3

Freight rates, maritime transport costs and their impact on prices

This chapter reports on recent developments in freight rates and transport costs. It covers 2020 and the first half of 2021, tracking changes in demand and supply across key shipping markets. It considers the immediate outlook for freight markets and examines the impact on prices.

As indicated in previous chapters, the COVID-19 pandemic led to a sudden dip in international seaborne trade. But by late 2020 there had been a swift rebound mainly in container and dry bulk shipping. The recovery in container trade flows, which was mainly on East-West containerized trade lanes, created a series of logistical challenges and hurdles, pushed up rates and prices, increased delays and dwell times, and undermined service reliability. As a result, there have been calls for more government intervention and regulatory oversight to mitigate any unfair market practices.

Sustained higher container freight rates would increase costs in global supply chains which could work their way through to higher consumer prices, with adverse economic effects globally – but particularly on the small island developing states (SIDS) and the least developed countries (LDCs) whose consumption and production depend more on international trade. There have been similar surges in trade and prices for dry bulk freight. The situation for tanker shipping, however, has been very different: a drop in global fuel demand and high carrying capacity have pushed tanker rates to record lows.

This chapter also highlights the structural determinants that shape transport cost such as port infrastructure, trade facilitation measures, liner shipping connectivity, and bilateral trade imbalances.

Freight rates, maritime transport costs and their impact on prices

MARITIME FREIGHT RATE MARKETS

Record-breaking freight rate levels

As of late 2020 and into 2021 freight rates surged across **containerised and dry bulk shipping markets** and hit record highs

Tanker markets came under pressure with tanker rates reaching low levels

Container freight rates

Skyrocketed amid surge in demand for container shipping and limited capacity including container shortages and congestion at ports

Dry bulk freight rates

Reached record breaking levels, driven by solid growth in demand that exceeded fleet growth

Tanker freight rates

Fell to record lows as global fuel demand decreased and the supply of vessel carrying capacity remained high

SIMULATED IMPACT OF CONTAINER FREIGHT RATE SURGES

Hardest hit will be SIDS

Simulation assumption:

Sustained increase in container freight rates

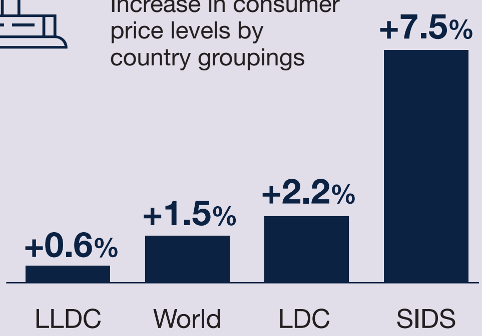
+243%

Simulation results:

Increase in global import price levels

+11%

Increase in consumer price levels by country groupings



SIMULATED IMPACT OF IMPROVING MARITIME TRANSPORT COST DETERMINANTS

Simulation is conducted using the new dataset developed by UNCTAD and the World Bank

Simulation assumption:

Improving structural determinants

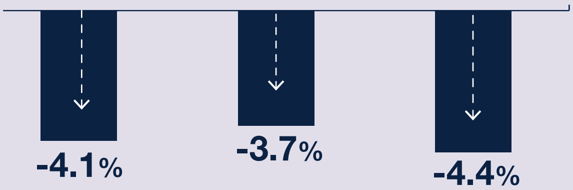
Port infrastructure

Trade facilitating environment

Shipping connectivity

Simulation results:

Reduction in maritime import transport costs



A. RECORD-BREAKING CONTAINER FREIGHT RATES

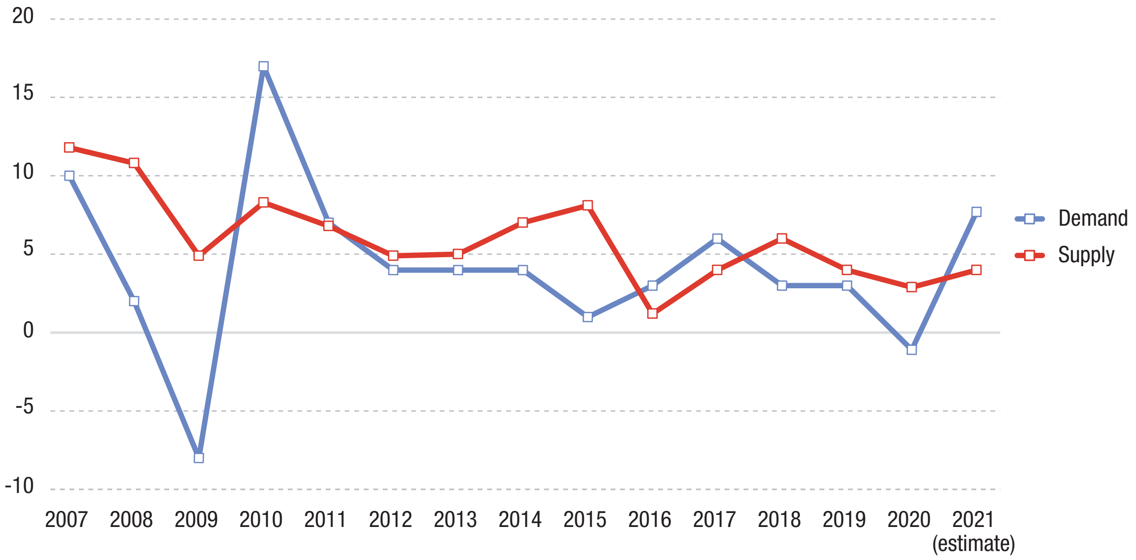
In 2020, lockdown measures and other impacts of COVID-19 suddenly cut the demand for containerized goods. April and May 2020 were the worst months: by the end of May 2020, a record 12 per cent of global container capacity was idle or inactive – 2.7 million TEU (BIMCO, 2020. Clarksons Research, 2021a). Liner shipping companies responded with measures to mitigate costs, manage capacity and sustain freight rates. By the second half of 2020, the situation had reversed, but this sudden boost in demand stumbled into limited capacity and congested ports.

1. In mid-2020 high demand and limited capacity led to rocketing spot freight rates

In the second half of 2020, demand for container shipping started to pick up and absorb spare capacity. Vessel supply capacity remained limited but idle container shipping capacity levels started to decline in line with growing demand as trade continued to recover. By the end of June 2020, idling was 9 per cent, but by July this proportion had fallen to 6 per cent, and by August to 4 per cent. By the end of September 2020, it was down to 3.5 per cent (going below the 4.1 per cent average level of idling for full year 2019) (Clarksons Research, 2021a).

In 2020, global container fleet capacity expanded by almost 3 per cent, to 281,784,000 dwt (see also chapter 2), while container trade contracted by 1.1 per cent to 149 million TEU (figure 3.1).

Figure 3.1 Growth of demand and supply in container shipping, 2007–2021, percentage



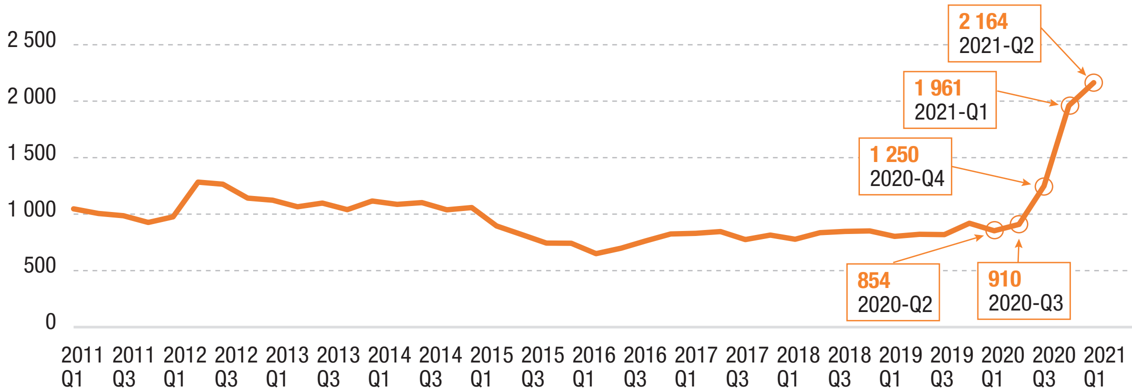
Source: UNCTAD secretariat calculations. Demand is based on data from chapter 1 – figure 1.5, and supply is based on data from Clarksons Research, *Container Intelligence Monthly*, various issues.

Notes: Supply data refer to total capacity of the container-carrying fleet, including multipurpose and other vessels with some container-carrying capacity. Demand growth is based on million TEU lifts.

In an effort to maintain freight rates during the period of lower demand, carriers restricted capacity. Then as demand picked up, they released more capacity but by that time the supply was being constrained by other factors, notably port congestion and equipment shortages which kept vessels waiting, especially in West Coast North America. The result was exacerbated disruption and inefficiency at port.

By the end of 2020, freight rates had surged to unexpected levels. This was reflected in the China Containerized Freight Index (CCFI) for both short- and long-term contracts (figure 3.2). In the second quarter of 2020, the CCFI stood at 854 points, but by the fourth quarter was 1,250 points, and for the first and the second quarters of 2021 had reached new records, beyond 2,000 points.

Figure 3.2 CCFI composite index, 2011-2021 (quarterly)



Source: Clarkson *Shipping Intelligence Network* Timeseries, Shanghai Shipping Exchange.

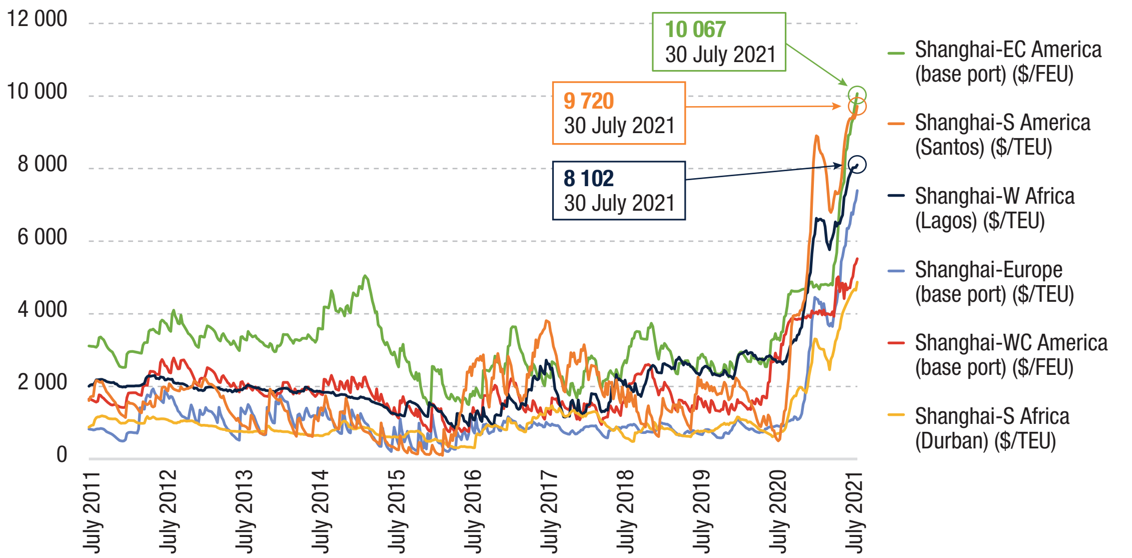
Note: The CCFI tracks spot and contractual freight rates from Chinese container ports for 12 shipping routes across the globe, based on data from 22 international carriers.

2. Container shortages, port congestion and delays result in higher freight rates, fees and surcharges

Towards the end of 2020 and into 2021, container shortages and congestion at ports, along with other disruption, led to record container freight rates, notably on the routes from China to Europe and the United States. These are reflected in the Shanghai Containerized Freight Index (SCFI) which covers cargo departing from Shanghai, China (figure 3.3). In June 2020, SCFI spot rate on the Shanghai-Europe route was less than $1,000/TEU but by the end of 2020 had reached around $4,000/TEU and remained firm throughout the first quarter of 2021. By the end of April, despite a 3 per cent increase in supply capacity (Clarksons Research, 2021a), the SCFI spot freight rate on the Shanghai-Europe route surged to $4,630/TEU, and by the end of July has reached $7,395/TEU.

Freight rates also escalated on the China-United States trade lane, and, faced with backlogs and longer waiting times, shipping lines have also been adding extra fees and surcharges. In the last quarter of 2020, on the Shanghai-West Coast North America route capacity expanded by 5 per cent and in the first quarter of 2021 by a further 7 per cent (Clarksons Research, 2021a). Nevertheless, the SCFI spot rate reached around $4,500/ forty-foot equivalent unit (FEU) in April 2021, compared to $1,600/FEU in April 2020, and climbed further to $5,200/FEU in July 2021. The trend was similar on routes from Asia to the East Coast. In the first six months of 2021, SCFI spot rates on the Shanghai-East Coast North America route more than doubled, and

Figure 3.3 Shanghai Containerized Freight Index weekly spot rates, 1 July 2011 to 30 July 2021, selected routes



Source: UNCTAD secretariat, based on data from Clarkson *Shipping Intelligence Network*.

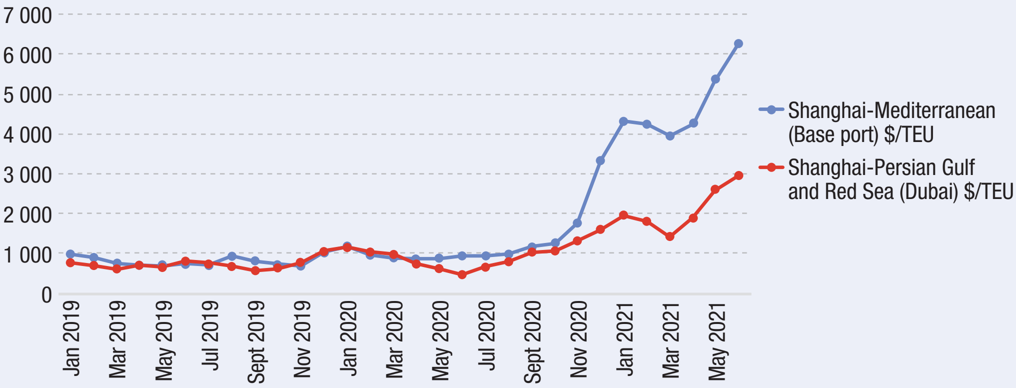
by the end of July 2021 had reached $10,067/FEU (figure 3.3). Moreover, this does not take into account the premiums cargo owners were often charged to get any certainty that their boxes would be moved promptly.

The surge in spot freight rates also extended across developing regions, including South America and Africa. On the China to South America (Santos) route the rate had been $959/TEU in July 2020 but by the end of July 2021 had reached $9,720/TEU. Over the same period, rates on the Shanghai to West Africa (Lagos) route increased from $2,672/TEU to $8,102/TEU. There was also a surge in rates from China to the Arab region. Box 3.1 provides further information on the impact of COVID-19 on maritime freight in the Arab region.

Box 3.1 Impact of COVID-19 on maritime freight rates in the Arab region

Fluctuations in freight rates reflect changes in lockdown policies and varying speeds of recovery, as well as the impact of shortages of both containers and ships and congestion in key ports and shipping nodes. These surges are likely to be amplified in most of the low- and middle-income countries of the Arab region, especially those suffering from conflicts or economic or financial crises which have had major impacts on patterns of production and consumption – and on maritime freight rates. Between October 2020 and June 2021 the SCFI from Shanghai to Dubai rose by 176 per cent and from Shanghai to the Mediterranean ports by 400 per cent.

Evolution of SCFI spot rates from Shanghai to Arab ports



Source: UNCTAD/ESCWA calculations based on data from Clarksons Research.

To alleviate the impact on consumer prices, some countries have adopted special measures. In Lebanon, for example, when calculating the customs fees on imported goods, the customs authorities are still using the official exchange rate, which is far below the black-market exchange rate. In Jordan, when calculating customs fees on imported goods, customs authorities have put a ceiling on freight rates. According to the International Chamber of Navigation in Beirut, both measures did slightly alleviate the impact on consumers. But these subsidies may be difficult to sustain, so it will be important to consider the economic and financial evidence, to see how they compare with more conventional trade facilitation procedures.

There have also been initiatives to address the impact of COVID-19 at the regional level. In October 2020, ESCWA/UNCTAD published a working paper 'COVID-19: Impact on Transport in the Arab Region', which was summarized in a policy brief. On 24 November and 8 December there was a remote round table within the activities of the 21st session of ESCWA committee on Transport and Logistics. This was serviced by a parliamentary paper on the 'Impact of the COVID-19 pandemic on transport in the Arab region'.

In addition, in partnership with UNCTAD and other UN regional commissions, ESCWA implemented several activities within the UN Development Account project on transport and trade connectivity in the age of pandemics. This included producing material on 'Coronavirus Disease (COVID-19): Trade and Trade Facilitation Responses in the Arab Region' as well as a report on the 'Collective Application of eTIR Across a Land Transport Corridor Connecting East Mediterranean to GCC countries (Lebanon-UAE)'. On 16–17 December 2020, in cooperation with ECE, International Road Transport Union (IRU) and the Euromed Transport Support Project, ESCWA developed three questionnaires for banks, firms and policy makers aimed at gauging the conditions for trade financing in the region.

ESCWA also organized an online capacity building workshop on 'Implementation of the eTIR International System in the ESCWA region'. Also, in cooperation with ECE, it helped connect the national customs system of Tunisia to the international eTIR system.

Finally, ESCWA has provided substantive support and input to the initiative led by the Department of Transport and Tourism of the League of Arab States on addressing the impact of COVID-19 – with recommendations that were categorized according as short term (containing), medium term (recovery) and long term (resilience to future crises). These recommendations were adopted by the 33rd session of the Council of the Arab Ministers of Transport, held in Alexandria, Egypt, on 21–22 October 2020.

Contribution from ESCWA.

High shipping costs arising from logistical bottlenecks and lack of containers and equipment

Since late 2020, shipping costs have increased in part because of a shortage of containers. Containers are shipped full from export-oriented locations, notably in Asia, and many usually return empty. As Asia slowly began to recover, other countries remained under national lockdown and restriction so the importing countries could not return containers. The resulting shortage of empty containers was exacerbated as carriers introduced blank sailings where empty containers were left behind and failed to be repositioned. These impediments led to higher container dwell times at ports, and empty containers not returning to the system where they were most needed (UNCTAD, 2021). This increased shipping costs as shippers were reported to be paying premium rates to get containers back (CNBC, 2021), in addition to surcharges arising from port congestion and delays, including delays in returning equipment.

With containers scarce and ports suffering from congestion, shippers, freight forwarders, and importers were charged increasingly higher demurrage and detention fees. Between 2020 and 2021, across the world's 20 biggest ports, the average demurrage and detention charge doubled – equivalent to $666 for each container (Container xChange, 2021).

3. Surge in spot freight rates leading to increases in contracted rates

An important part of containerized trade is carried out at confidential contract rates negotiated between shippers and shipping lines. These rates are influenced by prevailing market conditions so in 2021 when spot rates were high, contract rates were correspondingly high and some were negotiated quickly to secure deals. Shipping lines typically gave priority to larger and more established shippers – leaving out smaller ones who were often unable to renegotiate. For their part, shippers aiming to hedge against future increases and uncertainties were increasingly seeking multi-year contracts. In 2021, many shippers signed trans-Pacific volume contracts for between $2,000/FEU and $3,000/FEU (Hellenic Shipping News, 2021b) – far higher than previous rates on the same routes. See also table 3.1 on contract freight rates which includes all surcharges including terminal handling charges.

Table 3.1 Contract freight rates, inter-regional, 2018–2020, $ per 40-foot container (FEU)

From	To	Average	2018	2019	2020
Africa	Africa	1 862	1 812	1 849	1 924
	Asia	758	748	750	775
	Europe	1 607	1 431	1 643	1 747
	Latin America	1 950	2 010	1 860	1 979
Asia	Africa	1 946	1 800	1 927	2 112
	Asia	768	737	747	821
	Europe	1 848	1 782	1 847	1 916
	Latin America	2 198	2 290	2 075	2 230
	North America	2 580	2 426	2 603	2 711
	Oceania	1 803	1 770	1 790	1 850
Europe	Africa	1 701	1 595	1 650	1 858
	Asia	947	967	870	1 004
	Europe	887	804	881	976
	Latin America	1 232	1 019	1 302	1 376
	North America	1 838	1 518	1 742	2 256
	Oceania	2 002	1 996	1 933	2 077
Latin America	Africa	1 910	1 778	1 951	2 000
	Asia	1 796	1 623	1 963	1 802
	Europe	1 751	1 313	1 977	1 961
	Latin America	1 529	1 349	1 699	1 539
	North America	1 716	1 521	1 882	1 745
North America	Africa	2 994	2 890	3 112	2 981
	Asia	1 129	1 009	1 111	1 269
	Europe	1 097	858	1 109	1 323
	Latin America	1 353	1 254	1 318	1 486
	North America	1 516	1 534	1 429	1 584
	Oceania	2 722	2 538	2 634	2 996

Source: UNCTAD, based on data provided by TIM Consult Market Intelligence https://timconsult.com/service_areas/transport/benchmarking/.

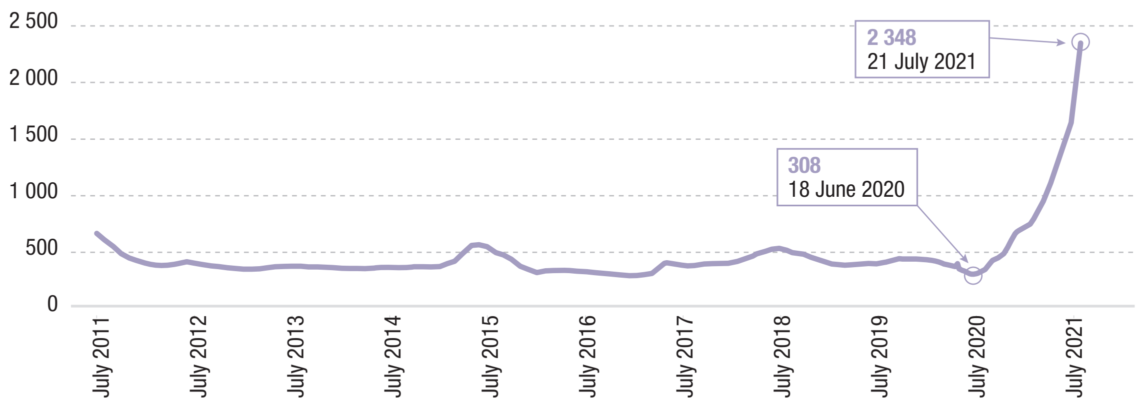
Note: The data set provides regional averages for forty-foot container dry cargo freight, as negotiated for routes where rates were available for at least 5 shippers and at least 500 TEU per year on port-pair basis.
Rates are "gate-in gate-out", i.e., including terminal handling charges and all charges and surcharges of ocean transport. Not included are pre- and on-carriage as much as classical administrative services of forwarders (customs clearance, booking and invoice control fees, etc.). The average is unweighted, based on representative main ports. Trade imbalance is also impacting freight rates.

The new data set, provided by TIM Consult Market Intelligence as per table 3.1, enables an overview of actual basic freight rates on different routes, including inter-regional routes, and their development over time.[1] Imbalanced trade flows mean that transport costs tend to be higher in the direction of the high-demand region thereby impacting freight rates (Jonkeren, Olaf, et al, 2011). Between 2018 and 2020, rates on the Asia-Europe leg, for example, were twice as high as those on the Europe-Asia leg. Similarly, rates for exports from Asia to North America were twice as import rates. As for the Asia-Africa trade the ratio was 2.6, and intra-African freight rates were 2.4 times higher than intra-Asian rates. Over this period the most volatile rates were those to and from Latin America.

4. Trends in charter market rates in sync with spot freight rates

In the first half of 2020, the COVID-19 crisis also reduced container ship charter rates, especially for larger ships. This was a period of falling demand, ship idling, capacity withdrawal, and blank sailings. But the situation reversed in the second half of 2020 with increasing demand for ships of all sizes. In June 2020, the New ConTex index fell to 308 points but by December 2020 had more than doubled to 687 points (figure 3.4). In 2021, the continuing imbalance between demand and supply pushed the ConTex average to unforeseen levels reaching 1,645 points in June and 2,348 in July.

Figure 3.4 New ConTex index, July 2011–July 2021



Source: UNCTAD secretariat, based on data from the New ConTex index produced by the Hamburg Shipbrokers Association. See http://www.vhss.de (Accessed on 25 July 2021).

Notes: The New ConTex is based on assessments of the current day charter rates of six selected container ship types, which are representative of their size categories: Type 1,100 TEUs and Type 1,700 TEUs with a charter period of one year, and Types 2,500, 2,700, 3,500 and 4,250 TEUs with a charter period of two years.
Index base: October 2007 – 1,000 points.

5. Container shipping profits are high, as are short and medium terms freight rates

High freight rates have boosted the profits of global container shipping companies. In the first quarter of 2020 their operating profits – earnings before interest and tax – were $1.6 billion, but in the same quarter of 2021 reached $27.1 billion. In 2020 the full-year profit of these carriers was around $25.4 billion, but 2021 it is likely to be an unprecedent $100 billion (Drewry, 2021). And this at a time of pandemic-related disruptions, congestion at ports and a persistent shortage of containers.

[1] TIM Market Intelligence Initiative Global Ocean Transport.
Overview & Methodology: TIM Consult are operating the Market Intelligence Initiative (MII) in global ocean transport (Full Container Load and Less Than Container Load) in support of a Community (consortium) of world-class enterprises (shippers only). The analyses cover ocean transport on more than 12,000 port pairs, pre- and on-carriage (all modes) and door-door-transport. The benchmarking as well as the monitoring of freight indices and service levels is updated on a monthly, quarterly, and annual basis. All input data is provided by shippers and represents actual agreements and volume allocations. No unnegotiated or not actually allocated rate information is included. Continuous data input is equivalent to approximately five per cent of world container transport. Data input is carefully cleansed by an expert team plus all strategic and operative drivers of rate and service levels as much as procurement performance clarified. The analyses and assessment of shippers' agreements are conducted by accurate segmentation (by box type, box size, port pair, process setup) and harmonization (normalization), taking into account all cost and service level drivers in full transparency. The rate benchmarking and the index information provided to UNCTAD are given on gate-in-gate-out level including all ocean transport-related charges and surcharges. Not included are pre- and on-carriage as much as classical administrative services of forwarders (customs clearance, booking and invoice control fees, etc.). MII members range from 1,000 TEU to 500,000 TEU per year. www.timconsult.com.

Increased earnings have encouraged carrier to order new ships. At the beginning of 2021 the orderbook for container ships was similar to that in 2018. As noted in chapter 2, the surge in new orders was also prompted by low prices for new, larger vessels and by the availability of ship financing.

Following the 2008–2009 financial crisis there was a similar rush in orders such that the container ship order book represented about 60 per cent of the global fleet, and new vessels started entering the market only a year after the crisis, leading to overcapacity and low freight rates. This is unlikely to happen now. Indeed the new ships are still unlikely to meet the demand. In recent years, shipping companies were faced with low earnings and uncertainties about complying with new IMO emission requirements, so had postponed placing orders (FitchRatings, 2021a). As it usually takes two to three years between the placement of vessel orders and delivery, the supply-demand imbalance is unlikely to be resolved in the short term so rates should remain high.

Indeed even the arrival of new ships may not be enough to reduce and stabilize container freight rates. Global freight rates will remain high until shipping supply-chain disruptions are unblocked and back to normal, and port constraints and terminal efficiencies are tackled (Hellenic Shipping News, 2021a). This would entail investing in new solutions, including infrastructure, freight technology and digitalization, and trade facilitation measures.

Moreover, even when they have new capacity, container lines faced with prolonged port congestion and closures may take capacity out of the system – keeping freight rates high. It can be argued that port congestion on the United States West Coast was initially caused by carriers responding to increased demand by inserting more capacity – but ports were then unable to handle the resulting surge. Moreover, despite recent improvements, overall port performance remains the lowest it has been in ten years of records (Global Maritime Hub, 2021).

All the above suggests that high freight rates may be sustained in both short and medium terms. This could have lasting effects on trade and global supply chains. By end of 2020 and early 2021, Europe was facing shortages of consumer goods imported from Asia – from home furnishings, bicycles and sports to children's toys and dried fruits. Some companies have stopped exporting to certain locations while others have been looking to shorten their supply chains by looking for goods or raw materials from nearer locations (Financial Times, 2021).

Another example is Viet Nam's exports of pepper. According to the Viet Nam Pepper Association, higher logistics costs have resulted in a loss of export markets. In 2020, for exports to the United States, the cost per 40-foot container was $2,000 to $3,000 but in the first six months of 2021 this had soared to an average $13,500. For exports to the European Union there was a corresponding increase, from $800-1,200 to $11,000. This caused importers to switch to pepper from Brazil; for the United States the shipping cost is only a third of that from Viet Nam and for the European Union only one tenth (Vietnamplus, 2021).

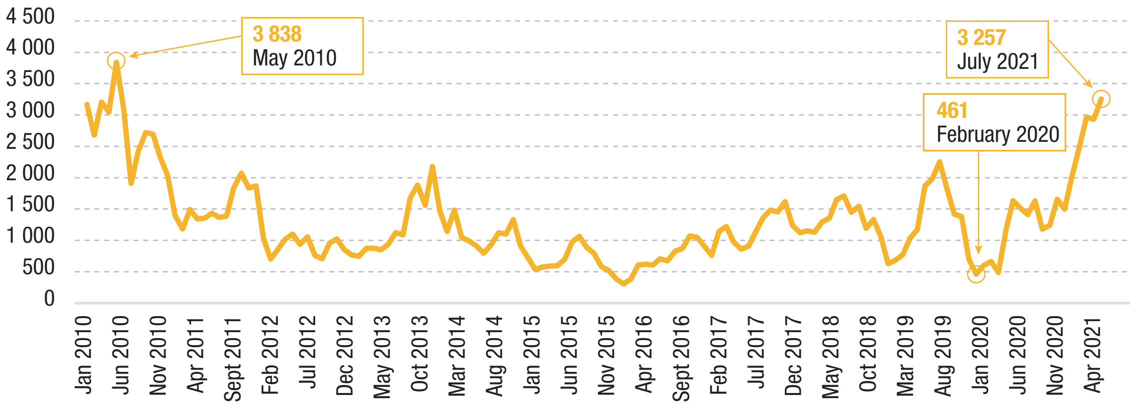
Shipping cost escalation, if sustained, would not only affect exports and imports, as well as production and consumer prices, but also the prospects for short- and medium-term economic recovery. A number of governments are worried about this, including China, Republic of Korea, United States, and Viet Nam, and have raised concerns about the shipping companies.[2] In China, faced with record highs in September 2020, the authorities had put pressure on carriers on the Transpacific routes for both pricing and capacity management and there were suggestions of setting a ceiling (Financial Times, 2020). In the Republic of Korea, to ensure that small and mid-sized shippers have access to capacity the government has announced a plan to subsidize shipping rates – a 20 per cent discount on freight rates and guaranteed shipping space if they sign long-term service contracts with domestic shipping lines (JOC.com, 2021).

B. DRY BULK FREIGHT RATES ALSO REACH HIGHS

In the first half of 2020, the demand shock from the COVID-19 pandemic added downward pressure to an overly supplied market and led to a drop in dry bulk shipping freight rates. The second half, in contrast, saw a rebound in demand for dry bulk cargo, particularly for iron ore and grain into China. Together with slower growth in the active fleet this pushed up freight rates. This was reflected in the Baltic Exchange Dry Index, which measures the cost of shipping various raw materials, such as coal, iron ore, cement, grain and fertiliser (figure 3.5). In February 2020 this stood at only 461 points but by July 2021 had reached 3,257 points.

[2] See: https://www.ft.com/content/a013548c-9038-4798-9b2e-f431c4eb2fba; https://splash247.com/chinese-authorities-say-there-needs-to-be-a-rates-ceiling-saade/; https://www.lloydsloadinglist.com/freight-directory/news/EU-shippers-call-for-box-line-competition-scrutiny/78198.htm#.YN3KJ0w6-Uk; and https://www.bloomberg.com/news/articles/2021-02-04/freight-cost-pain-intensifies-as-pandemic-rocks-ocean-shipping.

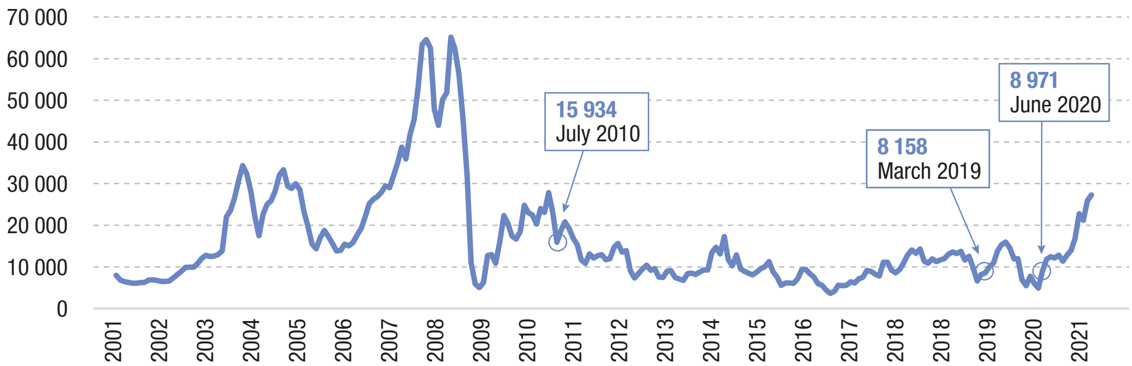
Figure 3.5 Baltic Exchange Dry Index, January 2010–July 2021



Source: UNCTAD, based on data from Clarkson *Shipping Intelligence Network*.

Freight rates were high through the first half of 2021 as a result of continuing higher demand, combined with fewer new vessel deliveries and increased scrapping activity. Rates were also affected by delays caused by port congestion. The number of vessels caught up in port congestion rose from 4 per cent of the fleet in the fourth quarter of 2020 to 5 per cent in the first quarter of 2021. This was mainly due to increases of exports of iron ore and grain products from Brazil which blocked up to 100 Capesize and Panamax vessels in Brazilian ports during February and March 2021 (Danish Ship Finance, 2021). The strength of the dry bulk market was good for carriers. In May 2020 the average monthly earnings of all bulkers were $4,894/day, but by June 2021 they were $27,275/day – the highest rates in a decade (figure 3.6).

Figure 3.6 Average weighted earnings all bulkers ($/day), July 2001–July 2021



Source: UNCTAD, based on data from Clarkson *Shipping Intelligence Network*.

Looking ahead, dry bulk demand should continue to grow and the capacity should be manageable so rates are likely to remain high. The orderbook is only around 6 per cent of the existing fleet capacity, the lowest level in three decades (Clarksons Research, 2021b). Future freight rates will be largely determined by demand growth, particularly from China, but the market will also be affected by the ongoing energy transition and shifts in fuel mix choices. However, high freight rates could stimulate newbuild orders so that in the medium term, supply capacity could exceed demand.

C. TANKER FREIGHT RATES DIP TO THE LOWEST LEVELS EVER

In the first half of 2020, there was a surge in tanker freight rates, boosting profits for tanker shipping companies. In the second half of the year the COVID-19 impacts weakened demand and rates started to drop in an oversupplied market. By January 2021, oil tanker spot earnings were $5,237/day, and by July had fallen to $2,753/day, the lowest levels ever (figure 3.7). Given current low global demand and future uncertainties, short-term tanker freight rates will probably remain low.

Figure 3.7 Average earnings, all tankers, July 2011–July 2021 (United States dollar per day)

Source: UNCTAD, based on data from Clarkson *Shipping Intelligence Network*.

D. ECONOMIC IMPACT OF HIGH CONTAINER FREIGHT RATES, PARTICULARLY IN SMALLER COUNTRIES

Containers offer efficient shipping services for a wide range of consumer and industrial commodities, including meats, beverages, textiles, and computers and by 2020 accounted for 17 per cent of the total volume of seaborne trade.[3] So, a surge in container freight rates will add to production costs which can feed through to consumer prices. This can slow national economies, particularly the structurally weak ones such as SIDS, LDCs, and landlocked developing countries (LLDCs) – whose consumption and production patterns are highly trade dependent. In 2019, for LDCs and LLDCs, merchandise imports made up 24 per cent of GDP, and for SIDS 58 per cent – compared with the global average of 21 per cent.[4]

1. High freight rates increase import and consumer prices, especially in SIDS

UNCTAD has simulated the impact of the current surge in container freight rates, concluding that at the global level import price levels will rise by 10.6 per cent, with an estimated one-year time lag (figure 3.8). This is an average for 200 economies for which data are available. The container freight rate surge refers to a 243 per cent increase in the CCFI between August 2020 and August 2021 and the simulation assumes that the levels in August 2021 will be sustained over the simulation period (technical note 1).

The impact is greatest in SIDS most of whose imports arrive by sea. In 2019, globally 27 per cent of total imports were seaborne, but for SIDS the proportion was 79 per cent.[5] As a result, the impact on their import prices is more than twice the global level, at 24 per cent. The situation is reversed for LLDCs: on average only one per cent of imports are transported by sea, so their import prices are simulated to increase by only 3.2 per cent.[6]

Increases in import prices also feed through to consumer prices. On average, for 198 economies for which data were available the global increase in prices between 2020 and 2023 is simulated at 1.5 per cent (figure 3.8). Consumer prices are less affected compared with import prices, due to the lower proportion of products that involve international shipping in the consumer basket. The level of increase also depends

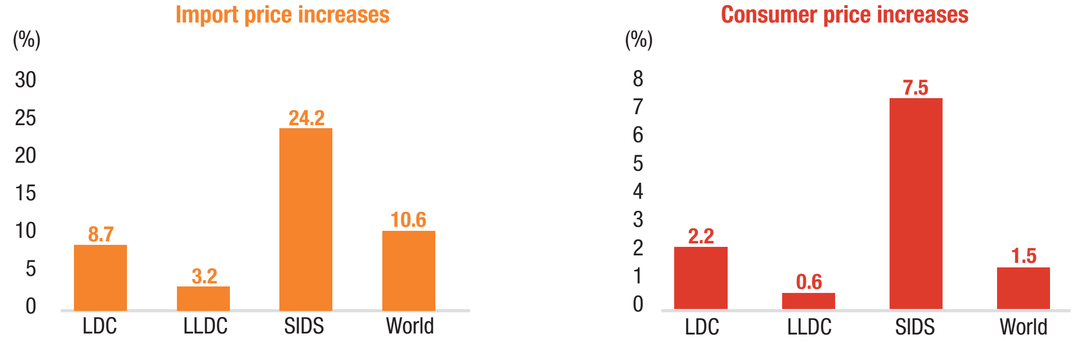
[3] UNCTAD estimation.

[4] UNCTADstat (https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=90759, accessed 26 July 2021). For the purposes of the analyses in this chapter, the definitions of LDC, LLDC, and SIDS follow the definitions of the Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UNOHRLLS) (https://www.un.org/ohrlls/content/profiles-ldcs, https://www.un.org/ohrlls/content/list-lldcs, https://www.un.org/ohrlls/content/list-sids, accessed 26 July 2021). The definition of SIDS includes Non-UN Members and Associate Members of the Regional Commissions.

[5] The share of maritime transport in SIDS total merchandise imports is calculated based on Comtrade Plus (https://comtrade.un.org/, accessed 16 June 2021) data for nine economies for which import value by mode of transport is available (i.e., Antigua and Barbuda, Belize, Comoros, Grenada, Guyana, Mauritius, São Tomé and Príncipe, Seychelles, and Suriname). The corresponding figure for non-SIDS is calculated based on Comtrade Plus data for 59 economies for which import value by mode of transport is available.

[6] The share of maritime transport in LLDC total merchandise imports is calculated based on Comtrade Plus data for 12 economies for which import value by mode of transport is available (i.e., Armenia, Azerbaijan, Botswana, Eswatini, Kyrgyzstan, Lao People's Democratic Republic, Mongolia, North Macedonia, Plurinational State of Bolivia, Republic of Moldova, Rwanda, and Zambia).

Figure 3.8 Simulated impact of current container freight rate surge on import and consumer price levels



Sources: UNCTAD calculations based on data provided by Clarksons Research, *Shipping Intelligence Network* (accessed 2 September 2021), the IMF, *International Financial Statistics* and *Direction of Trade Statistics* (accessed 1 June 2021), UNCTADstat (accessed 1-2 June 2021), and the World Bank, *World Integrated Trade Solution* (accessed 2 June 2021) and *Commodity Price Data* (The Pink Sheet, accessed 23 August 2021).

Note: Scenario with a 243 per cent freight rate increase compared to no freight rate increase (i.e., same freight rate level as August 2020) as a percentage of the import or consumer price level. The impacts of the container freight rate surge on prices are based on a 243 per cent increase in the CCFI between August 2020 and August 2021. See technical note 1 for the detail of the methodology.

on the extent to which wholesalers and retailers pass on the price increases; concerned about market share they may choose to absorb the import price increases by reducing their profits.[7]

In SIDS, the simulated increase is higher than the global average, at 7.5 per cent, because of their dependence on imports. The increase is also higher in LDCs than the global average at 2.2 per cent, partially because in high-inflation economies[8] firms tend to assume that increases in import prices will be persistent, and respond by increasing their prices.[9] In LLDCs, the increase in consumer prices is lower, at 0.6 per cent, owing to their limited dependence on maritime transport for imports.

2. Variations in price impacts across economies and types of goods

The adverse impacts of higher freight prices are not limited to SIDS and LDCs. Many other countries could see significant increases in consumer prices – ranging from 1.2 per cent in Brazil to 4.2 per cent increase in Slovakia (figure 3.9). It should be noted, however, that the simulation is limited to 27 European Union countries and 16 other major countries because it requires detailed information on sectoral-level input-output structures. The simulation assumes that all current freight increases and the corresponding increases in production costs are fully passed to consumers – with no change in other value-added components of production costs, such as wages and salaries (technical note 2).

The impact is generally greater in smaller economies. Thus, in Estonia consumer prices would rise by 3.7 per cent and in Lithuania by 3.9 per cent compared with only 1.2 per cent in the United States and 1.4 per cent in China. This partly reflects their greater ‘import openness’ – the ratio of imports to GDP – which is typically higher in smaller economies – 55 per cent in Lithuania and 60 per cent in Estonia, compared with 11 per cent in the United States and 15 per cent in China. Smaller economies are also likely to have a higher proportion of intermediate imported goods such as raw materials and components used for domestic production of consumer goods and services – 16 per cent in Lithuania and Estonia, compared with only 4 per cent in China and the United States.

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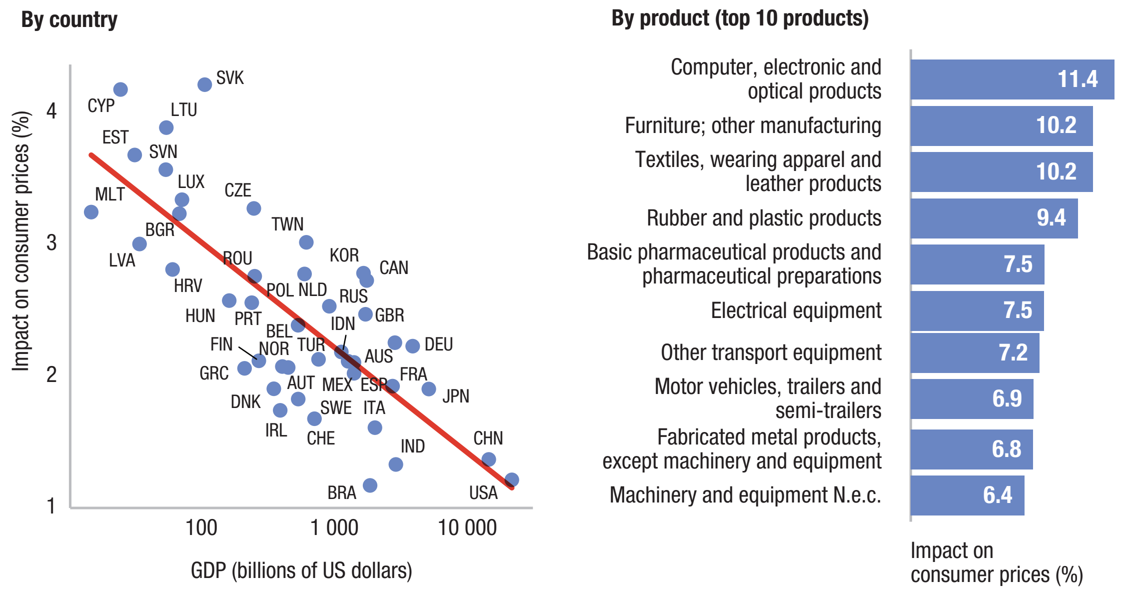
[7] An empirical literature on exchange rate pass-through provides evidence that the low sensitivity of consumer prices to import price and exchange rate fluctuations can be explained by “double marginalization”, wherein local wholesalers and retailers reduce their margins in response to exchange rate depreciations and import price increases to maintain market share at the retail level (Campa and Goldberg, 2010, and Hellerstein, 2008).

[8] Consumer price inflation in LDCs recorded 22.4 per cent in 2020, while the global inflation rate was 2.8 per cent (excluding the Bolivarian Republic of Venezuela due to its exceptionally high rate of inflation) according to UNCTADstat (https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=37469, accessed 6 August 2021).

[9] An empirical literature on exchange rate pass-through provides evidence that emerging economies generally display higher sensitivity of domestic prices to exchange rate and import price fluctuations than developed countries, and the degrees of price sensitivity are affected by inflation rate levels and monetary policy credibility (Schmidt-Hebbel and Tapia, 2002; Choudhri and Hakura, 2006; McCarthy, 2007; Reyes, 2007; World Bank, 2014; Ha et al., 2020). The rationale for the correlation between price sensitivity and inflation is provided by the Taylor’s hypothesis that firms in a higher and persistent inflation environment perceive exchange rate fluctuations to be more persistent and respond via price-adjustments (Taylor, 2000; Ca’ Zorzi, et al., 2007).

Figure 3.9 Simulated impacts of the container freight rate surge on consumer price levels, by country and by product



Sources: UNCTAD calculations based on the WIOD (accessed 7–8 June 2021) developed by Timmer et al., 2015, Clarksons Research, *Shipping Intelligence Network* (accessed 2 September 2021), UNCTADstat (accessed 24 June 2021), and the Centre d'Études Prospectives and d'Informations Internationales, *Gravity Database* (accessed 21 May 2021).

Note: The impacts of the container freight rate surge on prices are based on a 243 per cent increase in the CCFI between August 2020 and August 2021. The simulated impacts on price levels are long-term impacts, i.e., the simulation assumes that the current container freight rate surge and the corresponding increases in production costs are fully passed to consumers. See technical note 2 for the detail of the methodology.

Higher freight rates have a greater impact on the consumer prices of some goods than others, notably those which are more highly integrated into global supply chains, such as computers, and electronic and optical products (figure 3.9).[10] These often have to be shipped from East Asia towards consumption markets in the West with correspondingly higher shipping costs. For these goods, international shipping costs account for 2.6 per cent of the consumer price, compared with 1.2 per cent on average for other goods.[11] Higher prices will make such goods less affordable, so reduce consumer welfare.

Other goods for which surging freight rates are likely to increase consumer prices include low-value-added items such as furniture and textiles, wearing apparel and leather products.[12] Production of these goods is often fragmented across low-wage economies remote from major consumer markets. For example, international shipping costs account for 2.2 per cent of the consumer price for furniture and 1.8 per cent for textiles, wearing apparel and leather products.

3. Impact on global production processes and costs

Besides the consumer goods and services, other products that are closely integrated into global supply chains will be affected by surging freight rates. This is the case, for example, for investment-related products – capital goods and services used to create fixed assets, such as construction and computer programming (figure 3.10, technical note 2). Capital goods are more dependent than non-capital goods on supplies from foreign countries (Lian et al., 2020).

[10] Asia-Pacific Economic Cooperation (APEC), 2021 identified three key global value chain (GVC) industries in the APEC region based on their high values of GVC-related trade. They are computer, electronic and optical equipment, chemicals, and motor vehicle, trailers and semi-trailers. Among these three industries, computer, electronic and optical equipment showed the highest GVC participation rate in the APEC region.

[11] World average figures based on the World Input-Output Database (WIOD) used for the simulation. For this calculation (and the following calculations for furniture and textiles, wearing apparel and leather products), international shipping costs refer to only direct shipping costs of the final products from producer countries to consumer countries, and do not include shipping costs to source intermediate goods (i.e., raw materials and parts and components) used in the production process of the final products.

[12] For the purpose of the present analysis, furniture refers to furniture and other manufacturing sectors (i.e., divisions 31 and 32 in International Standard Industrial Classification, Rev.4, https://unstats.un.org/unsd/publication/seriesm/seriesm_4rev4e.pdf, accessed 30 July 2021).

Figure 3.10 Simulated impacts of container freight rate surges on prices for importers, consumers and firms, global average

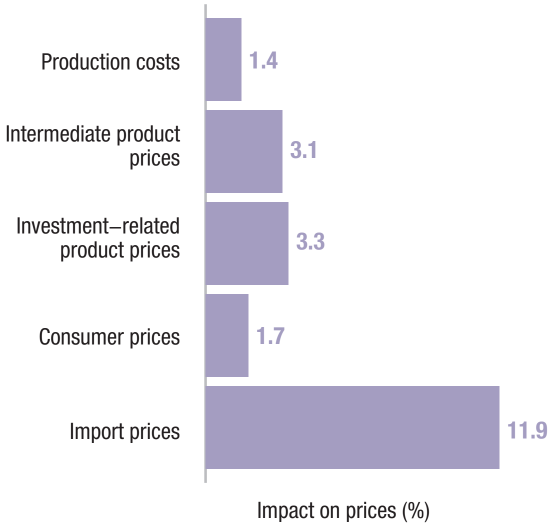
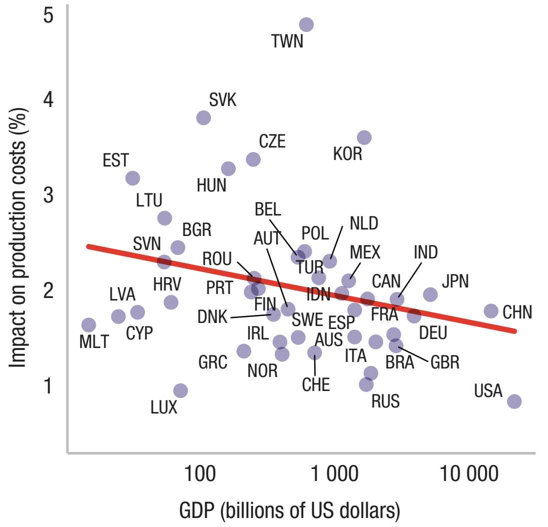


Figure 3.11 Simulated impact of container freight rate surges on production costs, by country and size of economy



Sources: UNCTAD calculations based on the WIOD (accessed 7-8 June 2021) developed by Timmer et al., 2015, Clarksons Research, *Shipping Intelligence Network* (accessed 2 September 2021), UNCTADstat (accessed 24 June 2021), and the Centre d'Études Prospectives and d'Informations Internationales, *Gravity Database* (accessed 21 May 2021).

Note: The impacts of the container freight rate surge on price levels are based on a 243 per cent increase in the CCFI between August 2020 and August 2021. The simulated impacts on price levels are long-term impacts, i.e., the simulation assumes that the current container freight rate surge and the corresponding increases in production costs are fully passed to final users (i.e., consumers and firms). See technical note 2 for the detail of the methodology.

Similarly, intermediate products are more strongly embedded in global supply chains than consumer products. These include raw materials, parts and components, and services used in production processes, such as banking and consultancy. For the dataset in the simulation, imported goods account for 14.6 per cent of total intermediate products used in domestic production processes, compared with 9.0 per cent for consumption products.

The impact is naturally lower for locally produced or assembled goods. Their production costs include not only the costs of intermediate products but also local value-added components such as labour. In the dataset used for the present simulation, globally these production factors account on average for 46 per cent of production costs. However, if the increase in prices triggers wage increases, this would increase the costs beyond those simulated.

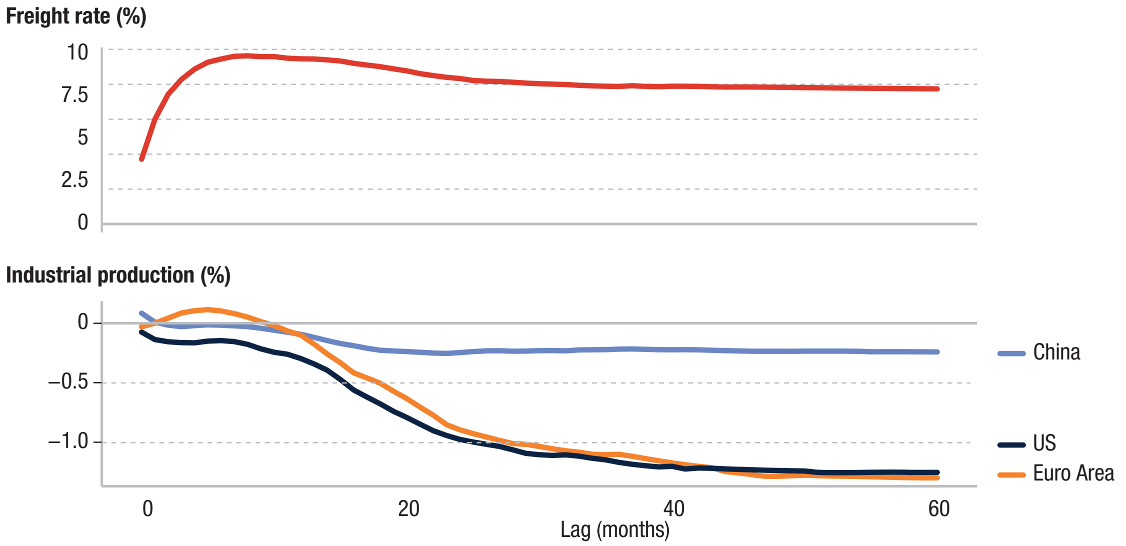
Sustained increases in freight rates will cause greater increases in production costs in smaller economies and thus undermine their comparative advantages (figure 3.11). Smaller countries will also find it more difficult to move up the value chain if they face higher costs of importing high-technology machinery and industrial materials. This will hamper their efforts to achieve the Sustainable Development Goals.

4. Higher costs and maritime transport disruption threaten the recovery in global manufacturing

Manufacturers in the United States and Europe rely mainly on industrial supplies from China and other East Asian economies, so continued cost pressures, disruption and delays in containerized shipping will hinder production. The present analysis shows that a 10 per cent increase in container freight rates, along with supply chain disruptions, is expected to decrease industrial production in the United States and the euro area by more than 1 per cent cumulatively (figure 3.12, technical note 3).[13] In China, production is expected to decrease by 0.2 per cent. In the short to medium term these disturbances are likely to undermine recovery in manufacturing in major economies.

[13] In the present analysis, the euro area refers to 16 countries out of 19 euro area countries where all data are available for the simulation.

Figure 3.12 Simulated dynamic impacts of container freight rate increase on industrial production



Sources: UNCTAD calculations based on data provided by Clarksons Research, *Shipping Intelligence Network* (accessed 3 June 2021), the World Bank, *World Development Indicators* (accessed 10 June 2021), Bank for International Settlements, *Effective exchange rate indices* (accessed 10 June 2021), and Feldkircher et al., 2020 (accessed 10 June 2021).

Note: Global Vector Autoregression, consisting of 8 variables and 31 countries, is estimated using GVAR toolbox 2.0 (Smith and Galesi, 2014). Included endogenous variables for individual countries are the industrial production index, the consumer price index, the equity price index, the real effective exchange rate index, nominal short-term interest rates, and nominal long-term interest rates. Global variables are oil prices and container freight rates. See technical note 3 for the detail of the methodology.

As of July 2021, industrial production in the United States had recovered considerably from the decline caused by the COVID-19 pandemic in 2020, but remained below the pre-pandemic level despite strong consumer demand for goods. By early 2021, production in the United States had started to recover. Nevertheless compared with February 2020, by July 2021, industrial production was 0.1 per cent lower while real personal consumption expenditure on goods was 14.8 per cent higher.[14] [15] These trends are consistent with the simulation for industrial production, suggesting that the container freight rate surge and the corresponding disruption in maritime transport are delaying a recovery in global manufacturing.

E. STRUCTURAL DETERMINANTS OF MARITIME TRANSPORT COSTS

As well as responding to global market factors such as strong shipping demand, limited supply and container shortages, maritime transport costs on specific routes are also determined by structural factors, including port infrastructure, trade facilitation measures and liner shipping connectivity. Indeed, compared with pandemic-induced fluctuations these can have a greater impact on transport costs and trade competitiveness in the long term. Improving these structural factors can mitigate future external shocks such as freight rate surges and maritime transport disruptions.

To investigate the structural determinants of maritime transport costs, UNCTAD has collaborated with the World Bank and Equitable Maritime Consulting to develop the Global Transport Costs Dataset for International Trade (GTCDIT).[16] This is a unique and comprehensive dataset disaggregated by mode of transport at commodity level (HS code 6-digit level). Transport costs are measured as differences between cost, insurance, and freight (CIF) values, and free on board (FOB) values. As of September 2021, data had been published for the year 2016. The dataset is currently being refined to improve data quality and add subsequent years.

[14] Based on data provided by the United States Board of Governors of the Federal Reserve System, Industrial Production and Capacity Utilization (https://www.federalreserve.gov/releases/g17/current/, accessed 27 September 2021).

[15] Based on data provided by the United States Bureau of Economic Analysis, Personal Income and Outlays (https://www.bea.gov/data/income-saving/personal-income, accessed 27 September2021).

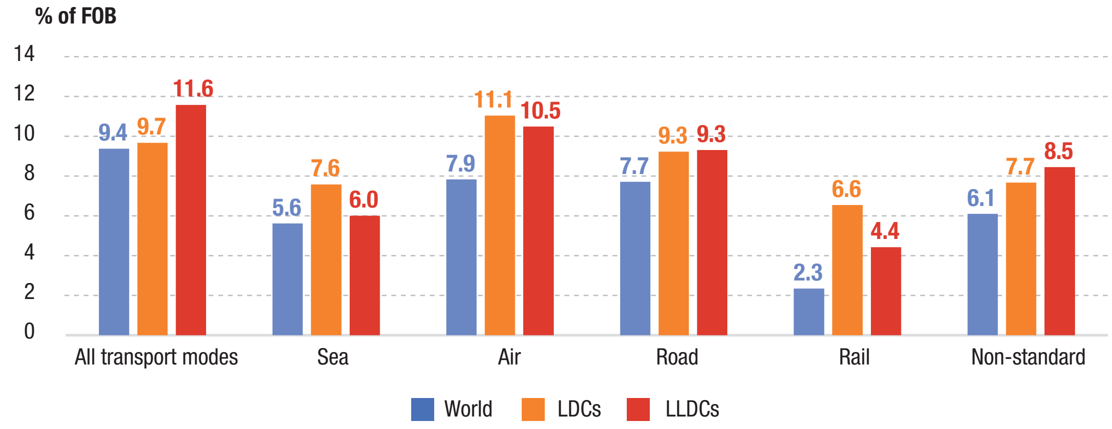
[16] https://unctadstat.unctad.org/EN/TransportCost.html (accessed 24 June 2021).

1. LDCs incur higher maritime transport costs

To capture overall trends in the GTCDIT, transport cost data have been aggregated for three importing country groups – LDCs, LLDCs and the world as a whole (figure 3.13). In 2016 the highest all-mode transport costs are for LLDCs at 11.6 per cent of FOB value, compared with 9.4 per cent for the world as a whole, and 9.7 per cent for LDCs. This is not surprising since many LLDCs are hampered by their geographical locations and depend on more expensive modes of transport such as air and road. For example the heatmap in figure 3.14 indicates especially high transport costs for Mongolia, Zimbabwe, Kyrgyzstan, the Republic of Moldova and Mali.

For maritime transport costs, figure 3.13 shows that the highest costs, at 7.6 per cent of FOB value, are in LDCs compared with a world average of 5.6 per cent. For LDCs, reducing maritime transport costs is a crucial development challenge as they rely on maritime shipping more frequently than others.

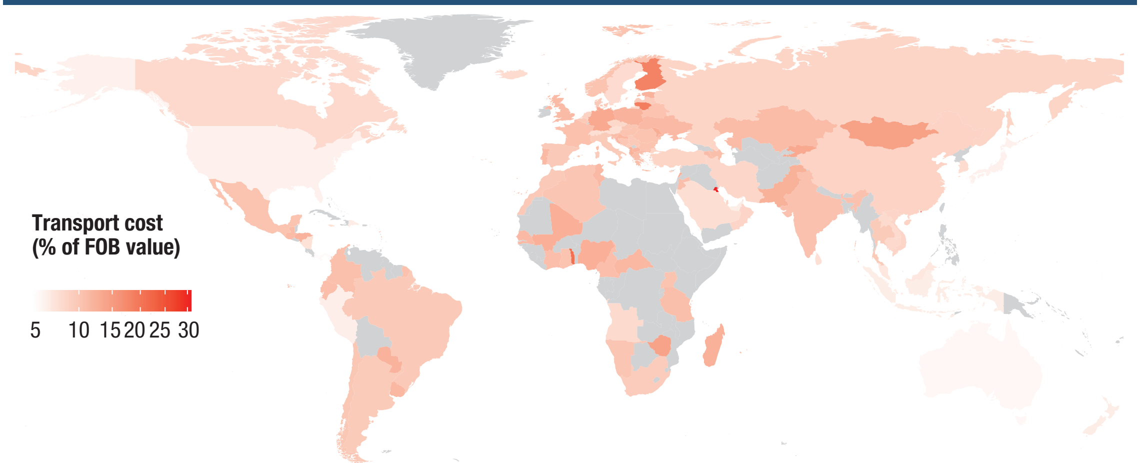
Figure 3.13 Transport costs for importing goods by transport mode, world, LDCs, and LLDCs, 2016, percentage of FOB value



Source: UNCTAD calculations based on the GTCDIT developed by UNCTAD, the World Bank, and Equitable Maritime Consulting (accessed 24 June 2021).

Note: Transport costs of each transport mode are aggregated by group of importing countries. The aggregation is the sum of transport costs over all commodities, importing countries in the respective importing country group, and trading partners, divided by the corresponding sum of the trade value (in FOB), for commodities and country pairs for which both transport costs and FOB values are available.

Figure 3.14 Transport costs heatmap for importing goods, all modes of transport, 2016, percentage of FOB value



Source: UNCTAD calculations based on the GTCDIT developed by UNCTAD, the World Bank, and Equitable Maritime Consulting (accessed 24 June 2021).

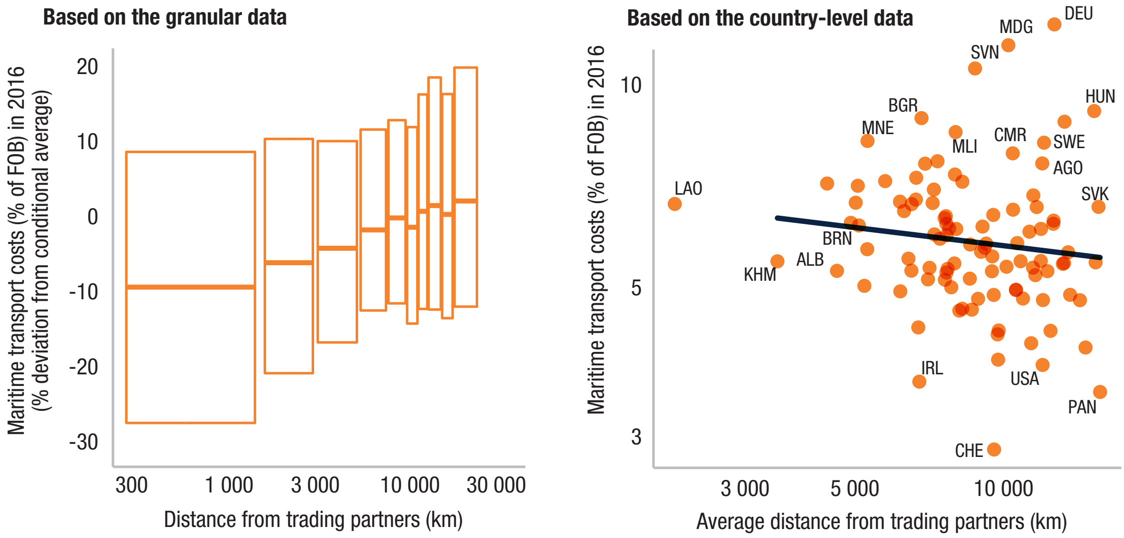
Note: Grey colour indicates countries where import transport costs data are not available.
Transport costs are aggregated by importing country. Importers' maritime transport costs are summed up over all commodities and trading partners and, divided by the corresponding sum of the trade value (in FOB), for commodities and country pairs for which both maritime transport costs and FOB values are available.

Maritime transport carried 56 per cent of the LDCs' total imports compared with a world average of 40 per cent.[17]

2. Better port infrastructure and trade facilitation would reduce maritime transport costs

The GTCDIT provides granular information on transport costs, which is useful to better understand the underlying relationships between these shipping costs and their determinants. This shows, for example, that, controlling for differences in product structure and local factors such as port infrastructure, the ad valorem maritime transport costs increase with the distance between trading partners, reflecting greater costs for fuel and crews. This relationship is visible in the granular data disaggregated at the commodity and bilateral country level (figure 3.15).[18] But it may not be evident in aggregated country level for average distance from trading partners. This is because some long-distance routes, such as between the United States and China, have larger volumes of trade that permit economies of scale, for example, by using larger vessels. Trade routes with longer distances and lower transport costs tend to have higher weights in the aggregation process.

Figure 3.15 Maritime transport costs for importing goods and distances from trading partners



Source: UNCTAD calculations based on the GTCDIT developed by UNCTAD, the World Bank, and Equitable Maritime Consulting (accessed 24 June 2021).

Notes: Left-hand side: The granular data is the bilateral trade data at the HS code 6-digit level. Distances from trading partners are divided into ten quantile groups. The y-axis shows the percentage deviation of maritime transport costs from their conditional average based on commodities and trading partners (obtained as residuals from a regression of maritime transport costs (as percentage of the FOB value) on commodity dummies and trading partner dummies). The boxplot shows the 25th percentile (lower line), median (middle line), and the 75th percentile (upper line) of maritime transport costs in each quantile group.
Right-hand side: Importers' maritime transport costs are summed up over all commodities and trading partners and, divided by the corresponding sum of the trade value (in FOB), for commodities and country pairs for which both maritime transport costs and FOB values are available.

In ad valorem terms, maritime transport costs tend to be higher for smaller economies (figure 3.16). This may be due to the lack of liner shipping connectivity, the lower quality of port infrastructure, and inadequate trade facilitation measures. These countries would benefit from upgrading their ports to enable better shipping services, and permit larger vessels with shorter waiting times before entering ports. They

[17] The world average of the maritime transport share in terms of FOB value (i.e., 40.2 per cent) is lower than the maritime transport share in terms of volume (i.e., 85.9 per cent in 2016 according to Clarksons Research, *Shipping Intelligence Network*) indicating that goods transported by air and over land have on average a higher price than goods transported by sea.

[18] In the granular data, the elasticity of the maritime transport costs in ad valorem terms with respect to the distance is estimated at 0.059 after controlling commodity and trading partner fixed effects (and 0.028 without the fixed effects), and it is statistically different from zero at a significance level of 1 per cent. In contrast, in the country level data, the estimated elasticity is -0.091 and it is not statistically different from zero at a significance level of 10 per cent.

Figure 3.16 Maritime transport costs for importing goods, by country and size of economy

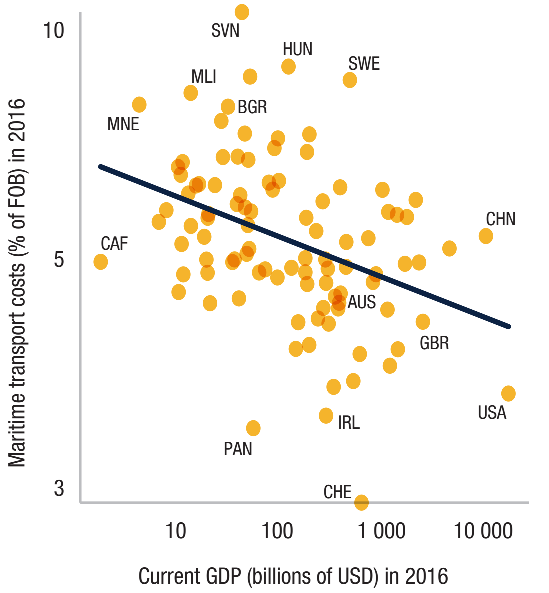
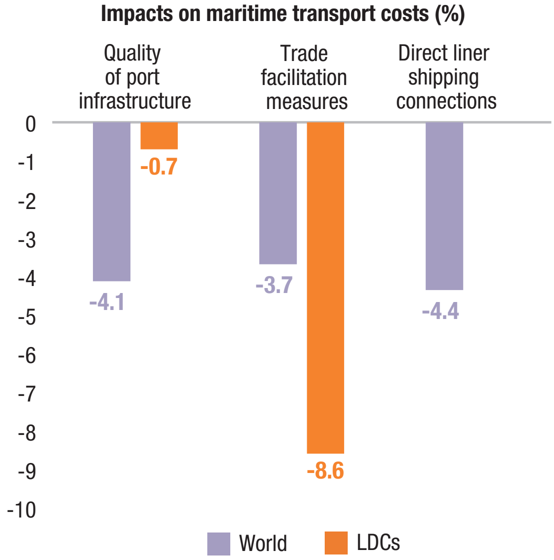


Figure 3.17 Impact of structural determinants on maritime transport costs for importing goods



Sources: UNCTAD calculations based on the GTCDIT developed by UNCTAD, the World Bank, and Equitable Maritime Consulting (accessed 24 June 2021), *World Development Indicators* published by the World Bank (accessed 24 June 2021), *Global Competitiveness Index* published by the World Economic Forum (accessed 24 June 2021), *UN Global Survey on Digital and Sustainable Trade Facilitation* conducted by the UN Regional Commissions (accessed 24 June 2021), and a dataset provided by MDS Transmodal.

Notes: Figure 3.16: Maritime transport costs are aggregated by importing country. The aggregation is the sum of transport costs over all commodities and trading partners, divided by the sum of trade values (in FOB) over the corresponding commodities and trading partners, for commodities and country pairs where transport costs data are available.
Figure 3.17: The impact on maritime transport costs is the impact of improving each transport costs determinant from the 25th percentile to the 75th percentile. See technical note 4 for the detail of the methodology and the data sources.

would also benefit from introducing paperless systems for trade facilitation, as well as from more direct liner shipping connections to reduce the need for transhipping containers.

The consequence of improving these determinants – from their 25th percentiles to 75th percentiles – is illustrated in figure 3.17. Improving the quality of port infrastructure would reduce world average maritime transport costs by 4.1 per cent, better trade facilitation measures by 3.7 per cent, and better liner shipping connections by 4.4 per cent (technical note 4). In LDCs, the greatest benefits would come from better trade facilitation, with a decrease of 8.6 per cent compared with 0.7 per cent from better port infrastructure.[19]

It should be noted that these impacts are measured at border-to-border prices. As these transport costs determinants (quality of port infrastructure, trade facilitation measures, and liner shipping connection) would also reduce border-to-door transport costs, changes in total transport costs (door-to-door transport costs) can be expected to be higher than the changes in the border-to-border transport costs.

3. Trade imbalances produce asymmetric maritime transport costs, alleviated by economies of scale

Maritime transport costs are also affected by bilateral trade imbalances – especially for containerized trade. For sailings from high-demand to low-demand countries many vessels have to return with empty containers making shipping costs higher to cover part of the ballast sailing costs for the return journey.

This imbalance effect is confirmed in the data provided by TIM Consult (see section A.3). It is also evident in the GTCDIT dataset. Trade routes with trade imbalances on average have maritime transport costs 2.4 per cent higher for one direction than the other (figure 3.18). The greater the imbalance the greater

[19] Among trade facilitation measures, cross paperless trade and trade facilitation institution are estimated to have higher impacts in LDCs. Improving cross paperless trade and trade facilitation institution from the 25th percentile to 75th percentile is associated with a reduction in maritime transport costs by 8.8 per cent and 7.6 per cent, respectively.

Figure 3.18 Maritime transport costs by direction of the trade imbalance

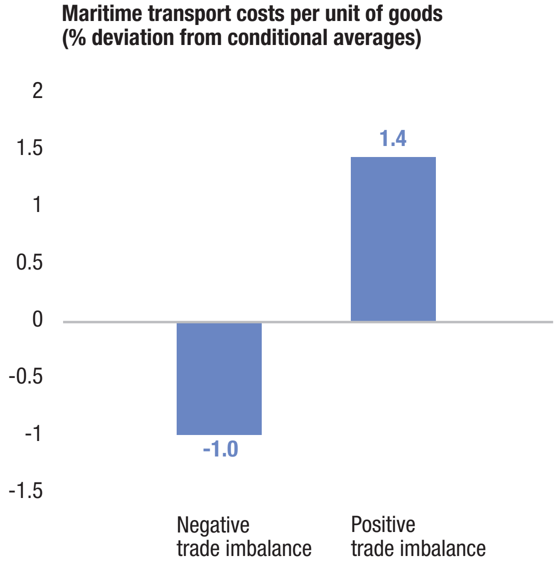
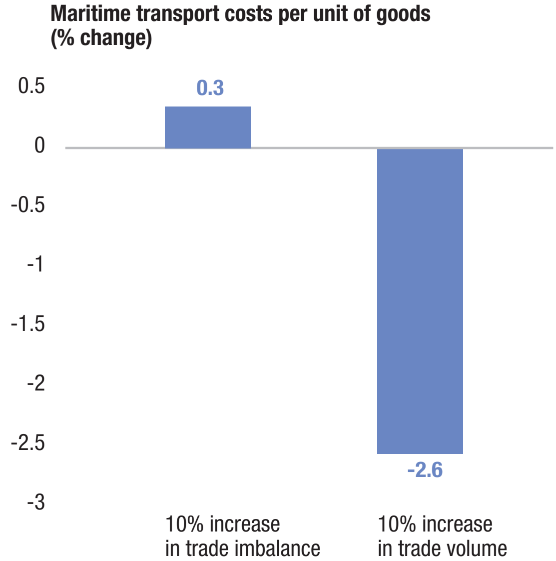


Figure 3.19 Impacts of trade imbalance and trade volume on maritime transport costs



Source: UNCTAD calculations based on the GTCDIT developed by UNCTAD, the World Bank, and Equitable Maritime Consulting (accessed 24 June 2021).

Notes: Figure 3.18: The figure shows the median of maritime transport costs in the sample of positive trade imbalances and the sample of negative trade imbalances. Maritime transport costs are percentage deviations from conditional averages based on commodities and bilateral country pairs (i.e., residuals from the regression of maritime transport costs (per unit of goods) on commodity dummies and bilateral country pair dummies). Differences in measurement unit of goods volume are controlled by the commodities dummies.

Figure 3.19: The figure shows the estimated elasticities (multiplied by 10) of maritime transport costs with respect to the trade (im)balance and the trade volume. See technical note 5 for the detail of the methodology and the data source.

the increase. Thus, if the imbalance increases by 10 per cent, maritime transport costs are expected to increase by 0.3 per cent (figure 3.19, technical note 5).[20]

The trade imbalance effect on maritime transport costs can be alleviated by other factors. For example, boosting cargo volumes to generate economies of scale could help cut maritime transport costs. The role of economies of scale effect in mitigating high transport costs is also confirmed when looking at the new transport costs dataset. An analysis based on this dataset shows that a 10 per cent increase in the trade volume is associated with a 2.6 per cent decrease in maritime transport costs (figure 3.19).

F. SUMMARY AND POLICY CONSIDERATIONS

Since late-2000 and into 2021, freight rates across containerized and dry bulk shipping markets have hit record highs, while tanker rates have plummeted. The surge in container rates in the second half of 2020 reflected higher-than-expected demand. As demand continued to surge, even an expansion of capacity was insufficient to constrain prices, because other supply-side factors came into play, including a global shortage of shipping containers, port congestion, delays, unreliable liner schedules, and increased fees and surcharges. Freight rates are expected to remain high – fuelled by continued strong demand against a background of growing supply uncertainty and concerns about the efficiency of transport systems and port operations.

The upward trajectory in freight rates has also raised questions about market behaviour and transparency in freight pricing – and about whether that situation has been exacerbated by greater market concentration.

The current surge in freight rates – if sustained – could have global economic impacts. The UNCTAD simulation suggests that it could increase global import price levels by 10.6 per cent, and consumer price levels by 1.5 per cent. The impact will be even greater in SIDS which could see import prices increase by 24 per cent and consumer prices by 7.5 per cent. In LDCs consumer price levels could increase by 2.2 per cent.

[20] In the quantitative analysis, the trade imbalance is defined as a ratio of the shipping value in one direction over the shipping value in the opposite direction.

Higher price increases are expected in important products. Globally, prices of computers are simulated to increase on average by 11 per cent, followed by 10 per cent increases in furniture and textiles, and a 7.5 per cent increase in pharmaceutical products. Some of these are low-value-added items produced in smaller economies which could face erosion of their comparative advantages.

Higher freight levels are also threatening to undermine a recovery in global manufacturing. In the short to medium term, a 10 per cent increase in container freight rates could lead to a cumulative contraction of around 1 per cent in industrial production in the United States and the euro area.

Over the longer term, maritime transport costs are also influenced by structural factors including port infrastructure quality, the trade facilitation environment, and shipping connectivity. There is potential for significant improvements that could reduce maritime transport costs by around 4 per cent.

If global trade is to flow more smoothly in future, and ports and maritime transport are to thrive and navigate through the historic disruption caused by the pandemic, this will require actions in some key policy areas, to:

- *Monitor markets* – To ensure a fair transparent and competitive commercial environment, governments will need to monitor freight rates, as well as fees and charges applied by carriers and port terminals. Policy makers should strengthen maritime transport competition authorities so that they can better understand market development and provide the requisite regulatory oversight (UNCTAD, 2021).
- *Share information and strengthen collaboration* – To enhance transport efficiency and operations there should be greater collaboration and sharing of data between various stakeholders along the maritime supply chain, including carriers, ports, inland transport providers, customs and shippers.
- *Analyse trends* – Relevant organizations, including UNCTAD, should continue to monitor trends in shipping markets, collect data and deepen their analysis of the structural determinants of transport costs. They can consider ways of cutting costs, enhancing efficiency and smoothing delivery of international maritime trade.
- *Upgrade ports* – To address congestion and ensure efficient and sustainable trade, port operations should be upgraded by improving infrastructure, and investing in new technology and digital solutions. Similar efforts should extend to trade facilitation to improve hinterland connectivity, particular for LDCs, SIDS and LLDCs.
- *Move up the value chain* – If smaller economies are to be more resilient to external shocks, including freight rate surges and maritime transport disruptions, they should be able to diversify by graduating to higher-value-added products.

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TECHNICAL NOTES

Technical note 1: Simulation of import/consumer price impacts (section D.1)

The analysis in section D.1 simulated the impacts of the current container freight rate surge on import and consumer price levels at the world level and for three country groupings, i.e., LDCs, LLDCs, and SIDS. The simulated price impacts are defined as percentage differences in import/consumer price levels in 2023 between the following two scenarios:

1. **Container freight rate surge scenario:** The level of the CCFI Composite Index in August 2021 (i.e., 3,027.91 points) is assumed to be sustained over the remaining simulation period (i.e., from September 2021 to December 2023).
2. **No container freight rate surge scenario:** The CCFI Composite Index is assumed to stay at the level observed before the freight rate surge (i.e., 884.02 points in August 2020) over the remaining simulation period (i.e., from September 2020 to December 2023).

Estimation of the elasticities

The regression in the present analysis extended the exchange rate pass-through equation in Goldberg and Campa, 2010 and Sekine, 2006, to add container freight rates as an explanatory variable and expand the country coverage to include small countries such as LDCs, LLDCs and SIDS. Given that only annual data are available for most of the small countries, the number of observations is significantly reduced for each country. To overcome the small sample size problem, the estimation is conducted at the world level and the country group level instead of at the individual country level, applying a panel data estimation.

The first difference of logarithm of import prices is regressed on country dummies and the first differences of logarithms of container freight rates, nominal effective exchange rates, foreign prices, GDP, commodity prices, and lagged variables:

$$\Delta \ln IPI_t^c = \alpha^c + \sum_{l=0}^{L}(\beta_{1,l}\,\Delta \ln CCFI_{t-l}^c + \beta_{2,l}\,\Delta \ln e_{t-l}^c + \beta_{3,l}\,\Delta \ln w_{t-l}^c + \beta_{4,l}\,\Delta \ln GDP_{t-l}^c + \beta_{5,l}\,\Delta \ln Com_{t-l}^c) + \sum_{l=1}^{L}\beta_{6,l}\,\Delta \ln IPI_{t-l}^c$$

where IPI_t^c is local currency import price index of country c in year t, α^c is country fixed effects (i.e., dummy variables for country c), $CCFI_{t-l}^c$ is container freight rates of country c (i.e., freight rates of the closest trade lane for country c, to be discussed below) in year t-l, e_{t-l}^c is the inverse of the nominal effective exchange rate of country c, w_{t-l}^c is foreign prices (i.e., a weighted average of consumer prices of trading partners) of country c, GDP_{t-l}^c is the real GDP of country c, and Com_{t-l}^c is global commodity prices in terms of country c's local currency unit. For the construction of $CCFI_{t-l}^c$, each country is matched with the closest trade lane from the 12 trade lanes covered in the CCFI. For example, a country in Sub-Saharan Africa region is matched with the CCFI China-South Africa Freight Index. For e_{t-l}^c, the inverse of the nominal effective exchange rate is used in the equation, so that an increase in this variable represents a currency depreciation.

With regard to the impact on consumer prices, the first difference of logarithm of consumer prices is regressed on country dummies and the first differences of logarithms of import prices, GDP, and lagged variables.

$$\Delta \ln CPI_t^c = \alpha^c + \sum_{l=0}^{L}(\gamma_{1,l}\,\Delta \ln IPI_{t-l}^c + \gamma_{2,l}\,\Delta \ln GDP_{t-l}^c) + \sum_{l=1}^{L}\gamma_{3,l}\,\Delta \ln CPI_{t-l}^c$$

where CPI_t^c is consumer price index of country c in year t.

The above equations are estimated by OLS based on annual panel data. The import price equation covers 200 economies from 2003 to 2019, and the consumer price equation covers 198 economies from 1981 to 2019. As the coefficients (βs and γs) are common to all economies, estimated elasticities can be interpreted as the world average (simple average). For the estimation at the country group level (i.e., LDCs, LLDCs, and SIDS), the estimation samples are restricted to the respective country groups. For the import price equation, the sample sizes are 44 economies for LDCs (out of 46 LDCs), 31 economies for LLDCs (out of 32 LLDCs), and 42 economies for SIDS (out of 58 SIDS). For the consumer price equation, the sample sizes are 43 economies for LDCs, 31 economies for LLDCs, and 42 economies for SIDS. Insignificant explanatory variables are dropped from the equations, and consequently the lag lengths became 1 year for most cases.

Simulation of the impacts

To simulate the impacts of the current container freight rate surge on import prices, the estimated elasticities of import prices with respect to container freight rates is multiplied by the difference in freight rate between the container freight rate surge scenario and the no container freight rate surge scenario:

$$\beta_{1,0}\left(\Delta ln\ CCFI_{2020}^{Composite} - \Delta ln\ CCFI_{2020}^{Composite*}\right)\left(\sum_{l=0}^{3}\beta_{6,1}^{l} + \beta_{6,2} + 2\beta_{6,1}\beta_{6,2} + \beta_{6,3}\right)$$
$$+ \left[\beta_{1,0}\left(\Delta ln\ CCFI_{2021}^{Composite} - \Delta ln\ CCFI_{2021}^{Composite*}\right)\right.$$
$$\left.+ \beta_{1,1}\left(\Delta ln\ CCFI_{2020}^{Composite} - \Delta ln\ CCFI_{2020}^{Composite*}\right)\right]\left(\sum_{l=0}^{2}\beta_{6,1}^{l} + \beta_{6,2}\right)$$
$$+ \left[\beta_{1,0}\left(\Delta ln\ CCFI_{2022}^{Composite} - \Delta ln\ CCFI_{2022}^{Composite*}\right) + \beta_{1,1}\left(\Delta ln\ CCFI_{2021}^{Composite} - \Delta ln\ CCFI_{2021}^{Composite*}\right)\right.$$
$$\left.+ \beta_{1,2}\left(\Delta ln\ CCFI_{2020}^{Composite} - \Delta ln\ CCFI_{2020}^{Composite*}\right)\right](1 + \beta_{6,1})$$
$$+ \left[\beta_{1,1}\left(\Delta ln\ CCFI_{2022}^{Composite} - \Delta ln\ CCFI_{2022}^{Composite*}\right) + \beta_{1,2}\left(\Delta ln\ CCFI_{2021}^{Composite} - \Delta ln\ CCFI_{2021}^{Composite*}\right)\right.$$
$$\left.+ \beta_{1,3}\left(\Delta ln\ CCFI_{2020}^{Composite} - \Delta ln\ CCFI_{2020}^{Composite*}\right)\right]$$

where $CCFI_t^{Composite}$ is CCFI Composite Index in year t under the container freight rate surge scenario, and $CCFI_t^{Composite*}$ is CCFI Composite Index in year t under the no container freight rate surge scenario. Actual simulation equations are simpler because insignificant variables are dropped from the estimation equations. In the simulation, the CCFI Composite Index (instead of individual freight indices used in the estimation) is used for container freight rates to simplify the calculations.

A corresponding equation for the consumer price simulation can be obtained by replacing $CCFI_t^{Composite}$, $CCFI_t^{Composite*}$, $\beta_{1,l}$, $\beta_{6,l}$ with IPI_t, IPI_t^*, $\gamma_{1,l}$, $\gamma_{3,l}$, respectively, where IPI_t is import price index at the world level (or LDC, LLDC, or SIDS) in year t under the container freight rate surge scenario, and IPI_t^* is import price index under the no container freight rate surge scenario. IPI_t and IPI_t^* are calculated during the process of applying the above equation for the import price simulation.

Data

Import prices, consumer prices, real GDP, container freight rates, and commodity prices

Unit value indices of imports are reported in the UNCTADstat database (https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=184185, accessed 2 June 2021). Given that the reported unit value indices are denominated in US dollars, they are converted to local currency units using market exchange rates. Data on market exchange rates are retrieved from the IMF, *International Financial Statistics* (https://data.imf.org/?sk=4c514d48-b6ba-49ed-8ab9-52b0c1a0179b, accessed 1 June 2021) and UNCTADstat (https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=117, accessed 1 June 2021). For the 19 Euro area countries, the unit value indices of imports are converted to the former local currency units (before the Euro) because the dataset for the present analysis starts from 2003, which is before the adoptions of the Euro in some countries (i.e., Slovenia adopted the Euro in 2007, followed by Cyprus and Malta in 2008, Slovakia in 2009, Estonia in 2011, Latvia in 2014 and Lithuania in 2015).

Consumer price indices (CPI) and real GDP are retrieved from UNCTADstat (https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=37469 for CPI and https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=96 for real GDP, accessed 2 June 2021). CCFI composite index and the individual freight indices for 12 trade lanes are sourced from Clarksons Research, *Shipping Intelligence Network* (accessed 2 September 2021).

Commodity prices for energy, non-energy and precious metals are reported in the World Bank, *Commodity Price Data* (The Pink Sheet, https://www.worldbank.org/en/research/commodity-markets, accessed 23 August 2021). A simple average of the three indices are converted to local currency units using market exchange rates above.

Nominal effective exchange rates and foreign prices

The nominal effective exchange rate indices and the foreign price indices are normalized to 100 in the first year (i.e., 2003 for the most countries but a later year for some countries), and extended to subsequent years using the following chained formulas based on a geometric weighted average of bilateral exchange rates/trading partners' consumer price indices with trade values (i.e., bilateral total trade values for nominal effective exchange rates and bilateral import values for foreign prices) as weights:

$$NEER_t^c \Big/ NEER_{t-1}^c = \prod_{p \neq c} \left(\frac{E_t^c / E_t^p}{E_{t-1}^c / E_{t-1}^p} \right)^{W_t^{c,p}} , \quad w_t^c \Big/ w_{t-1}^c = \prod_{p \neq c} \left(CPI_t^p \Big/ CPI_{t-1}^p \right)^{\mathrm{W}_t^{c,p}}$$

where $NEER_t^c$ is the nominal effective exchange rate index of country c in year t, E_t^c is the market exchange rate of country c's currency in US dollars, E_t^p is the market exchange rate of trading partner p's currency in US dollars, and $W_t^{c,p}$ is the total bilateral trade value (i.e., the sum of the bilateral export value and the bilateral import value) between country c and trading partner p. For the right-hand side equation, w_t^c is the foreign price index of country c in year t, CPI_t^p is the consumer price index of trading partner p, and $\mathrm{W}_t^{c,p}$ is the bilateral import value of country c from trading partner p.

An increase in the nominal effective exchange rate index represents an appreciation of the country c's currency. In the estimation, the inverse of the nominal effective exchange rate index is used, so that an increase in this variable represents a currency depreciation.

The total bilateral trade value (i.e., $W_t^{c,p}$) and the bilateral import value (i.e., $\mathrm{W}_t^{c,p}$) are the average of the data reported by country c and trading partner p. If only either country c's or trading partner p's data is available, only the available data is used. If both data are not available, the missing value is imputed by the average of the previous and next year's values. Data on bilateral trade values and bilateral import values are retrieved from the IMF, *Direction of Trade Statistics* (https://data.imf.org/?sk=9D6028D4-F14A-464C-A2F2-59B2CD424B85, accessed 1 June 2021) and the World Bank, *World Integrated Trade Solution* (https://wits.worldbank.org/, accessed 2 June 2021). The data on market exchange rates (i.e., E_t^c and E_t^p) is the same data used in the calculation of import prices in local currency units (i.e., sourced from the International Monetary Fund, *International Financial Statistics* and UNCTADstat). Also, the data on trading partners' consumer price indices (i.e., CPI_t^p) is the same data used as the dependent variable in the consumer price equation (i.e., sourced from UNCTADstat).

Technical note 2: Simulation of price and production cost impacts (section D.2 and D.3)

The analyses in section D.2 and D.3 simulated the impacts of the current container freight rate surge on prices for importers, consumers and firms at the country level. The simulated impacts are "long-term" impacts, i.e., the simulation assumes that the current container freight rate surge and the corresponding increases in production costs are fully passed to final users (i.e., consumers and firms), although other production costs components such as wages and salaries are assumed not to change. The simulated impacts are defined as percentage differences in price/production cost levels between the following two scenarios:

1. **Container freight rate surge scenario:** The level of the CCFI in August 2021 (i.e., 3,027.91 points) is assumed to be sustained in the long-term (i.e., until increases in production costs are fully passed to final users).
2. **No container freight rate surge scenario:** The CCFI is assumed to stay at the level observed before the freight rate surge (i.e., 884.02 points in August 2020) in the long-term.

Estimation of the elasticities

In the first step, elasticities of production costs at the country and product level are estimated by the price model of the input-output table (see Tamamura, 2014; and Miller and Blair, 2009):

$$\boldsymbol{\eta} = \Delta\,(\mathbf{B}^t\,[\mathbf{b} + \boldsymbol{\upsilon} + \mathbf{d}]) = \mathbf{B}^t\,\Delta\mathbf{b}$$

where $\boldsymbol{\eta}$ is a column vector whose element η_i^c represents an elasticity of the production cost of product i in country c with respect to freight rates, $\mathbf{B}^t = \{[\mathbf{I}\text{-}\mathbf{A}]^{-1}\}^t$ is the Leontief inverse matrix, $\boldsymbol{I}$ is an identity matrix (i.e., a square matrix with ones on the diagonal and zeros elsewhere), $\boldsymbol{A} = (a_{j,i}^{p,c})$ is the technical coefficient matrix and its element $a_{j,i}^{p,c} = Z_{j,i}^{p,c} / X_i^c$ represents the share of the input of product j produced in country p into the production of product i in country c (i.e., $Z_{j,i}^{p,c}$) in the total input for the production of product i in country c (i.e., X_i^c), $\boldsymbol{b}$ is a column vector whose element $b_i^c = IntTTM_i^c / X_i^c$ represents the ratio of the international transport margins involved in the production of product i in country c (i.e., $IntTTM_i^c$) over the total input for the production of product i in country c (i.e., X_i^c), $\boldsymbol{\upsilon}$ is a column vector whose element $v_i^c = VA_i^c / X_i^c$ represents the ratio of the value added (i.e., labour costs and capital costs) involved in the production of product i in country c (i.e., VA_i^c) over the total input for the production of product i in country c (i.e., X_i^c), and $\boldsymbol{d}$ is a column vector whose element $d_i^c = \tau_i^c / X_i^c$ represents the ratio of the indirect taxes less subsidies (i.e., import tariffs) involved in the production of product i in country c (i.e., τ_i^c) over the total input for the production of product i in country c (i.e., X_i^c).

The difference operator Δ represents element by element difference of a matrix/vector induced by a one per cent increase in container freight rates. Among the four matrices/vectors in the equation, i.e., $\boldsymbol{B}^t$, $\boldsymbol{b}$, $\boldsymbol{\upsilon}$, and $\boldsymbol{d}$, only the shares of the international transport margins (i.e., $\boldsymbol{b}$) are assumed to change. The share of transport margins involved in the production of product i in country c (i.e., b_i^c) is assumed to increase by one per cent if all imported products used in the production of product i in country c (i.e., $Z_{j,i}^{p,c}$ for all j,p) are fully containerized. If some imports are partially containerized, the transport margins of these products are assumed to increase by the containerized ratio divided by 100. Therefore, the change in the share of the international transport margins is calculated by the following formula:

$$\Delta b_i^c = \sum_{j,p} \left[Z_{j,i}^{p,c} \times R\_IntTTM_j^{p,c} \times \frac{CR_j^{p,c}}{100} \right]$$

where $b_i^c = \sum_{j,p} [Z_{j,i}^{p,c} \times R\_IntTTM_j^{p,c}]$ is the share of international transport margins involved in the production of product i in country c, $R\_IntTTM_j^{p,c}$ is the ratio of the international transport margins of product j's import from country p to country c over the import value of product j from country p to country c, and $CR_j^{p,c}$ is the containerized ratio of product j's import from country p to country c. The containerized ratio is calculated by the following formula:

$$CR_j^{p,c} = \sum_{h \in j} MIMP_h^{p,c}\, 1_{containerized}(h) \Big/ \sum_{h \in j} IMP_h^{p,c}$$

where $MIMP_h^{p,c}$ is the maritime import value of commodity h (in product group j) from country p to country c, $IMP_h^{p,c}$ is the total import value of commodity h (in product group j) from country p to country c, and $1_{containeriezed}$ is an indicator function which equals to one if commodity h is containerized and zero otherwise. The commodity h is considered as containerized according to the definitions used in the OECD Maritime Transport Cost database (see Appendix Table II.3. in Korinek, 2011).

In the second step, the elasticity of the final user prices (i.e., prices for consumers and firms) at the country and product level are estimated by summing the elasticity of the production costs η_i^p (estimated above) and the increase in the international transport margins for importing the product:

$$\zeta_i^{p,c} = \eta_i^p + \Delta R\_IntTTM_i^{p,c} = \eta_i^p + R\_IntTTM_i^{p,c} \times \frac{CR_i^{p,c}}{100}$$

where $\zeta_i^{p,c}$ is the elasticity of the final user price of product i imported from country p to country c, η_i^p is the elasticity of production cost of product i in country p, and $\Delta R\_IntTTM_i^{p,c}$ is the change in the international transport margin ratio of product i's import from country p to country c induced by a one per cent increase in container freight rates. If product i is fully containerized, the international transport margin ratio is assumed to increase by 1 per cent. Otherwise, the international transport margin ratio is assumed to increase by the containerized ratio divided by 100 (i.e., $CR_i^{p,c}/100$).

In the final step, the elasticity of the final user price and the elasticity of the production cost at the country and product level are aggregated to the country or product level using the final demand amounts or output values as weights:

$$\zeta^c = \sum_{i,p} \zeta_i^{p,c} f_i^{p,c} \quad , \quad \zeta_i = \sum_{c,p} \zeta_i^{p,c} f_i^{p,c} \quad , \quad \zeta^{global} = \sum_{i,c,p} \zeta_i^{p,c} f_i^{p,c} \quad , \quad \eta^c = \sum_i \eta_i^c X_i^c$$

where ζ^c is the aggregated elasticity of final user prices in country c, ζ_i is the global elasticity of the final user price of product i, ζ^{global} is the global level elasticity of final user prices, η^c is the aggregated elasticity of production costs in country c, $f_i^{p,c}$ is the final demand of country c for product i produced in country p, and X_i^c is output of product i in country c. If the final demand vector $\boldsymbol{f}^c = (f_i^{p,c})$ is the consumption of country c, the elasticity of final user prices (i.e., ζ^c) becomes the elasticity of consumer prices. The elasticities of import prices, investment-related product prices, and intermediate product prices are calculated by replacing the final demand vector by the respective demand vector.

Simulation

The impacts of the current container freight rate surge on prices and production costs at the country or product level are calculated by multiplying the aggregated elasticities by the changes in the CCFI level between the two scenarios:

$$\zeta^c \times \left(\frac{CCFI_{long}^{Composite}}{CCFI_{long}^{Composite*}} \times Adj - 1 \right) := \zeta^c \times \left(\frac{CCFI_{August\ 2021}^{Composite}}{CCFI_{August\ 2020}^{Composite}} \times Adj - 1 \right)$$

where $CCFI_{long}^{Composite}$ is the level of the CCFI Composite Index in the "long-term" under the container freight rate surge scenario (i.e., 3027.91 points in August 2021), $CCFI_{long}^{Composite*}$ is the level of the CCFI Composite Index in the "long-term" under the no container freight rate surge scenario (i.e., 884.02 points in August 2020), and Adj is an adjustment factor to convert changes in the CCFI to changes in international transport margin. Adj is calibrated by aligning changes in total international transport margin implied by the current simulation with changes calculated from a regression analysis at macroeconomic level (i.e., total international transport margin is regressed on the CCFI, and the estimation result is used for the extrapolation). The aggregated elasticity of final user prices at the country level (i.e., ζ^c) is replaced by the elasticity at the product level (i.e., ζ_i), at the global level (i.e., ζ^{global}), or the elasticity of production costs at the country level (i.e., η^c) when impacts on product level final prices, global level final prices or country level production costs are calculated.

Data

The estimation of the elasticities of prices and production costs at the country or product level is mainly based on the World Input-Output Database (WIOD, http://www.wiod.org/home, accessed 7-8 June 2021) developed by Timmer et al., 2015. The WIOD covers 43 countries (i.e., 28 EU countries and 15 other major countries) and 56 sectors. The calculation of the containerized ratio is based on the bilateral trade data by transport mode (the GTCDIT) retrieved from the UNCTADstat (https://unctadstat.unctad.org/EN/TransportCost.html, accessed 24 June 2021). The data on CCFI Composite Index is sourced from Clarksons Research, *Shipping Intelligence Network* (accessed 2 September 2021).

Technical note 3: Simulation of dynamic impacts on industrial production (section D.4)

The analysis in section D.4 simulated the dynamic impacts of container freight rate increases on the industrial production in major economies. The simulated impacts are defined as cumulative changes in the level of the industrial production induced by an increase in container freight rates.

Estimation

The regression is based on the global vector autoregression (GVAR) model developed by Pesaran et al., 2004. The GVAR consists of a set of vector autoregression (VAR) models at the individual country level:

$$\boldsymbol{x}_{i,t} = \boldsymbol{a}_{i,0} + \boldsymbol{a}_{i,1}\, t + \sum_{l=1}^{p_i} \boldsymbol{\Phi}_{i,l}\boldsymbol{x}_{i,t-l} + \boldsymbol{\Lambda}_{i,0}\boldsymbol{x}^*_{i,t} + \sum_{l=1}^{q_i} \boldsymbol{\Lambda}_{i,l}\boldsymbol{x}^*_{i,t-l} + \boldsymbol{\Psi}_{i,0}\boldsymbol{\omega}_t + \sum_{l=1}^{q_i} \boldsymbol{\Psi}_{i,l}\boldsymbol{\omega}_{t-l} + \boldsymbol{u}_{i,t}$$

$$\boldsymbol{\omega}_t = \boldsymbol{\mu}_0 + \boldsymbol{\mu}_1\, t + \sum_{l=1}^{p_\omega} \boldsymbol{\Phi}_{\omega,l}\boldsymbol{\omega}_{t-l} + \sum_{l=1}^{q_\omega} \boldsymbol{\Lambda}_{\omega,l}\boldsymbol{x}^*_{\omega,t-l} + \boldsymbol{\eta}_t$$

$$\boldsymbol{x}^*_{i,t} = \sum_{j\neq i}^{N} w_{i,j}\boldsymbol{x}_{j,t}\,,\ \boldsymbol{x}^*_{\omega,t} = \sum_{j=0}^{N} w_{\omega,j}\boldsymbol{x}_{j,t}$$

where $\boldsymbol{x}_{i,t} = (y_{i,t}\,, \pi_{i,t}\,, eq_{i,t}\,, er_{i,t}\,, sr_{i,t}\,, lr_{i,t})^t$ are the country-specific endogenous variables of country i in time t, $\boldsymbol{x}^*_{i,t} = (y_{i,t}{}^*\,, \pi_{i,t}{}^*\,, eq_{i,t}{}^*\,, er_{i,t}{}^*\,, sr_{i,t}{}^*\,, lr_{i,t}{}^*)^t$ are the foreign variables (i.e., weighted average of foreign countries' endogenous variables) for country i, $\boldsymbol{\omega}_t = (p_t^{oil}\,, p_t^{freight})^t$ are the global variables common for all countries, $w_{i,j}$ is the weight on country j's endogenous variables for constructing country i's foreign variables such that $\sum_{j\neq i}^{N} w_{i,j} = 1$, $w_{\omega,j}$ is the weight on country j's endogenous variables for constructing feedback variables for the global variables such that $\sum_{j=0}^{N} w_{\omega,j} = 1$, and $\boldsymbol{u}_{i,t}$ are cross sectionally weekly correlated error terms. $y_{i,t}$ is the industrial production, $\pi_{i,t}$ is the consumer inflation, $eq_{i,t}$ is the real equity price, $er_{i,t}$ is the real effective exchange rate, $sr_{i,t}$ is the nominal short-term interest rate, $lr_{i,t}$ is the nominal long-term interest rate, p_t^{oil} is the oil price, and $p_t^{freight}$ is the freight rate. All variables are in levels and, with the exception of the interest rates, in logarithmic transform. Data on industrial production and consumer prices are seasonally adjusted.

In the country i's VAR model, $\boldsymbol{a}_{i,0}$ is the intercept term, $\boldsymbol{a}_{i,1}$ is the coefficient on the time trend term, $\boldsymbol{\Phi}_{i,l}$ is the matrix of coefficients on the lagged endogenous variables, $\boldsymbol{\Lambda}_{i,0}$ is the matrix of coefficients on the contemporaneous foreign variables, $\boldsymbol{\Lambda}_{i,l}$ is the matrix of coefficients on the lagged foreign variables, $\boldsymbol{\Psi}_{i,0}$ is the matrix of coefficients on the contemporaneous global variables, and $\boldsymbol{\Psi}_{i,l}$ is the matrix of coefficients on the lagged global variables. In the VAR model for the global variables (i.e., the dominant unit model with the feedback effects), $\boldsymbol{\mu}_0$ is the intercept term, $\boldsymbol{\mu}_1$ is the coefficient on the time trend, $\boldsymbol{\Phi}_{\omega,l}$ is the matrix of coefficients on the lagged global variables, and $\boldsymbol{\Lambda}_{\omega,l}$ is the matrix of coefficients on the lagged feedback variables. The lag orders in the individual countries' VAR models and the dominant unit model (i.e., p_i, q_i, p_ω, and q_ω) are determined by the Akaike Information Criterion (AIC). The individual countries' VAR models and the dominant unit model are estimated using the GVAR toolbox 2.0 (Smith and Galesi, 2014).

Simulation

An impulse response analysis is conducted to simulate the impact of freight rate increases on the industrial production. The impact of the one standard deviation shock in freight rates is calculated by the generalized impulse response functions using the GVAR toolbox 2.0 (Smith and Galesi, 2014).

Data

The present analysis covers 31 major economies in the world (i.e., 24 countries in the EU-27 and 7 other major countries). The primary data source for the six endogenous variables (i.e., industrial production, consumer inflation, real equity prices, real effective exchange rate, nominal short-term interest rate, and nominal long-term exchange rate) is a dataset constructed by Feldkircher et al., 2020 (accessed 10 June 2021).

The other data sources used in the analysis are as follows: For the real effective exchange rates, the monthly real effective exchange rate indices (broad indices) calculated by the Bank for International

Settlements (https://www.bis.org/statistics/eer.htm, accessed 10 June) are used in the present analysis. For Container freight rates, the Containership Timecharter Rate Index is sourced from Clarksons Research, *Shipping Intelligence Network* (accessed 3 June 2021). For regional aggregation of the country level results and the construction of the feedback variables for global variables, current GDP based on purchasing power parity (PPP) is used as weights. The GDP data is sourced from the World Bank, *World Development Indicators* database (https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD, accessed 10 June).

Technical note 4: Simulation of impacts of improving structural determinants on maritime transport costs (section E.2)

The analysis in section E.2 simulated the impacts of improving the structural determinants of maritime transport costs (i.e., the quality of port infrastructure, trade facilitation measures, and direct liner shipping connections) on maritime transport costs in ad valorem terms.

Estimation of the elasticities

The elasticities of maritime transport costs with respect to the structural determinants are estimated by the following panel regression:

$$ln\,Cost_i^{c,p} = \alpha_i + \alpha^p + \beta x^c + \gamma\,log(Dist^{c,p})$$

where $Cost_i^{c,p}$ is the maritime transport costs (per cent of FOB value) for importing commodity i (at the HS code 6-digit level) from country p to country c, α_i is the commodity fixed effects, α^p is the partner country (i.e., exporting country) fixed effects, x^c is a transport costs determinant of country c, and $Dist^{c,p}$ is the distance between country c and p. The country c's fixed effects are not included in the regression because they will cause the multicollinearity problem if they are included together with the transport costs determinants of country c. Only one transport costs determinant (i.e., either the quality of port infrastructure, trade facilitation measures, or the direct liner shipping connectivity) is included in the above equation at the same time to avoid the multicollinearity problem. The regression is run for each of the transport costs determinants to estimate the respective elasticity β.

When estimating the elasticities for the LDCs subsample, the equation is augmented to include an interaction term between the transport costs determinants and the dummy variable for the LDCs:

$$ln\,Cost_i^{c,p} = \alpha_i + \alpha^p + \beta x^c + \delta(x^c \times Dum_{LDC}^c) + \gamma\,log(Dist^{c,p})$$

where Dum_{LDC}^c is the dummy variable for LDCs and equals to one if country c is a LDC and zero otherwise. The elasticity of the maritime transport costs with respect to the transport costs determinants for LDCs is given by the sum of β and δ.

Simulation

To simulate the impacts of improving the structural determinants on maritime transport costs, the estimated elasticities are multiplied by the difference between the 25th percentile and the 75th percentile of the structural determinant: $\beta \times (x^{75th} - x^{25th})$, where x^{zth} is the zth (i.e., 75th or 25th) percentile of one of the transport costs determinants (i.e., the quality of port infrastructure, trade facilitation measures, or the direct liner shipping connectivity). In the simulation for the LDCs subsample, the formula is modified as follows: $(\beta + \delta) \times (x^{75th} - x^{25th})$.

Data

The maritime transport costs in 2016 at the commodity and bilateral country level are based on the Global Transport Costs Dataset for International Trade (GTCDIT, https://unctadstat.unctad.org/EN/TransportCost.html, accessed 24 June) developed by UNCTAD, the World Bank, and Equitable Maritime Consulting. The maritime transport costs in ad valorem terms are calculated by the following formula: $(CIF_i^{c,p} - FOB_i^{c,p}) / FOB_i^{c,p}$, where $CIF_i^{c,p}$ is the CIF value of commodity i's imports from country p to country c, and $FOB_i^{c,p}$ is the corresponding FOB value. The distance between the exporting country (i.e., country p) and the importing country (i.e., country c) is also recorded in GTCDIT.

The quality of port infrastructure is assessed in the Global Competitiveness Report published by the World Economic Forum. The score ranges from 1 (i.e., extremely underdeveloped) to 7 (i.e., well developed and efficient by international standards). The data for 2015-2016 are retrieved from the World Bank, TCdata360 (https://tcdata360.worldbank.org/indicators/IQ.WEF.PORT.XQ?country=BRA&indicator=1754&viz=line_chart&years=2007,2017, accessed 24 June). The data on trade facilitation measures are sourced from the *UN Global Survey on Digital and Sustainable Trade Facilitation* conducted by the UN Regional Commissions (https://www.untfsurvey.org/, accessed 24 June). The total trade facilitation score in 2015 is used in the analysis in the main text. The impacts of the five main individual scores (i.e., cross-border paperless trade, paperless trade, institutional arrangement and cooperation, formalities, and transparency) are also assessed and reported in relevant footnotes. For liner shipping connectivity, the number of directly connected countries in the liner shipping network (i.e., called degree centrality in the network analysis literature) is calculated based on a dataset provided by MDS Transmodal. Unlike the other two transport costs determinants, the logarithmic form is used for the estimation and simulation.

Technical note 5: Impacts of the trade imbalance and trade volume on maritime transport costs (section E.3)

Estimation of the elasticities

The analysis in section E.3 estimated the elasticity of maritime transport costs with respect to the trade (im)balance and the trade volume based on the following regression:

$$\ln Cost_i^{c,p} = \alpha_i + \alpha^{c,p} + \beta LBalance_i^{c,p} + \gamma \log(Volume_i^{c,p})$$

where $Cost_i^{c,p}$ is the maritime transport costs (per quantity unit of goods) for importing commodity *i* from country *p* to country *c*, α_i is the commodity fixed effects, $\alpha^{c,p}$ is the bilateral country pair fixed effects, $LBalance_i^{c,p}$ is the log of the trade balance of commodity *i* between country *c* and country *p*, and $Volume_i^{c,p}$ is the import volume of commodity *i* from country *p* to country *c*. The unit of the goods quantity used in the variables $Cost_i^{c,p}$ and $Volume_i^{c,p}$ is different by commodity. For example, the quantity of tomatoes is measured in kilograms while the quantity of textile wallcoverings is measured in square meters. The difference in the measurement unit is controlled by the commodity fixed effects α_i in the regression. Also, the impacts of the distance and the transport costs determinants analyzed in section E.2 (i.e., the quality of the port infrastructure, trade facilitation measures, and the direct liner shipping connections) are controled by the bilateral country pair fixed effects $\alpha^{c,p}$ in the present analysis.

The estimated elasticities, β and γ, are multiplied by 10 in figure 3.19. β represents the trade imbalance effect, and γ represents the economies of scale effect. It should be noted that the estimated economies of scale effect can be overestimated due to the reverse causality stemming from the trade promotion effect of low transport costs.

Data

All the variables used in the regression are based on the Global Transport Costs Dataset for International Trade (https://unctadstat.unctad.org/EN/TransportCost.html, accessed 24 June) developed by UNCTAD, the World Bank, and Equitable Maritime Consulting. The number of observations in the regression is 763,352 after selecting observations where the maritime trade value on the opposite direction is available.

The maritime transport costs per quantity unit of goods, $Cost_i^{c,p}$, are calculated by the following formula: $(CIF_i^{c,p} - FOB_i^{c,p}) / Volume_i^{c,p}$, where $CIF_i^{c,p}$ is the CIF value of commodity *i*'s imports from country *p* to country *c*, and $FOB_i^{c,p}$ is the corresponding FOB value. The log of the trade balance, $LBalance_i^{c,p}$, is calculated by the following formula: $LBalance_i^{c,p} = \log(Value_i^{c,p}) - \log(Value_i^{p,c})$, where $Value_i^{c,p}$ is the import value (in terms of FOB) of commodity *i* from country *p* to country *c*, and $Value_i^{p,c}$ is the trade value of commodity *i* in the opposite direction (i.e., from country *c* to country *p*).