3

PERFORMANCE INDICATORS

This chapter looks at a series of performance indicators relating to the maritime transport sector. It provides an update on port activity, with a focus on the liner shipping connectivity index, the time ships spend in ports and data on the operation of container terminals. It also offers insights from the port performance scorecard of the TrainForTrade Port Management Programme of UNCTAD. Finally, the chapter presents novel metrics on greenhouse gas emissions from shipping in terms of flag, vessel type and other parameters.

The port data offer useful information on the determinants of port performance, including infrastructure investments, private sector participation and trade facilitation. The data also show the relevance – and the limits – of economies of scale as they apply to container shipping and port operations. Each of the different data sources is helpful in the analysis of complementary information:

- Section A uses automatic identification system data for the complete world fleet and port calls at the country level, with a high level of detail about the vessels and the time they spent in port in 2018, 2019 and early 2020.[7]
- Section B is devoted to data relating to container ships. It employs data on their shipping schedules and presents statistics on the network of the services and companies from 2006 to early 2020.[8] Unlike the automatic identification system data discussed in section A, the data in section B do not cover other vessel types.
- Section C utilizes data obtained from 10 of the world's largest shipping companies on container ports of call of these companies in 2019. The section provides a detailed analysis of the performance of container terminals for these ports.[9]
- Section D uses data from selected ports that are members of the TrainForTrade Port Management Programme, based on a detailed questionnaire elaborated by UNCTAD.[10]
- Section E makes use of automatic identification system data, coupled with information about vessel types and other ship characteristics, to discuss a key performance indicator for the shipping side of maritime transport, notably carbon-dioxide emissions. By doing so, it is possible to provide statistics on the annual carbon-dioxide emissions of the world fleet.[11]

It is reassuring that the statistics generated by different means from different sources are consistent in their main metrics, for example, as regards the relationships between vessel sizes, their position in the shipping network and economic development on the one hand, and performance indicators on the other.

[7] Underlying data provided by MarineTraffic.

[8] Underlying data provided by MDS Transmodal.

[9] Underlying data provided by Journal of Commerce–IHS Markit.

[10] Underlying data provided by the ports in annual surveys.

[11] Underlying data provided by Marine Benchmark.

PERFORMANCE INDICATORS

Most connected port pairs

1. **Ningbo–Shanghai, China**
52 liner shipping companies providing 154 direct services and a total deployed annualized capacity of 50.1 million TEUs
2. **Port Klang, Malaysia–Singapore**
41 companies
3. **Busan, Republic of Korea–Shanghai, China**
38 companies
4. **Shanghai–Qingdao, China**
37 companies

Port calls

in 2019

Recorded arrivals
4,362,737

Median time in port
0.966 day

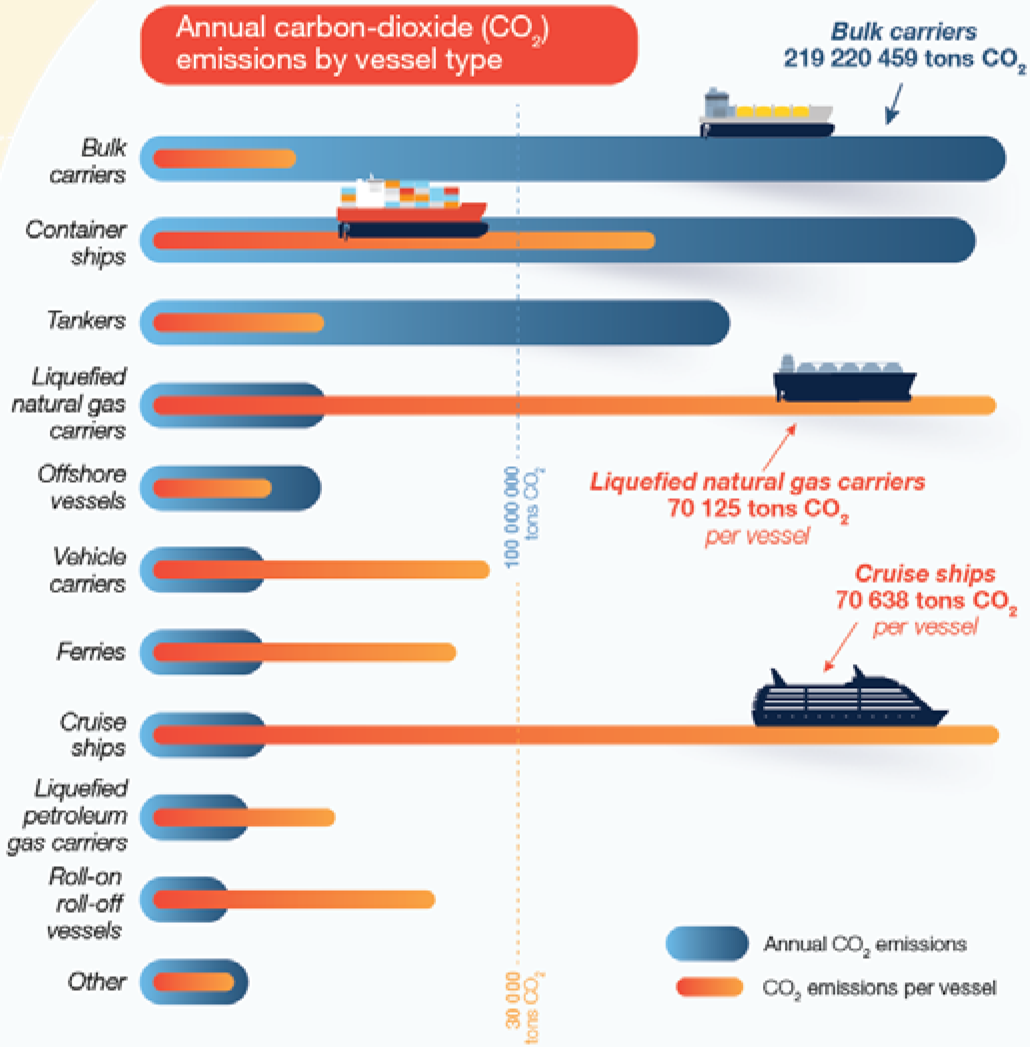
Average age of vessels
18 years

Average size of vessels
14,980 gross tons

Maximum size of vessels
234,006 gross tons

Maximum container carrying capacity of vessels
23,756 TEUs

Annual carbon-dioxide (CO_2) emissions by vessel type



A. PORT CALLS AND TURNAROUND TIMES

1. Port calls increase and turnaround times improve

The global number of recorded commercial shipping port calls of ships of 1,000 gross tons and above rose by 6.07 per cent between 2018 and 2019 (figure 3.1). Ports further improved their overall efficiency, as the median time a ship spent in port decreased slightly by 0.41 per cent (table 3.1), from 0.970 days to 0.966 days.

The performance of seaports is an important determinant of trade costs and connectivity (Sánchez et al., 2003; UNCTAD, 2017a). The longer ships spend in port, the less time they have at sea to carry cargo for international trade. Longer times in port will lead to either higher speeds at sea and thus greater fuel consumption and carbon-dioxide emissions or the use of additional vessels to maintain the same frequency of services. This also results in longer transit times and higher inventory-holding costs. Neither of these outcomes is desirable for carriers or shippers. For ports, too, faster turnaround times are of interest, as they effectively increase their throughput capacity with the same fixed assets. Port efficiency and prompt turnarounds are therefore mutually rewarding.

A shorter time in port is a positive indicator of a port's efficiency and trade competitiveness, although there may also be good reasons for a ship to spend more time in a port, as it may bunker, purchase goods or services, or simply load and unload high volumes of goods for import and export. Benefiting from a data set provided by MarineTraffic, which draws on automatic identification system data emitted by the world's commercial fleet, this section provides an update on the time ships spent in port during calls in 2018 and 2019, including initial trends that can be observed during that period.[12]

In 2019, more than half (55 per cent) of recorded port calls worldwide were passenger ships, followed by tankers and other wet bulk carriers (12 per cent), container ships (11 per cent) and general cargo break bulk ships (10 per cent) (table 3.2). Container ships had the fastest turnaround time, with a median of 0.69 days, an improvement of one per cent over 2018. Dry bulk carriers took the longest to load and unload – more than two days' median time. For all vessel types, 2019 recorded an increase in port calls and a slight decrease in the median turnaround time, as compared with 2018.

[12] UNCTAD calculations are based on data provided by MarineTraffic (www.marinetraffic.com). Aggregated figures are derived from the fusion of automatic identification system data with port-mapping intelligence by MarineTraffic, covering ships of 1,000 gross tons and above. Passenger ships and roll-on roll-off carriers are not included in the computation of turnaround times. Only arrivals have been taken into account to measure the number of port calls. Cases with less than 10 arrivals or 5 different vessels on a country level per commercial market as segmented are not included. The data will be updated every six months on the maritime statistics portal of UNCTAD (http://stats.unctad.org/maritime).

2. Turnaround times vary by vessel type

Container ships

The maximum vessel size of container ships in gross tons went up by 6.87 per cent between 2018 and 2019, while the increase in TEUs was even greater, at more than 10.94 per cent. The largest container ships are now de facto as big as the largest wet bulk carriers and bigger than the largest dry bulk carriers and cruise ships (table 3.2; see also chapter 2 for more details of the world fleet).

The countries with the most container ship port calls in 2019 (table 3.3, figure 3.2), were China (72,583), Japan (39,066) and the Republic of Korea (23,933). Among the top 25 countries in container port calls, only 4 recorded median turnaround times of more than one day, notably Australia, Indonesia, Viet Nam and the United States, while in Japan and Taiwan Province of China, a container ship spent a median time of less than half a day in port (table 3.3).

Section C discusses in more detail the possible determinants of why container ships may spend more time in port in some countries than in others. Most importantly, the time in port is associated with the number of containers that are loaded and unloaded during each port call.

Tankers and other liquid bulk carriers

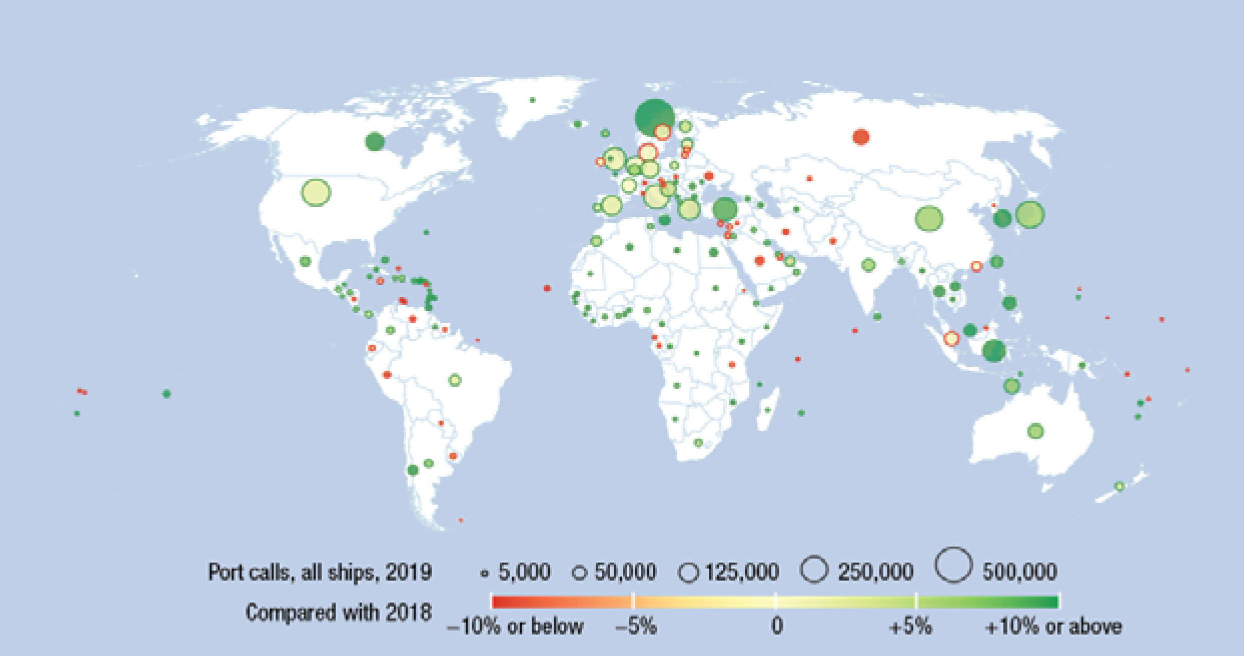
With 44,633 port calls to its name, Japan continued to record the largest number of arrivals of tankers and other liquid bulk carriers in 2019, albeit slightly less (-0.55 per cent) than in 2018. It is followed by the Netherlands (41,042 arrivals), China (40,702) and Singapore (36,187). Together, these four countries account for 30.9 per cent of the world total for this vessel type, while the top 20 countries account for 74.6 per cent.

Japan (7.4 hours) and Germany (8.5 hours) represent the shortest median turnaround times, compared with India and the United States, whose tankers spent the longest time in port. There is a close relationship between vessel sizes and time spent in port, as smaller ships take less time to load or unload. Most countries among the top 20 receive ships of 300 000 dwt and above. The exceptions are Belgium, Hong Kong, China and the Russian Federation, where port depth and infrastructure do not accommodate vessels of this size.

Dry bulk carriers

The largest dry bulk carriers of 404,389 dwt are deployed for the transportation of iron ore from Brazil to China or to a distribution hub in Malaysia. With regard to port calls, China received by far the largest number of dry bulk carriers in 2019 (60,420 arrivals), followed by Japan (30,528 arrivals) and Australia (15,399 arrivals).

Figure 3.1 Port calls, all vessel types, 2019



Source: UNCTAD calculations, based on data provided by MarineTraffic.

Notes: Ships of 1,000 gross tons and above. For data that include all countries, see http://stats.unctad.org/maritime.

Table 3.1 Recorded port calls and time in port, 2018 and 2019

Port calls	2018	2019	Change 2019 over 2018
Number of recorded arrivals	4 112 944	4 362 737	6.07
Median time in port (days)	0.970	0.966	- 0.41
Average age of vessels (years)	18	18	0.00
Average size of vessels (gross tons)	15 066	14 980	- 0.57
Maximum size of vessels (gross tons)	234 006	234 006	0.00
Maximum container-carrying capacity of vessels (20-foot equivalent units)	21 413	23 756	10.94
Total	**7.66**	**1.58**	**0.53**

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

Roll-on roll-off carriers

Japan leads the world in roll-on roll-off ship arrivals, with 34,995 port calls in 2019. It is followed by the United Kingdom (16,465), the Netherlands (12,494), Spain (11,529) and Italy (9,465). This vessel type mainly includes ferries for coastal and inter-island transport, as well as car carriers. As an island economy and major automobile exporter, Japan is particularly dependent on roll-on roll-off shipping.

Passenger ships

In 2019, Norway accounted for the largest share of port calls (535,649) of passenger ships of 1,000 gross tons, followed by the United States (213,902) and Italy (194,992). The latter two are home ports to many cruise ships that are included in this category. In the Baltic and Mediterranean seas, as well as in countries with large archipelagos, such as Indonesia, Japan, Norway, the Philippines and Turkey, maritime passenger transport often replaces buses and trains as the most economical and environmentally friendly mode of public transport.

Liquefied natural gas carriers

The number of arrivals of liquefied natural gas carriers rose significantly between 2018 and 2019 (more than 15 per cent), in line with the growing demand for this source of energy and the corresponding fleet growth (table 2.1). The countries with the most port calls in this segment were Japan (1,901), Australia (1,179) and Qatar (1,043). Among the top 20 countries, ships spent

Table 3.2 Port calls and time in port by vessel type, 2019

Vessel type	Number of arrivals	Number of arrivals, change over 2018 (percentage)	Median time in port (days)	Median time in port (days), change over 2018 (percentage)	Average size of vessels (gross tons)	Average size of vessels, change over 2018 (percentage)	Average age of vessels	Maximum size of vessels (gross tons)
Container ships	474 553	4.52	0.69	-1.09	38 172	-0.90	13	232 618
Dry break bulk carriers	446 817	3.83	1.10	-0.71	5 476	0.70	20	91 784
Dry bulk carriers	277 872	7.06	2.01	-2.14	32 011	0.22	15	204 014
Liquefied natural gas carriers	12 222	15.12	1.11	-0.15	95 469	1.79	10	168 189
Liquefied petroleum gas carriers	55 227	11.89	1.01	-0.60	10 300	-3.40	14	59 226
Passenger ships	2 378 937	6.80	-		8 859	-0.77	21	228 081
Roll-on roll off carriers	190 907	1.80	-		25 277	-0.36	19	100 430
Wet bulk carriers	526 202	6.49	0.93	-0.56	15 702	1.02	14	234 006
All	**4 362 737**	**6.07**	**0.97**	**-0.41**	**14 980**	**-0.57**	**18**	**234 006**

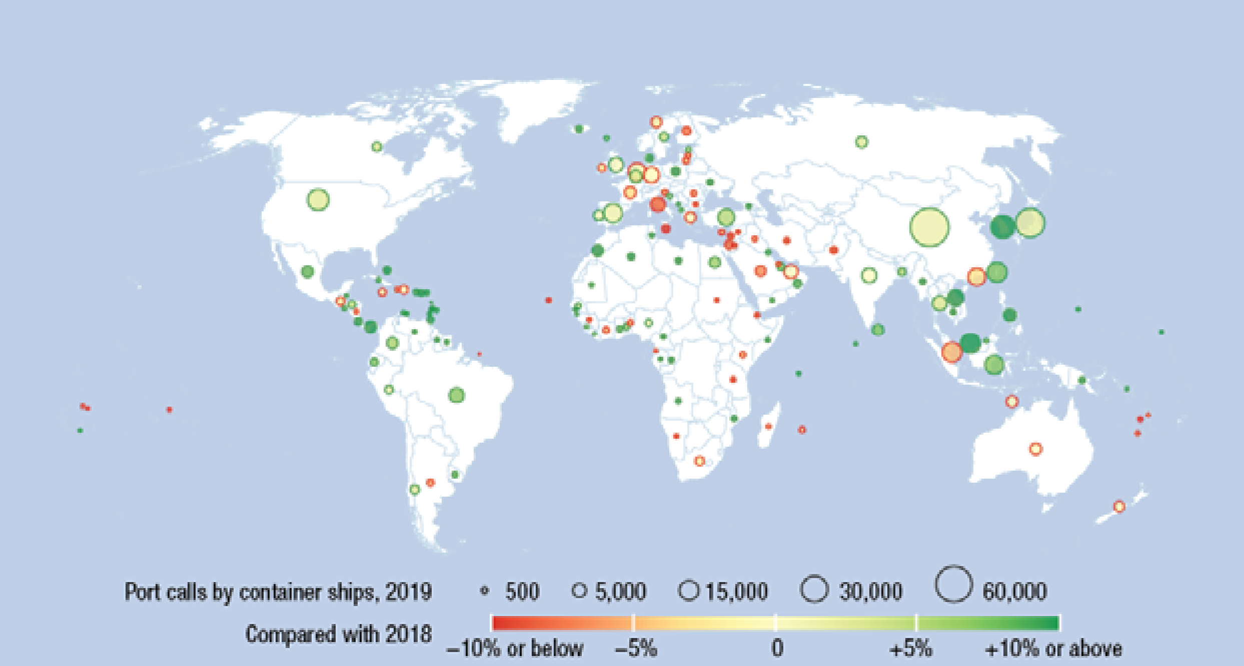
Source: UNCTAD calculations, based on data provided by MarineTraffic (www.marinetraffic.com).
Note: Ships of 1,000 gross tons and above.

Table 3.3 Port calls and median time spent in port by container ships: Top 25 countries, 2019

Country	Number of arrivals	Median time in port (days)	Average age of vessels (years)	Average size of vessels (gross tons)	Maximum size of vessels (gross tons)	Maximum cargo-carrying capacity of vessels (TEU)
China	72 583	0.60	12	50 062	232 618	23 756
Japan	39 066	0.35	12	17 205	219 688	20 388
Republic of Korea	23 933	0.58	14	30 951	232 618	23 756
United States	19 574	1.03	13	59 336	194 250	19 462
Taiwan Province of China	16 733	0.44	14	29 571	219 775	20 388
Malaysia	16 459	0.75	14	41 499	232 618	23 756
Singapore	16 299	0.77	13	54 612	228 741	21 413
Spain	15 137	0.65	14	35 592	232 618	23 756
Indonesia	14 715	1.05	14	15 475	131 332	11 356
Hong Kong, China	12 355	0.53	14	39 826	228 741	21 413
Netherlands	12 155	0.80	13	32 385	232 618	23 756
Turkey	11 011	0.63	16	34 599	176 490	15 908
Viet Nam	10 041	1.03	16	18 459	175 688	16 000
Germany	9 543	0.74	13	42 018	232 618	23 756
United Kingdom	8 395	0.73	14	36 766	232 618	23 756
India	8 211	0.91	15	46 994	153 666	13 386
Italy	8 171	0.91	15	44 772	194 849	19 462
Thailand	8 130	0.68	17	22 653	154 000	14 220
Brazil	8 050	0.73	9	62 947	119 441	11 923
United Arab Emirates	7 082	0.94	15	47 830	219 277	21 200
Philippines	5 492	0.84	15	19 124	71 786	6 800
Belgium	5 190	1.00	14	52 967	232 618	23 756
France	4 468	0.75	13	56 344	219 277	20 776
Australia	4 400	1.18	12	48 715	109 712	9 971
Panama	4 347	0.63	11	45 162	150 000	14 000
World total	**474 553**	**0.69**	**13**	**38 172**	**232 618**	**23 756**

Source: UNCTAD calculations, based on data provided by MarineTraffic.
Notes: Ships of 1,000 gross tons and above. For data that include all countries, see http://stats.unctad.org/maritime.

Figure 3.2 Port calls by container ships, 2019



Source: UNCTAD calculations, based on data provided by MarineTraffic.

Notes: Ships of 1,000 gross tons and above. For data that include all countries, see http://stats.unctad.org/maritime.

the least time per port call in Norway (eight hours on average), and the longest in Singapore (two days).

Break bulk vessels

Norway (33,564 calls), China (30,007) and the Russian Federation (28,837) are the countries with the most port calls by break bulk general cargo vessels. Among the top 20 countries in this category, Germany and Norway have the shortest median turnaround times at 0.35 and 0.33 days respectively, while in France (1.58 days), Italy (1.98 days) and the Russian Federation (1.61 days), general cargo ships spent the longest time in their ports.[13]

3. Small island economies depend heavily on general cargo ships

Break bulk general cargo ships have a declining share in the world fleet (see also chapter 2). They remain, however, particularly important for small island economies and destinations with little port traffic, where the deployment of more specialized ships may not be justified. For small island economies or countries that are archipelagos, such as Indonesia or the Philippines, break bulk general cargo vessels account for a substantial share of the countries' total port calls.

Some small island economies are among those with the longest port turnaround times for general cargo vessels, as they may lack infrastructure or specialized port equipment. Others have very short turnaround times, owing to the lack of congestion because of low frequencies and the low cargo volumes in loading and unloading (UNCTAD, 2019a). Between 2018 and 2019, the Comoros, Maldives and New Caledonia saw significant improvements both in terms of increased port calls and shorter port turnaround times. Fiji and New Caledonia are served by the youngest and most modern fleet of general cargo ships, while French Polynesia, Maldives and Saint Kitts and Nevis receive vessels that are on average more than 30 years old (table 3.4).

4. A downturn in port calls during the COVID 19 pandemic

The COVID 19 crisis led to fewer port calls for most vessel types during the first half of 2020 (figure 3.3).

Liquefied natural gas and liquefied petroleum gas carriers and tankers (wet bulk carriers) continued to record increases in port calls during the first quarter of 2020. In the second quarter, however, all vessel types experienced a decline in the number of port calls. The hardest hit were roll-on roll-off vessels, which include ferries and other vessels that also carry passengers.

With regard to container ship port calls, the number of arrivals started to fall below 2019 levels about week 12 (mid-March 2020) and began to recover gradually about week 25 (third week of June) (figure 3.4). By mid-June, the average number of container vessels arriving weekly at ports worldwide had sunk to 8,722, an 8.5 per cent year-on-year drop. Since then, the average weekly calls started to recover, rising to 9,265 in early

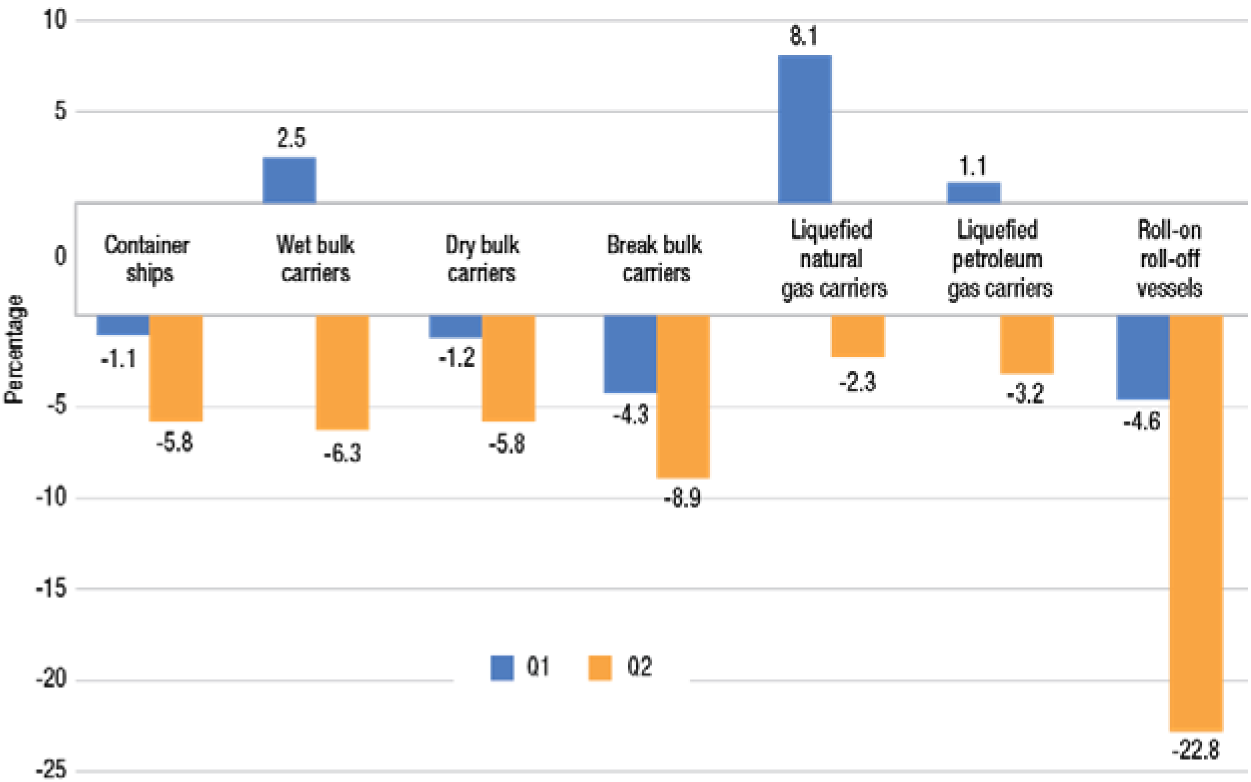
13 See http://stats.unctad.org/maritime for the complete tables concerning all vessel types.

Table 3.4	Port calls and median time spent in port, general cargo ships, 2019 (Selected small island economies)						
Country or territory, break bulk cargo	**Number of arrivals 2019**	**Number of arrivals, change 2019 over 2018 (percentage)**	**Median time in port, 2019 (days)**	**Median time in port, change 2019 over 2018, (percentage)**	**Average age of vessels (years)**	**Average size of vessels (gross tons)**	**Maximum size of vessels (gross tons)**
American Samoa	57	-6.6	0.63	10.3	16	9 494	18 100
Antigua and Barbuda	193	12.9	0.39	3.4	22	5 797	17 644
Aruba	59	- 51.2	0.73	82.3	19	9 729	28 805
Bahamas	464	-15.3	0.41	28.9	26	4 831	91 784
Barbados	309	-5.8	0.56	4.3	22	6 813	22 698
Cabo Verde	360	36.9	0.63	-10.6	21	5 095	46 295
Cayman Islands	153	-14.0	0.56	3.8	24	7 513	27 818
Christmas Island	50	-35.1	0.43	-10.7	14	5 913	10 021
Comoros	197	32.2	1.03	-25.3	15	6 352	24 960
Curaçao	320	-31.9	0.53	1.9	18	3 285	16 137
Dominican Republic	107	-0.9	0.40	-1.2	16	6 586	14 413
Fiji	457	40.6	0.95	39.7	7	4 914	40 393
French Polynesia	555	-12.9	0.19	20.4	39	3 165	54 529
Grenada	124	-23.5	0.58	43.8	24	7 016	16 639
Guam	67	-25.6	2.11	-2.5	20	8 979	61 185
Guernsey	339	63.0	0.14	13.4	25	1 687	2 601
Haiti	384	-4.5	0.96	1.9	21	4.760	24 140
Jamaica	576	1.4	0.90	-10.6	13	9.099	29 688
Maldives	101	44.3	0.49	-89.1	31	4.041	20 965
Martinique	193	-9.0	0.40	2.5	17	8.628	27 828
Mauritius	133	-10.1	3.48	47.6	21	5 317	21 483
Mayotte	25	-66.2	2.23	-8.1	11	7 219	24 960
Micronesia	73	-24.0	0.35	-53.6	22	4 352	9 924
New Caledonia	549	52.5	1.24	-24.0	8	7 507	29 829
Reunion	53	-11.7	1.30	-13.6	12	8 323	21 483
Samoa	68	-2.9	0.54	41.9	15	9 045	18 100
Seychelles	137	-18.5	5.22	-8.7	24	5 384	16 803
Sint Maarten	179	-39.9	0.38	-25.0	18	6 374	22 698
Solomon Islands	50	-38.3	1.75	2.9	17	10 509	18 468
Saint Kitts and Nevis	207	6.2	0.27	14.3	35	3 274	14 413
Saint Lucia	287	8.7	0.41	-10.6	28	5 892	16 137
Saint Vincent and the Grenadines	116	-38.6	0.38	23.6	16	9 761	16 137
Timor-Leste	164	6.5	0.98	-2.5	16	4 339	9 719
Tonga	82	3.8	0.39	-12.3	15	8 363	18 100
Trinidad and Tobago	584	-14.4	0.91	13.6	16	7 326	30 488
Turks and Caicos Islands	197	-27.0	0.43	-3.6	19	1 749	2 191
Tuvalu	69	-4.2	11.21	-19.9	28	4 047	6 965
Vanuatu	17	-55.3	0.83	21.4	15	15 551	18 100
Word total	**446 817**	**3.8**	**1.10**	**-0.7**	**20**	**5 476**	**91 784**

Source: UNCTAD calculations, based on data provided by MarineTraffic.

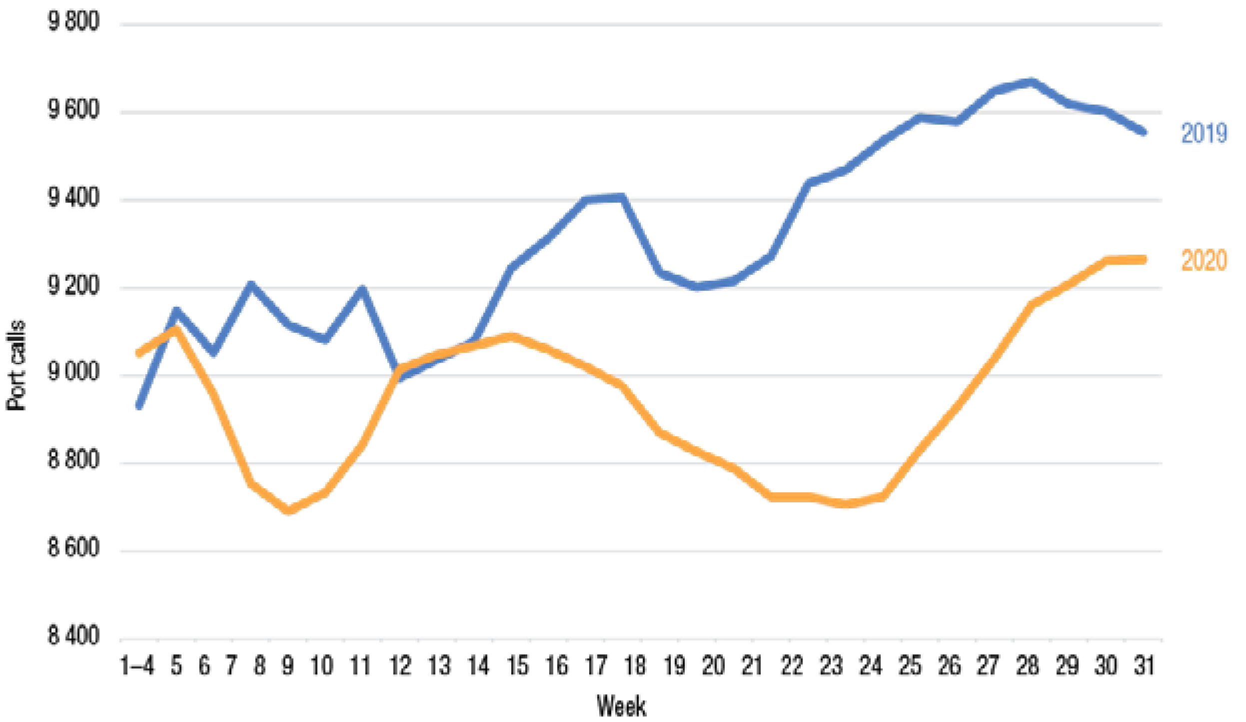
Note: Ships of 1,000 gross tons and above. For data that include all countries, see http://stats.unctad.org/maritime.

Figure 3.3 Global change in the number of port calls, first and second quarters of 2020 compared with the first and second quarters of 2019, selected vessel types



Source: UNCTAD calculations, based on data provided by MarineTraffic.
Abbreviation: Q, quarter.

Figure 3.4 Number of weekly container ship port calls worldwide, moving four-week average, 2019 and 2020



Source: UNCTAD calculations, based on data provided by MarineTraffic.

August 2020, just 3 per cent below the levels recorded 12 months earlier. For a more detailed analysis by region, see UNCTAD, 2020a (https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2465).

5. Future uses of automatic identification system data to assess port and shipping performance

The automatic identification system was initially developed and introduced as a tool to support navigational safety. Today, the signals transmitted through the system are used to track the movement of vessels, even if the owners of those vessels may prefer otherwise. Without publicly available data, the data and analysis presented above would not be possible. The transmission of signals from automatic identification systems is mandatory and increasingly scrutinized, and the data coverage is continuously improving. Combining automatic identification system-derived statistics with other sources of data and information can help respond to growing demands for optimization of the supply chain, monitoring of emission data and trade forecasts.

Optimizing the supply chain

Already today, initiatives such as port-call optimization benefit from automatic identification system data (UNCTAD, 2020b). Beyond the seaside of the operation, the whole supply chain can benefit from exchanging data, including automatic identification system data on ship movements, but also data on other modes of transport, ports and the goods that are being traded. In this context, digitalization, artificial intelligence, blockchain, the Internet of things and automation are of growing relevance. They help optimize existing processes, create new business opportunities and transform supply chains and the geography of trade (UNCTAD, 2019b).

Notwithstanding the potential opportunities and benefits offered by the automatic identification system, including low-cost global access, its use requires capacity-building and investments in digitalization, especially in developing countries. There is a need for policy design at the national and international levels to ensure that developing countries can benefit from the automatic identification system and the digitalization of maritime transport (UNCTAD, 2019b).

Trade statistics and forecasts

Automatic identification system data do not include information about the cargo the ships carry. However, by combining the data on vessel moves and drafts with information on vessel type, trade flows and countries of departure and destination, automatic identification system data can help obtain an increasingly exact and up-to-date picture of trade flows (Arslanalp et al., 2019; Cerdeiro et al., 2020; United Nations, 2020; World Bank, 2020). Combined with information on the speed of vessels, port departures and idle ships, this can serve to produce nowcasts and forecasts of trade and economic growth. It can also help verify trade statistics by checking published trade data against the vessel moves that would be necessary to actually transport those goods. Such efforts would benefit from further standardization of data.

Reducing emissions

Shipping will have to move away from carbon. Initiatives such as the Getting to Zero Coalition, supported by UNCTAD, aim to reduce carbon-dioxide emissions from shipping to net zero (Global Maritime Forum, 2020). A ship's emissions depend on numerous factors, including vessel size, engine type, fuel used and speed. Automatic identification system data – combined with information on the ship's engine and fuel – can help assign carbon-dioxide emissions to the country of the vessel's flag or the country's waters where the carbon dioxide is being emitted. Section E below provides an example of such use of automatic identification system data.