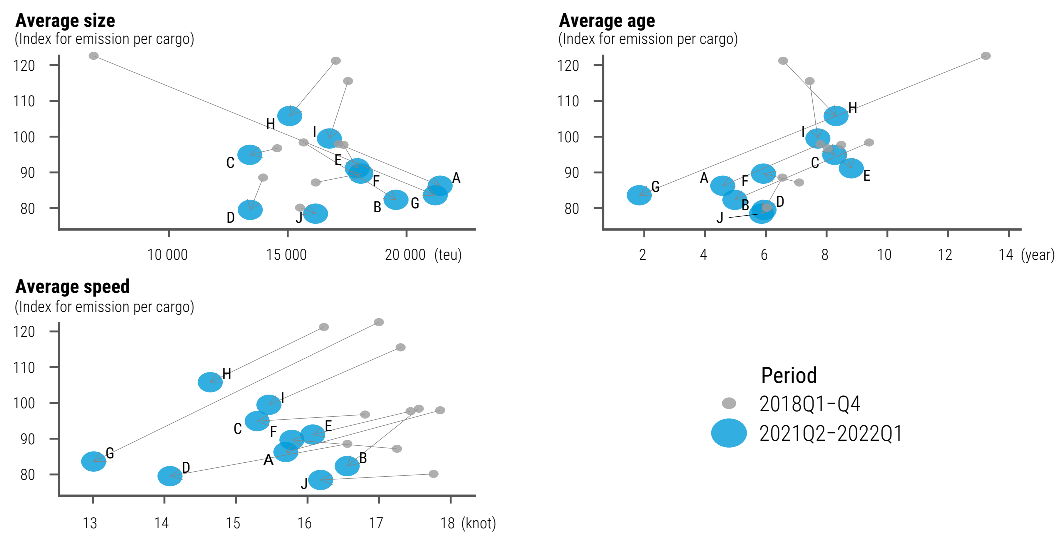
Figure 4.38 Average CO_2 emissions per ton cargo transported of container ships on the trade lane from Far East to North Europe for ten major carriers, quarterly, index (average across carriers in 2018Q1 = 100)



Source: UNCTAD, based on data provided by Marine Benchmark and Xeneta.

Note: CO_2 emissions from vessel specific calculated bunker fuel from AIS.

Figure 4.39 Average CO_2 emission per ton cargo transported, vessel size and age, and steaming speed of container ships on the trade lane from the Far East to North Europe for ten major carriers (Carriers A-J), averages over 2018Q1–2018Q4 and 2021Q2–2022Q1, index (average across carriers in 2018Q1 = 100), TEU, year and knot



Source: UNCTAD, based on data provided by Marine Benchmark and Xeneta.

Note: CO_2 emissions from vessel specific calculated bunker fuel from AIS. Based on vessels assigned to the trade lane from Far East to North Europe. Steaming speed is average speed above 6 knots.

4. From 2023, IMO regulations will encourage slower speeds and retrofitting energy saving technologies

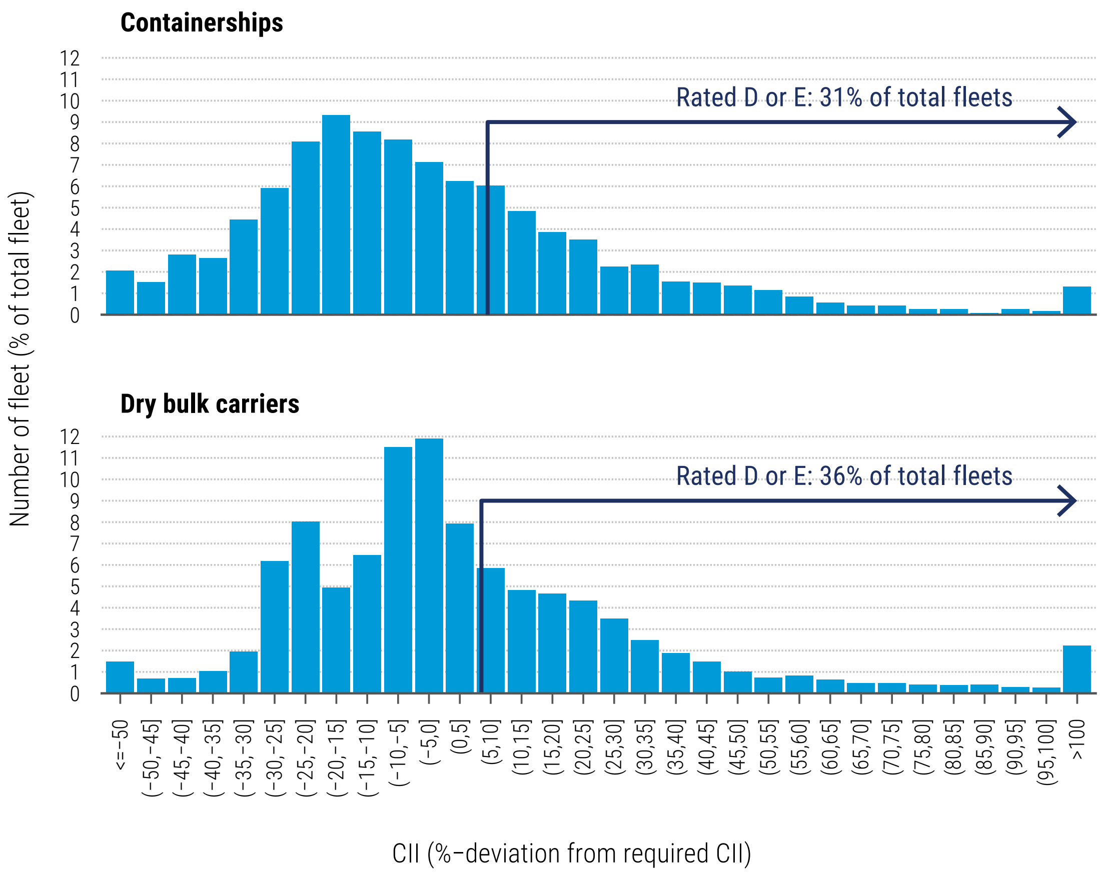
From January 2023, IMO will implement regulations for existing ships. These are based on two indices, the first is the energy efficiency existing ship index (EEXI) which addresses energy efficiency of ship design including retrofitting. The second is the carbon intensity indicator (CII) which deals with the ship's operational energy efficiency. Ships are required to achieve a certain level of energy efficiency based on these indices.

The EEXI regulation would encourage carriers to steam more slowly and retrofit energy-saving technologies. Around 65 per cent of the fleet capacity of tankers and bulk carriers is already compliant with the EEXI although some need to undergo engine power limitation.[45] Other vessels would be required to slow down or fit new technologies.

To analyse the potential impact of the CII regulation, UNCTAD has compared actual and required CII for container ships and dry bulk carriers in 2021 (figure 4.40). Most container ships were CII-compliant while 31 per cent would be rated D or E. For dry bulk carriers, the share of rate D or E vessels was estimated at 36 per cent. This result is consistent with the conclusion from Clarksons Research that 42 per cent of the existing tanker, bulk carrier and container fleets would be rated D or E in 2026 if they had not modified their speeds or specifications.[46]

A vessel with a D rating for three consecutive years or an E rating in any one year would not comply. Owners are required to implement corrective plans, but there is no significant penalty if they do not. The regulations will be more effective if shippers and consumers require vessels with higher environmental standards.

Figure 4.40 Distribution of percentage deviation of actual CII from required CII, individual fleets, per cent of total fleet, 2021



Source: UNCTAD, based on data provided by Sea/ (www.sea.live).

Note: Ships of 5,000GT and above. Required CII reference line is calculated as 1984 * vessel's capacity (in dwt) ^ -0.489 for container ships and 4745 * min (vessel's capacity, 279,000) ^ -0.622. Required CII in 2021 is two per cent below the reference line, and the threshold for D rating is seven per cent higher than the required CII for container ships and six per cent higher for dry bulk carriers. Actual CII is Annual Efficiency Ratio (AER): CO_2 emissions per dwt-mile. For the details of the CII regulation, see IMO, 2022a, 2022b, 2021, 2022c.

H. SUMMARY AND POLICY CONSIDERATIONS

The pandemic disrupted port operations almost everywhere, causing serious shortages of skilled port workers and delays in hinterland transport and upstream supply chain operations. Port congestion was greatest in major trading lanes, but it had far-reaching cascading effects in other routes, through late arrival of vessels, container shortages, and withdrawal of vessel capacity for redeployment to the United States and China.

Problems have been exacerbated by "locally optimal" behaviour. To increase the efficiency of their services, liner companies in Northwest Europe, reduced the number of port calls, though this increased the average cargo exchange volume per port call, lengthening the time for terminal work and adding further pressure to the main ports.

Some regions managed the crisis better than others. North Africa did so by developing port infrastructure. India strengthened and upgraded port capacity and launched dwarf-container train services. Performance of container ports in the US West Coast in contrast, suffered from long-term underinvestment in infrastructure.

The findings in this chapter suggest the following policy implications:

- **Strengthen coordination across stakeholders** – Maritime shipping involves complex networks, that require coordination. Stakeholders need to share information and prepare for negative cascading effects by developing "globally optimal" solutions. Such coordination should be supported by real-time digital platforms, using information from the AIS/GIS system and electronic single windows.
- **Boost resilience with better port infrastructure** – Port upgrades should be based on engagement with the private sector and be accompanied by improvements in hinterland connections. Future shipping demand should be carefully assessed, particularly for potential pandemic-related shifts in shipping and supply chain patterns.
- **Accelerate female participation in the port industry** – Relatively few women work in ports. As port congestion is partly due to a shortage of skilled workers, accelerating female participation will strengthen port resilience.
- **Encourage compliance with new IMO regulations** – Maximizing the effectiveness of the new regulations will require raising the awareness of stakeholders, including transport user companies and consumers.
- **Reinforce training opportunities, particularly for digitalization and decarbonization** – Further technological development will require continual upgrading of expertise, with more resources allocated to training.

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