Efficient yet Exposed

Why container port congestion isn't going away anytime soon

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Efficient yet Exposed: Why container port congestion isn't going away anytime soon is part of a series of discussion papers produced by Foresion that aim to holistically explore contemporary supply chain issues and future directions, focusing on logistics, emerging technologies, and environmental sustainability. These papers are aimed at business practitioners, policymakers, and governments as a vehicle for improving integration and visibility along key supply chains.

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Cover photo credits: Mike Kelly, Port Technology

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Glossary

Beam	Vessel width
Break-bulk Cargo	Cargo not containerised but otherwise packed or bundled
Bulk Cargo	Unpacked dry cargo (e.g., iron or coal ore, crude oil etc.)
Draught	The distance between a ship's keel and the waterline of the vessel
Economy of Scale	Decreasing unit costs experienced with increases in scale
Gateway Ports	Ports that mainly serve as transfer points for cargo/containers between (in)land and sea transport
Intermodal Container	Container unit of standard dimensions that can be transported by container ships
Port Call	A port where ships customarily stop for supplies, loading, unloading or transhipment of cargo
SCFI	Shanghai Containerised Freight Index reflects the ocean freight and the associated seaborne surcharges of individual shipping routes on the spot market
Service Rationalisation	The concentration of shipping lines' services on a limited number of ports to take advantage of economies of scale in port calls and cargo handling
Shipper	Cargo owners or entity responsible for cargo that consigns or receives goods for transportation
Shipping Line	Operator of container vessels that offers scheduled sea transport services to shippers
Short-sea Shipping	Sea transport mainly focused on coastal shipping, and which does not include an ocean transit leg
Slow Steaming	Sailing at less than vessel design speed
TEU	Twenty-Foot Equivalent Unit is a measurement unit used to determine the capacity of container ships and terminals
Transhipment Hubs	Ports that mainly serve as transfer points for cargo/containers between different ships
ULCV	Ultra Large Container Vessel


Credit:
Port Technology

Executive Summary

In the wake of the Ever Given incident in the Suez Canal on March 23rd [1] and the production stoppages due to pandemic-related restrictions, the world witnessed the implications of serious port congestion. As of the 12th of October 2021, 143 container ships totalling more than 1 million TEU in capacity were at anchor outside some of the world's largest ports. The Shanghai Containerised Freight Index (SCFI) almost doubled in months following the Ever Given incident and shipping rates of more than 15,000 USD for a 40ft container on the Asia-Europe route were quoted[2]. The disruption to container shipping was so serious that Coca Cola announced that they would be shipping cargo in break-bulk ships to keep their supply chain functioning[3]. IKEA and Walmart rushed to charter their own container ships and to buy their own containers to avoid the capacity crunch[4] while other retailers air freighted goods to maintain sufficient inventory[5].

Containerised shipping has been the main driving force behind unprecedented growth in international trade. It has been instrumental in the globalisation of supply chains because of its immense transport efficiency. However, it is also vulnerable and recent events have pushed many large companies to adopt less efficient, more expensive, and/or less environmentally sustainable transport modes. Of concern, is that these modes are likely to continue even after container liners and terminals clear the backlog of ships in most of the world's largest ports?

While a complex set of factors interacted to generate the on-going global container crisis, two major elements at the core of containerised shipping were key: the emphasis on **economies of scale** and extensive use of **slow steaming**.

Container ships have increased in size since the turn of the century to take advantage of economies of scale in ship sizes and fuel consumption. Reaping the benefits of economies of scale required concentrating cargo volumes into a few large ports. Shipping lines have also adopted slow steaming as a standard practice to increase fuel efficiency. However, optimising ship designs for slow steaming has reduced their flexibility by making them extremely costly to run at higher speeds if needed– such as during the current crisis.

The quest for economies of scale in container shipping and fuel efficiency through slow steaming spurred the appearance of ultra large container vessels (ULCVs), that travel the world's oceans The unintended consequence of this drive has been that shipping lines are more exposed to disruptions. Lines limited their adaptability and redundance in port choice and limited their flexibility to make up distance between ships. Consequently, port congestion at many of the world's major ports is worsening and is unlikely to be resolved within the next 12-24 months.

Clearing port congestion will likely require time, cooperation, resources, and dedicated effort from all participants in supply chains. Shipping lines and shippers have several levers available to address port congestion over both the short and longer terms.

Shipping lines need to consider improving service flexibility, resilience, and redundancy. In the short term this may require coordinating with port operators and shippers to skip port calls and increase the use of transhipment and short sea shipping services. In the longer term, shipping lines need to consider diversifying services to minimise the impact of disruptions. Carriers could also consider using foldable containers. This would significantly reduce pressures on landside and ship-to-shore (STS) operations by allowing trucks, trains, and port equipment to handle more containers more efficiently.

Shippers should consider modal shift where possible, whether this is from shipping to rail or road or from container to break-bulk. Loading containers on bulk ships can also decrease the pressure on the container shipping fleet and take advantage of the otherwise empty return voyages of most bulk vessels. In the longer term, shippers should consider nearshoring production.

EVER Given stuck in Suez Canal
Credit: Ahmed Gomaa/Xinhua/Zuma Press

Introduction

It only took 6 days to re-float Ever Given after it grounded while navigating the Suez Canal on March 23rd and this short time was enough for more than 350 vessels to amass on both sides of the Suez Canal[6]. During the re-floating operation, some shipping lines had to make the difficult decision of navigating around Africa' Southern-most point, the Cape of Good Hope. Diverting around the Cape of Good Hope would add 2 weeks to ships' sailing time but avoided the Suez chokepoint. Global supply chains had already been placed under stress following factory closures in China and other pandemic-related decisions. The Suez Canal obstruction was unlikely to help supply chains' recovery.

As ships began to transit the Suez following the re-floating of the Ever Given on the 28th of March, it seemed that the worst had passed. In fact, global supply chain problems were only just beginning!

The Suez obstruction meant that the distance between ships assigned to the same loop or calling the same port was reduced. Container ships generally operate in loops – sequences of ports that container ships call to load and unload containers. Each loop usually features a weekly call to a certain port. Reducing or eliminating the distance between ships on the same loop or calling the same ports triggered congestion in many of the world largest container ports.

Port congestion started shortly after the first ships sailed from the Suez after March 28th and continued for several months. By October 12th more than 140 container ships totalling more than 1 million TEU in capacity were anchored outside major ports in Asia, Europe, and North America.

These drastic decisions raise however some key questions:

- How did the Suez obstruction and the pandemic-related disruptions bring global supply chains to a standstill?
- Why would companies contemplate using supposedly less efficient shipping mode, such as break-bulk shipping, or smaller container ships in light of these disruptions?
- What are the options to reduce port congestion and restart global trade?

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Approach and Structure

This report examines the evolution of two key dimensions of container ships: size and sailing speed. The implications for container terminals, ports and the land-side operations are discussed. Next, the report analyses the consequences for shipping services, ports and global supply chains following the Ever Given incident. Finally, several options for shipping lines and shippers are proposed to mitigate the consequences of port congestion, global supply chain disruptions and to build resilience in global container shipping

Crawling Ocean Giants

Although several factors played a role in reaching the ensuing global container crisis, two major factors stand out: the sector's emphasis on **economies of scale** and extensive use of **slow steaming**.

Container ships have increased in size since the turn of the century to take advantage of economies of scale in shipping capacity and fuel consumption. Reaping the benefits of economies of scale required concentrating cargo volumes into a few large ports.

Ships have also adopted slow steaming as a standard practice to increase fuel efficiency. However, optimising ship designs for slow steaming reduced their ability to run at higher speeds was or made it extremely costly to do so.

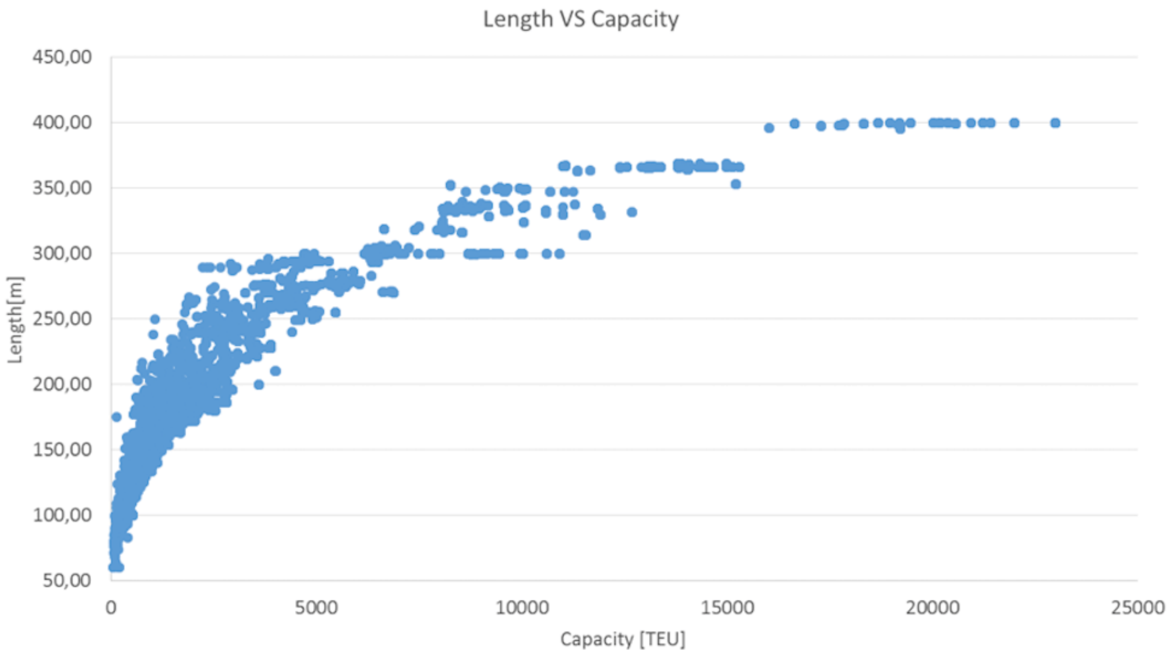


Figure 1 Container Ship Length vs Capacity (Source: Port de Barcelona[7])

Ship Length

Ever since the first intermodal containers was loaded onboard a ship, container ships have been getting larger and larger. Encounter Bay, built in 1968, had a capacity of 1530 TEU. Close to 40 years later, the 6th generation container ship, Emma Maersk had a nominal capacity of 11,000 TEU[8]. Since the Emma Maersk, container ships have increased in size at an accelerated pace into ultra-large container vessels (ULCV). On September 18th 2021, the 400 metre long, 62 metre wide beam and 16 metre maximum draught Ever Ace set the record for the largest container ship in the world with a carrying capacity of 23,992 TEU[9]. More carrying capacity generally means bigger ships – longer, wider beam, and increased draught. The beam of a ship measures its width. The draught of a ship measures the distance between the lowest point of the ship and the waterline.

Container ships' lengths seem to have stabilised around the 400-metre mark. Even the largest container ship, Ever Ace, is 400-metres long. Length does however have some implications on port access and efficiency.

Port berths, the long piece of concrete or tarmac next to which a ship docks, are built in different configurations and lengths. Some container terminals such as Northport 1 and 2 and Westport in Port Klang, Malaysia feature a continuous berth length of almost 4 kilometres[10]. Other ports such as Trieste in Italy feature a single berth of 770-metres long. Increasing vessel lengths have limited effects on container terminals such as those in Port Klang. However, ULCV do affect the capacity of some ports. While two 300-metre-long ships could berth at Trieste simultaneously, only one 400-metre ULCV can berth next to a much smaller ship.

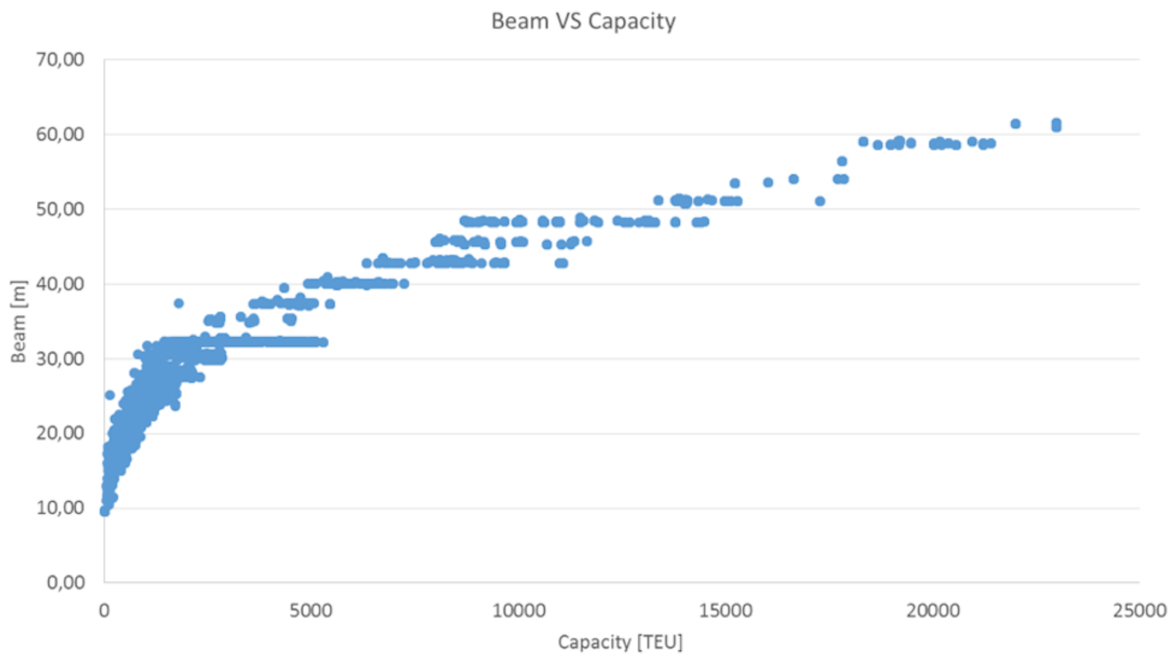


Figure 2 Container Ship Beam vs Capacity (Source: Port de Barcelona[7])

Ship Draught

Intuitively, draught would increase with the increase in container ship carrying capacity. However, this is not necessarily the case. Although draught has increased with ship size, it plateaued at 16-metres for ships from 10,000 TEU. Most ports can however handle ship draughts of around 16 metres. Dredging may be required cases where ports are located on rivers such as Hamburg, Germany or Antwerp, Belgium. Although draught may act as a limiting factor in some cases, it is generally not the most influential.

Ship Beam

Ships' beams have increased over time and seem to be the one dimension of container ships that kept increasing with the increase in carrying capacity. Ever Ace has a 62-metre beam. Increases in ship beams had however major implication for container terminals and ports.

The wider a ship beam's, the larger the ship-to-shore (STS) cranes. Larger cranes also entail more weight and power consumption thus generally requiring quay-side upgrades. Economically, the investments in larger STS cranes made sense for ports that had a stable and substantial captive hinterland or transhipment cargo which could ensure an acceptable return on investment. Few already established and typically large container terminals and ports could justify investments in STS cranes large enough to handle ULCV.

Longer, wider beam, greater draught and higher capacity container vessels could improve efficiency for shipping lines and, to some extent port efficiency. However, larger ships required more, and larger equipment and larger terminals and ports. Some container yards required expansion or improvements to ensure sufficient container storage capacity.

Credit: Gheys

Slow Steaming: Sailing Further, Slower

Slow steaming was adopted by shipping lines starting from 2008 in response to rising bunker fuel prices and the excess shipping capacity the global financial crisis had created[11]. Slow steaming means that container ships travel at less than their design speed. Prior to 2008 many container ships would sail at 20-25 knots. Through slow steaming, ships sailed at 18-20 knots. More recently, lines have introduced super slow steaming which means sailing at 15-18 knots [12]. Slow and extra slow steaming practices had a significant impact both on the ships' fuel consumption and shipping capacity absorbed.

Slow steaming helped significantly reduce vessels fuel consumption. The fuel savings obtained from slowing down container ships from 24 to 20 knots are approximately 180 tonnes per day. Slowing down to 18 knots reduces fuel consumption by a further 40 tonnes per day. Over the course of a 70+ day voyage of a container ship on a typical Asia-Europe loop the fuel savings achievable are close to 14,000 tonnes of bunker. The cost and environmental implications of slow steaming clearly make this practice attractive to shipping lines. More recently, shipping lines have further committed to slow steaming by optimising ULCV designs to slower speeds.

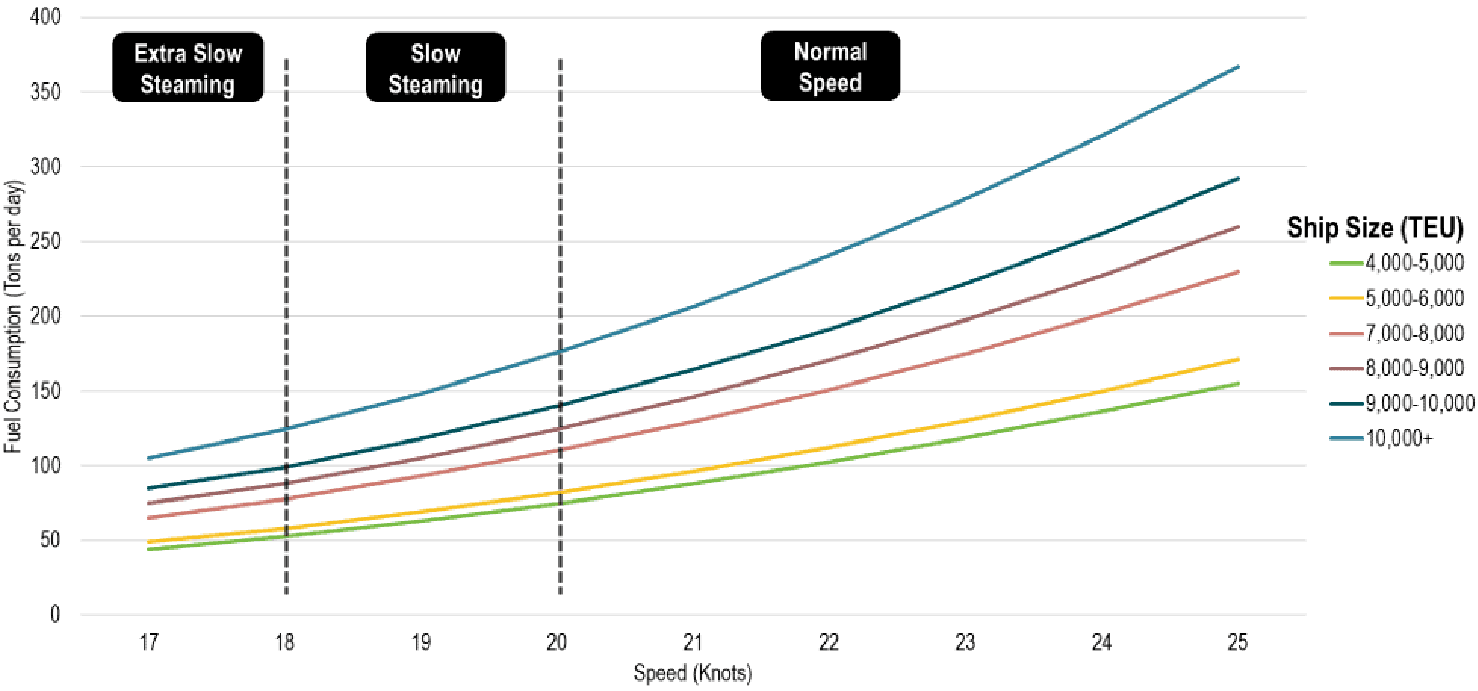


Figure 3 Container ship bunker fuel consumption by size and speed (Source: Transport Geography[12])

One of the most visible design changes is the removal of vessels' bulbous bows[13]. However, as newer ships are designed for slow steaming, their ability to run at higher than design speeds is impaired, or extremely costly.

Slower sailing increases the number of ships required on a loop to maintain a weekly sailing schedule. The sailing time on a typical Asia-Europe loop today is 70+ days and 10-11 vessels are used on a loop to provide weekly services. Similar Asia-Europe loops sailing prior to slow steaming would likely require 7-8 ships, depending on the number of port calls. Services on the Asia to America West Coast loop provide a typical sailing time of 40 days and use 6 vessels. Similarly, prior to slow steaming, a typical Asia to America West Coast loop only consisted of up to 5 vessels on a rotation. However, an unintended consequence of having more vessels on a loop is that when sailing schedules are disrupted more ships can be affected.

Figure 4 LEFT Container ship design with bulbous bow RIGHT Bulbless bow container ship design (Source: GCaptain[22], CMA CGM[23])


Credit: Container Mag

Shipping Services and Port Implications of Larger Ships

The increase in container ships' sizes brought with it a new set of challenges for ports. Port access channels required dredging to maintain a sufficient depth. Some berths required lengthening and strengthening to manage several ships berthing simultaneously. Larger ship-to-shore (STS) were required to reach across the beam of ULCVs. Larger ships loaded and unloaded more container per port call More containers raised new yard and gate management challenges. Fuller container yards are generally more difficult to manage mainly because the net/gross container lifts ratio of yard cranes decreases. In other words, more containers must be lifted to find the right container to be loaded onboard the ship. Terminal gates were also busier because of the influx of trucks arriving to deliver and pick-up containers within the delivery windows. More trucks require more yard equipment.

Some efficiency improvements were brought about by the increase in container ships' size. Greater ship length allowed more STS cranes to work on a particular ship during a port call[14]. Additional cranes decreased the duration of port calls. Consequently, despite increases in container ship sizes, the average port call duration of a container ship, almost irrespective of its size or capacity, is roughly 0.7 days or just 17 hours[15].

To take advantage of the economies of scale offered by larger container ships, shipping lines rationalised their services. Service rationalisation means that larger container ships operating on major trade lanes (Asia-North Europe, Asia-Mediterranean, Asia-West Coast North America, Europe-East Coast Americas, etc.) call at a limited number of hub ports [16]. Shipping lines formed hub and spoke networks.

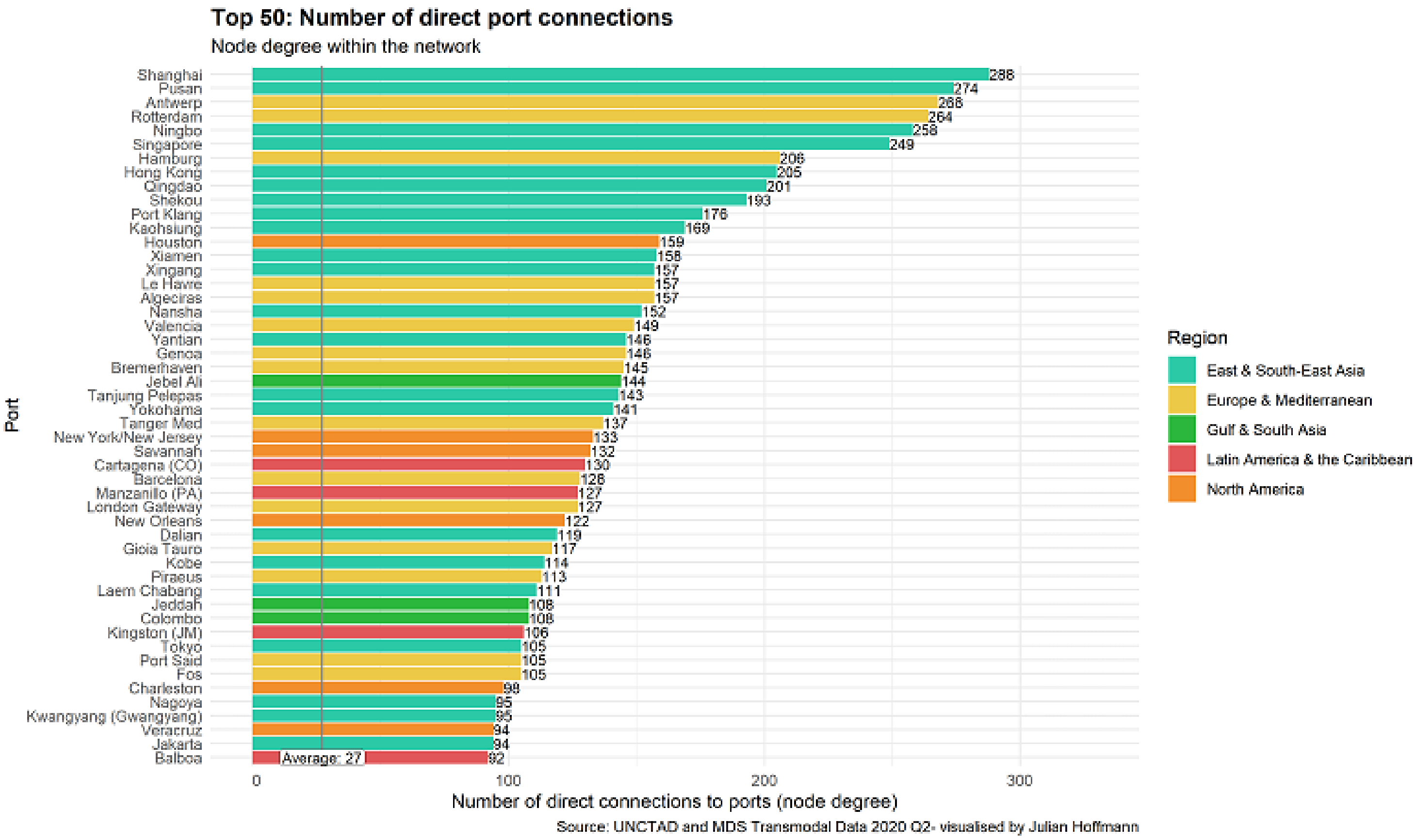


Figure 5 Top 50 container ports by direct connections (Source: UNTCAD[17])

Hubs are connected to regional ports through low- or medium-capacity feeder services and connected with one-another through high-capacity liner services. Hub ports can be either gateways serving an extensive hinterland (such as Rotterdam, Yantian, Los Angeles/Long Beach) or are mainly transhipment points (such as Piraeus, Gioia Tauro, Singapore) to transfer containers from feeder to liner services. What gateways and transhipment ports have in common is the vast amounts of infrastructure and equipment required to handle ULCVs. Importantly, few terminals and ports can afford or justify the expansion to accommodate ULCVs.

Hub ports generally enjoy many direct connections with other ports, while smaller ports are typically connected with few other regional ports and hubs. In 2020, 12,748 direct port-to-port routes connected the world's 939 container ports. However, a limited number of container ports have absorbed most direct connections. Shanghai, the most connected port features 288 direct connections, Rotterdam and Antwerp have more than 260 each and Houston has close to 160[17]. The top 50 ports feature 7,500 of the 12,748 direct port-to-port connections. The remainder of ports feature on average just 6 direct connections.

The shipping network that emerged from the rationalisation process included relatively few ports and overlap across loops of different companies. For instance, 52 shipping lines include the Ningbo-Shanghai port pair in their services, 38 lines include the Busan-Shanghai route, and 24 lines include the Antwerp-Rotterdam pair. From a connectivity perspective, this network overlap across companies provides shippers with choice. However, from a resilience perspective, this overlap reduces the networks' redundancy and limits shipping lines' ability to react in case of disruptions. As we will see later these aspects played an important role in the port congestion issues that ensued after the Ever Given incident.

Container Ships Anchored outside Los Angeles
Credit: Mike Kelly

The Consequences of Exposure

The sector's drive for economies of scale and conviction for slow steaming spurred giant container ships but also left lines **exposed** to disruptions. Network redundance was sacrificed in favor of rationalisation to take advantage of economies of scale in ports. The reduction in redundance limited the lines' flexibility to disruptions, such as those caused by the Ever Given incident. The overlap between shipping lines' networks meant that the disruption cascaded to other ports. The optimised vessel design for slow steaming also reduced individual vessels' ability to distance themselves from one-another Consequently, port congestion at many of the world's major ports is worsening.

As of the 12th of October 2021, 63 ships totalling 447,000 TEU capacity were waiting in the LA/LB port complex, 24 ships (217,000 TEU capacity) at anchor outside Savannah, GA, 30 ships (119,000 TEU capacity) at anchor in Singapore, 12 ships totalling 118,000 TEU capacity were anchored outside Rotterdam and Antwerp, 5 ships (60,000 TEU capacity) at anchor outside Hamburg, 5 ships (51,000 TEU) outside Felixstowe, 4 ships (53,000 TEU capacity) were waiting at Le Havre. With so much shipping capacity tied down in congestion, shipping rates soared to record highs.

The SCFI almost doubled in themonths following the Ever Given incident (from USD 2,583/TEU on the 19th March 2021 to USD 4,674/TEU on the 8th October 2021)[18] and rates of more than 15,000 USD for a 40tf on the Asia-Europe route were quoted[2].

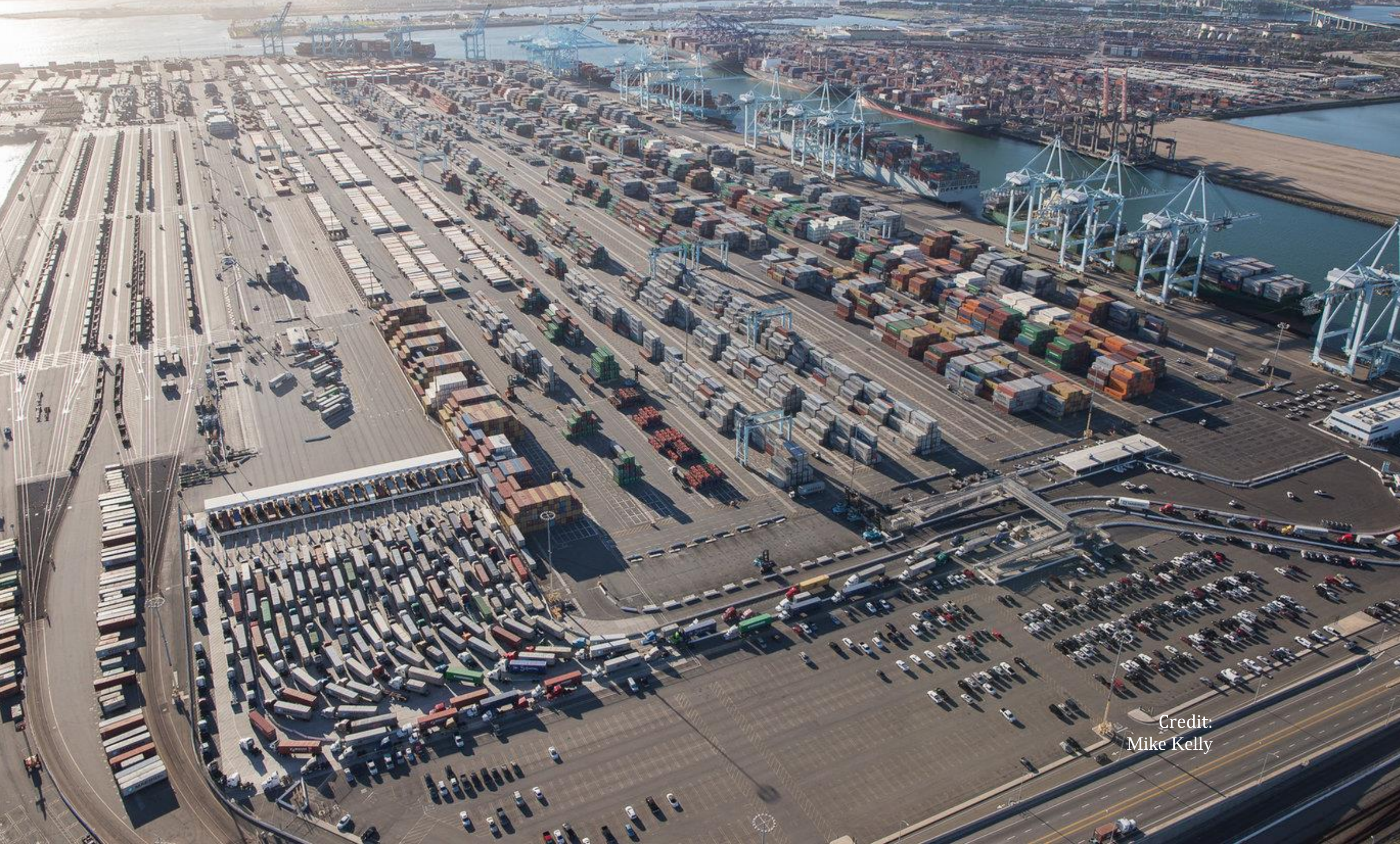
Ironically, this capacity crunch achieved what shipping lines had been struggling to achieve for quite a while, higher rates.

Port congestion, the declining schedule reliability[19] the increased freight rates and the resulting lengthening of transit times and container shortage contributed to the disruption of global supply chains. Global supply chains were forced to reconfigure. However, reconfiguring in time of crisis is not likely to result in the most cost or fuel effective or the least environmentally impacting outcomes.

The increase in container transport cost and transport times improves the comparative advantage of other transport modes – road, rail or break-bulk shipping. Before the widespread adoption of containers, general cargo ships spent several days if not weeks in ports because cargoes were handled manually. Manual handling added time and delays in supply chains. Containerisation changed this dramatically. Modern container ships spend less than a day in port. However, as container port congestion worsens, transport times increase, and the appeal of other transport modes improves. Coca Cola's announcement that the company will be shipping cargo using break-bulk ships to keep their supply chain functioning[3] is an example of improving comparative advantage in favor of break-bulk shipping. Break-bulk ships are generally smaller so typically less fuel and cost efficient as larger container ships.

Increasing freight rates can close the economic gap between using liner shipping services and chartering. Charter vessels have the added advantage that most chartered vessels are more likely to access a wider network of less congested ports because of their smaller size. This seemed to be IKEA's and Walmart's strategy when the companies rushed to charter their own container ships and buy their own containers[4].

Port congestion brings with it supply chain uncertainty. For companies that generally experience massive uptakes in sales during certain periods, such as the Christmas holidays, supply chain uncertainty means uncertain profits. To circumvent port congestion, retailers such as Aritzia Inc. chose to airfreight goods to maintain sufficient inventory ahead of the holidays.[5] However, airfreight can generate more than 30-50 times the carbon footprint as shipping.



Restarting Global Trade: Options for Sailing Forward

Clearing port congestion will require time, cooperation, resources, and dedicated effort from all participants in supply chains. The emergence of congestion in or outside ports does not necessarily imply that congestion must be solved by ports or shipping lines. Although shipping lines and ports are front and centre in the discussion on port congestion, they are not the only parties in global supply chains. Consequently, addressing port congestion will likely require changes in global supply chains at multiple levels.

As long as port congestion and supply chain disruptions continue, companies in global supply chains are likely to search and improve on transport alternatives. How container shipping and global supply chains will look like at the end of this crisis is still an open question.

Shipping lines and shippers in particular have several levers available to address congestion on the short and longer terms.

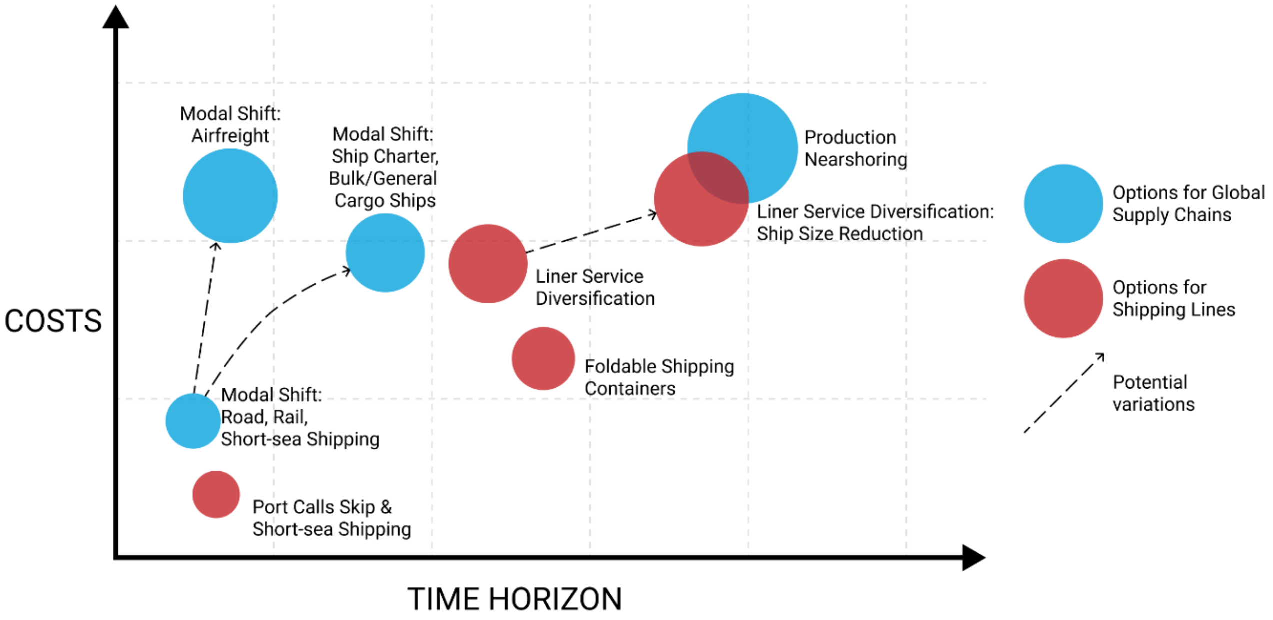


Figure 6 Potential shipper and shipping line actions to restart global supply chains (Source: Foresion 2021)

Options for Shipping Lines

Shipping lines should consider improving service flexibility and redundance. On the short term this may mean coordinating with port operators and shippers to skip port calls and increase the use transhipment and short sea shipping services. On the medium and longer term, shipping lines should consider diversifying services to minimise the impact of disruptions. Lines could also consider using foldable containers.

- **Coordinate with port operators and shippers** to skip calls in congested ports and ship containers either from transhipment hubs using short-sea shipping services or to less congested ports. This approach would maintain supply chains operational, reduce transit times by avoiding congestion and distribute containers to less congestion affected ports. However, re-routing ships will require significant collaboration between shipping lines, ports and shippers and will entail extra costs. Some lines such as CMA CGM and Hapag Lloyd have already these measures[20].
- **Diversify shipping network** to smaller ports to ease pressure from major gateway ports. A diversified shipping network may also help shipping lines differentiate their services from one-another and thus develop additional competitive advantage. On the longer term, shipping lines should consider limiting the maximum vessel size to maintain a wide network reach. The added shipping costs per TEU from operating lower-sized vessels may be compensated by the additional revenues generated from a differentiated shipping service.
- **Adopt foldable containers**. Landside operations can contribute to or aggravate port congestion. Foldable containers can reduce the pressure on port and landside logistics by reducing space and handling requirements in terminals and allowing more efficient and cost-effective landside repositioning.

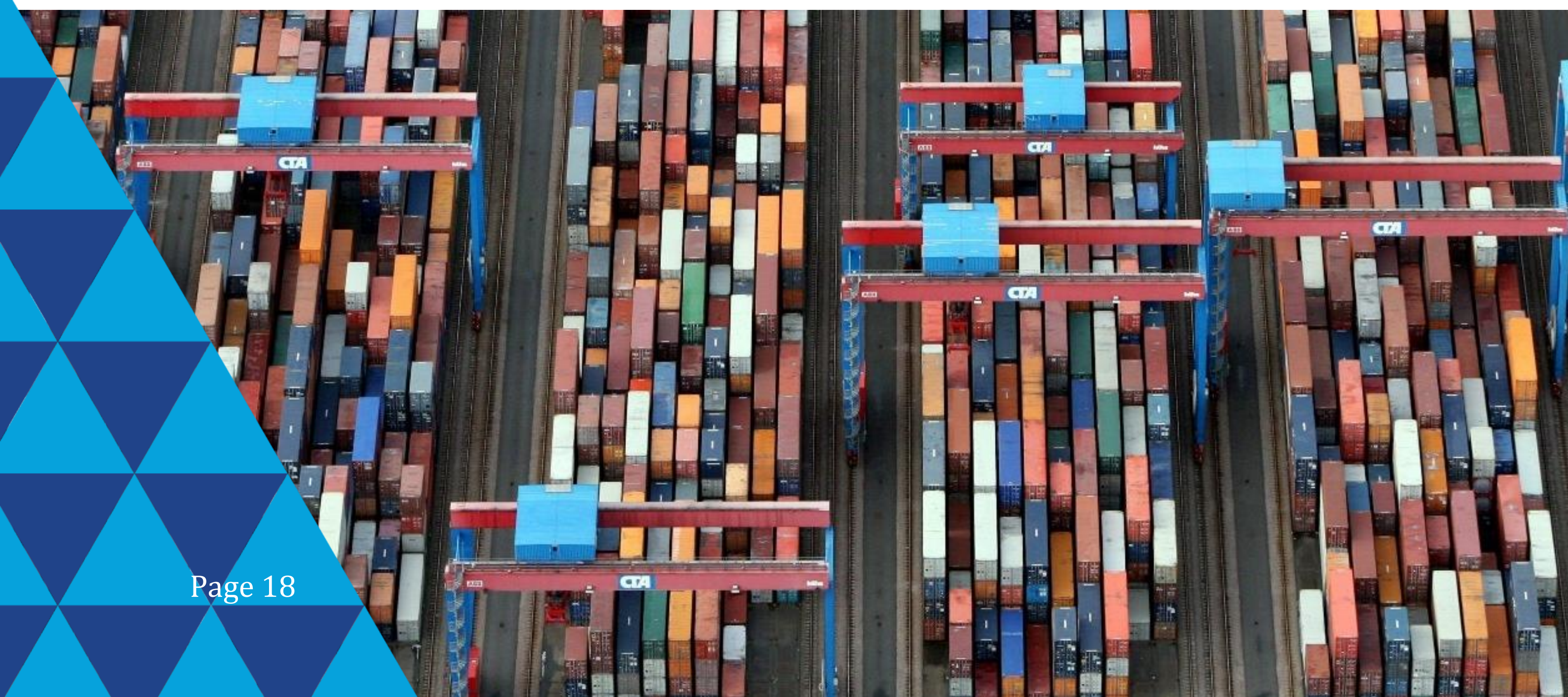
Foldable containers have so far failed to attract significant attention from shipping lines mainly due to incentive misalignment. Empty containers are generally repositioned on the backhaul leg of vessels' journeys where space is not usually constrained. Empty container repositioning is therefore a considerable cost for shipping lines but dwarves when compared to other expenses The cost savings achievable from foldable containers would likely be directly reaped by container terminals and transporters. Neither of these players have a say in the decision to introduce foldable containers.

Options for Shippers

Shippers should consider modal shift where possible, whether this be from shipping to rail or road or from container to break-bulk . Loading containers on bulk ships can also decrease the pressure on the container shipping fleet and take advantage of the otherwise empty return voyages of most bulk vessels. On the longer term, shippers could consider nearshoring production.

- **Modal shift**. Shippers should consider modal shift to rail or road where such links are available (see the Eurasian Landbridge for Asia-Europe trade[21]) and short-sea shipping for intra-region trade. Airfreight may be an option for higher value goods but should be considered as a short-term relief. However, the costs and environmental impact of airfreight are not negligible.

  On the medium term, shippers could use break-bulk ships or the return journeys of bulk ships. Break-bulk shipping may be more inefficient from a scale perspective but may provide flexibility benefits and may eliminate the need for distribution centres in some supply chains. Bulk ships (grain, ore, etc.) generally sail empty after delivering cargoes. This otherwise unused transport capacity can, with some innovation, be used to ship goods. Shippers can also consider chartering their own break-bulk or container ships. This entails a shift in business models, as shipping management is integrated in the operational management of the company.
- **Nearshoring production**. As production moves further inland in manufacturing centres such as China in search of lower labor costs transit times and supply chain uncertainty increase. Events such as the Ever Given incident have exposed the true costs of outsourcing. As labor costs increase in manufacturing centres such as China, the advantages of out-sourcing production may be counterbalanced by the disadvantages – lack of visibility, longer lead times and uncertainty. This should prompt shippers to consider relocating production closer to their key demand markets.



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