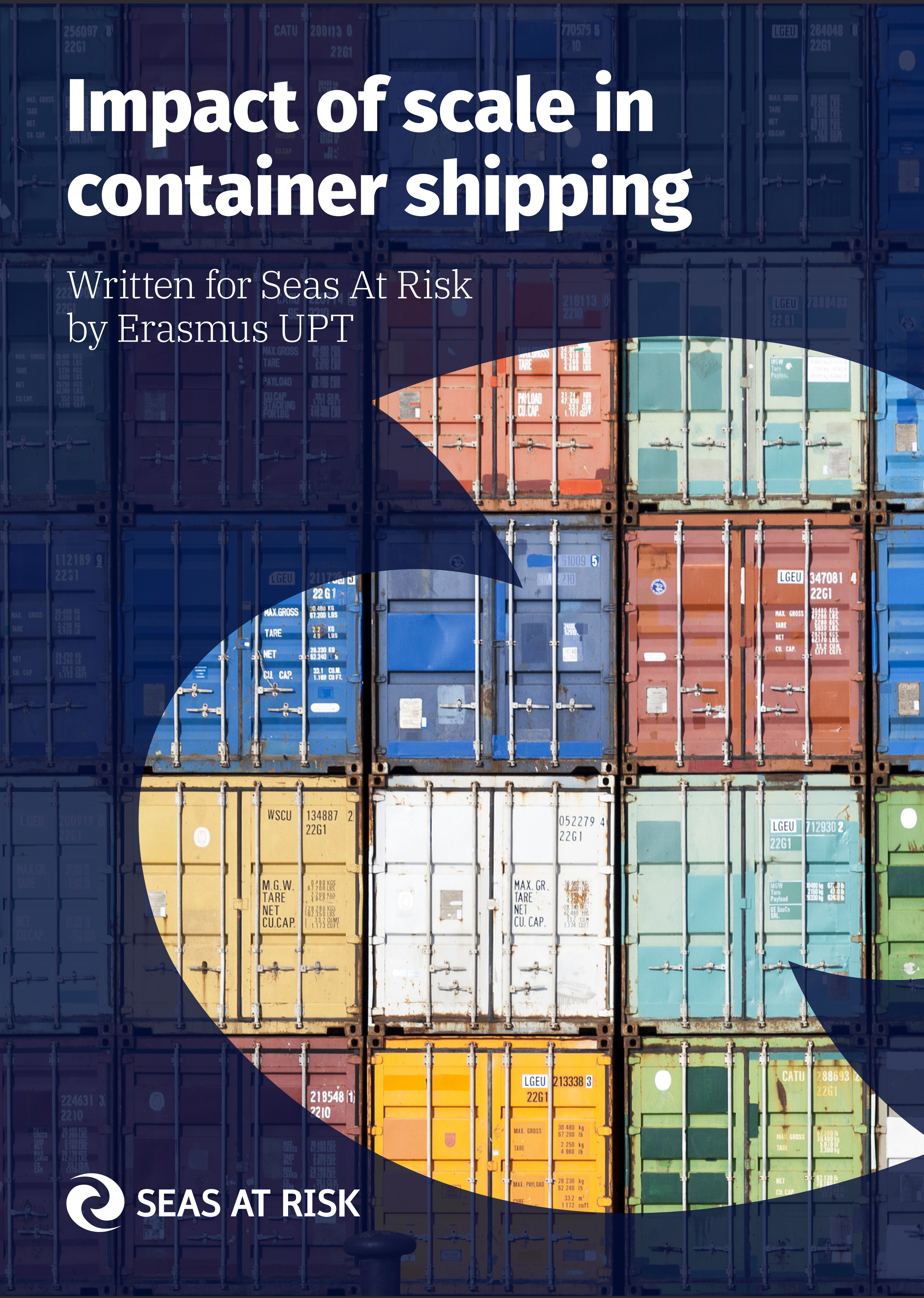
# Impact of scale in container shipping

Written for Seas At Risk
by Erasmus UPT




SEAS AT RISK

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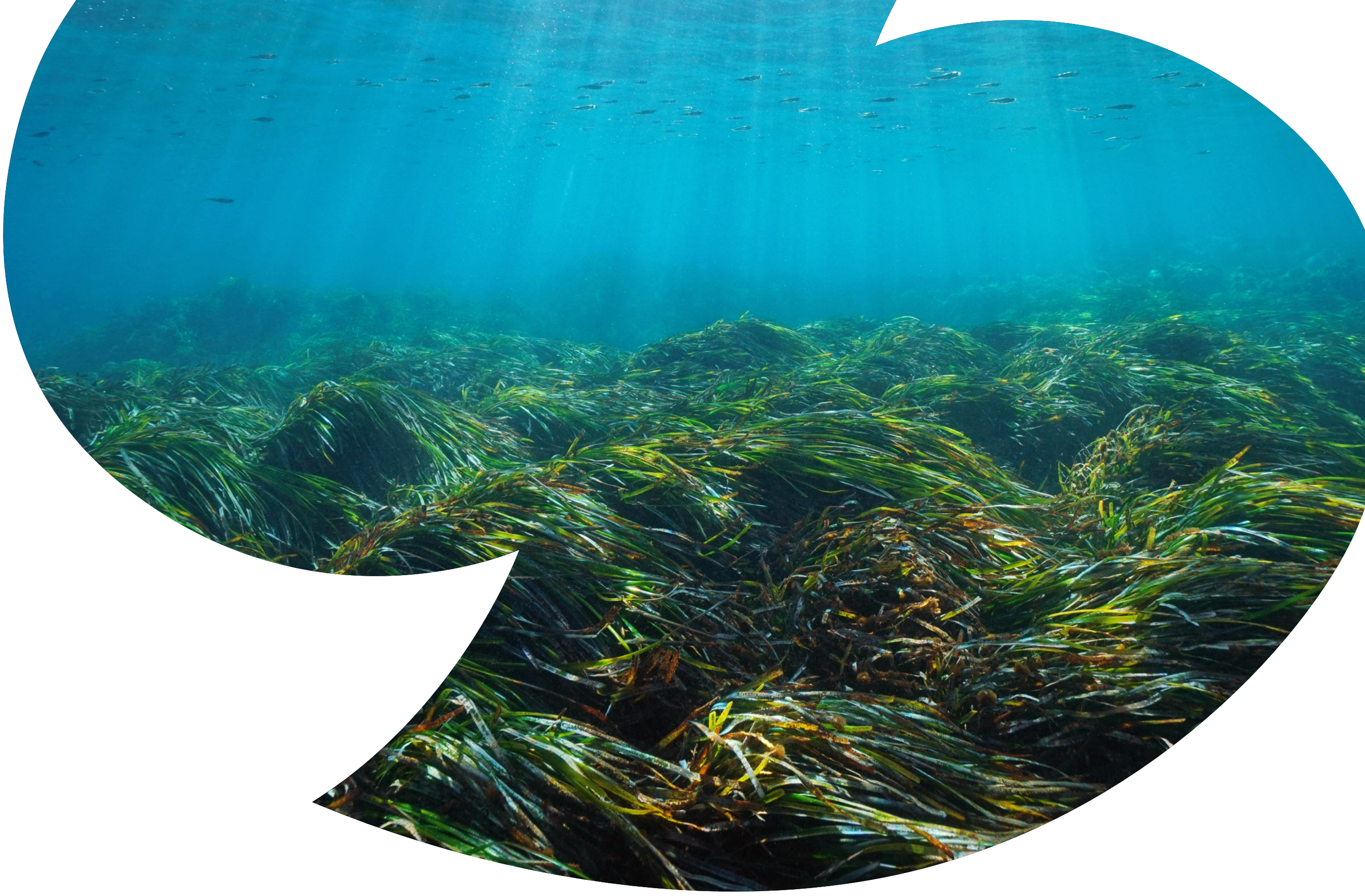


# 1. Preamble

Seas at Risk is an organization that fights for the preservation of the marine environment. Cargo shipping is one of the main threats for this environment. While ocean shipping organizations have, with some reluctance, adopted some environmental ambitions for shipping in 2030 and 2050, these are not yet fully in line with the Paris Agreement on CO2 reduction. In addition, recent years have seen large dynamics in the industry as a result of COVID-19 and other disturbances in the world transport system by sea. One of the main questions looming especially in the global container shipping industry is the impact of the size of ships on both the transport system and the environment. Current container ships measure their cargo carrying capacity in twenty foot equivalent units (TEU: the standard ISO container) and the largest ships can carry more than 24.000 TEUs. These ships are too large to enter many ports fully loaded, and this has sparked a debate for quite some years about the scale ambitions of the container shipping industry.

Seas at Risk has asked Erasmus UPT to compile a report on the container shipping industry that clarifies some of the industry dynamics and that also discusses the impact of the scale of ships. In this report, we combine some of the insights we have gained from other projects in this field, as well as some new analysis.

# Executive summary

This report aims to assess the impact of scale developments in container shipping on international trade, the cargo interests and the logistics chains of which shipping is a part. In the report, we take different perspectives to achieve this goal: a historic perspective on the development of liner shipping regulation, an economic perspective on cooperation, pricing and cyclicality, and an operational perspective on the interaction between ships and terminals and other operators in the hinterland of ports.

The background for this analysis is the unprecedented events during the Covid years, where severe congestion developed in the container shipping system, as well as extreme price hikes for transporting containers around the world. These events should be seen in the context of an ongoing discussion (at the time of writing – early October 2023) in the European Union on the anti-trust exemption that the industry has enjoyed for many decades. The fact that prices for container transport have found their way into the mainstream media has sparked a more fierce debate about this exemption than we have seen since at least 20 years.

In our historical overview, we point out that the container shipping is 'liner shipping', which means they offer scheduled, frequent and reliable services for a decent price to the 'world trade community'. To compensate for the risks they take with this type of shipping, the industry has been granted anti-trust exemptions in one way or another for more than a century. In Europe, this exemption is called the Consortium Block Exemption Regulation (CBER) for liner shipping. This CBER needs to be renewed in the EU in 2024. The discussion, currently, seems to be on hold. The opposition to the CBER has gained a number of strong arguments due to the price hikes and other shipping company behaviour in the Covid years.

Our economic analysis dives deeper into the economic issues related to liner shipping. We point out that the regulatory framework under which liner shipping operates is ancient, and does not cover any logistic performance requirement that would be suitable for the cargo shipping in containers. The reliance on expensive ships created a strong drive to manage costs. One effective way of doing that is building bigger and bigger ships. On the other hand, these large ships come with challenges: in terms of their utilization, their limited access to ports, and their low versatility in switching between routes. We also point out that, regardless of the trade facilitation narrative of liner shipping (reliable services for a decent price), the consortia have proven to be unable to control prices in times of short term capacity shortages. As a final point, we elaborate on the decline of container shipping service quality which has been going on for more than a decade.

Our economic analysis continous with a detailed look at the orderbook. This is where container shipping companies spent a large part of the extreme profits they earned during the Covid years. The interesting features in the orderbook are: investments in the largest ships concentrates on 24000 teu, but the number of orders is much less than expected. In addition to that, the industry workhorse seems to be a 15.000 teu neo-panamax container ship, which received the highest number of orders (apart from the really small coastal container ships). If the industry invests in environmentally friendly technology, it is in this category. The 24000 teu vessels receive much less attention in terms of scrubbers or alternative fuels. As environmental strategies go, both scrubbers and alternatives fuels are by no means perfect solutions.

The final part of the economic analysis is the discussion on how the container shipping industry deals with its cyclical environment. We pointed out that capacity reduction in the short run (through blanked sailings and slow steaming) has proven an effective measure in the financial crisis, but worked our disastrously in the Covid crisis.

Over time, the container shipping industry has also come up with all kinds of financial incentives for its customers to steer them away from certain cargoes, certain ports, certain periods in the year and so on. This results in very complicated invoicing, and there is also some evidence that these additional fees are more a means to generate extra revenue than an actual incentive mechanism. We also find that in 'normal' years, the rate control mechanisms of shipping lines seem to work reasonably well. In times of shocks, however, they do not have much control at all.

We present the results of a simulation study, in which we look at the impact of large ships on terminal and hinterland operations. We specifically take into account that these large ships are treated with priority in container terminals. Our model shows that large ships do have positive and negative impacts. For the terminal, handling a large ship has operational benefits. For other parties (trucking companies, barge and feeder operators), as well as the terminal itself, there are also negative consequences: peaks times, more uneven use of assets and storage space, as well as waiting times for all other transport operators. Uncertainty created by shipping lines aggrevates these negative effects. We also show the consequences of the specific situation in Rotterdam, where the 24000 teu vessels are handled twice with a so-called split call. This results in all the negative impact, but non of the positive impact of large vessels.

In our outlook, we comment on the illusion of control the container shipping industry seems to have developed. Given the significant developments that await this industry – possibly abolishing CBER, environmental policy in the EU, raised awareness of operational partners of their secondary position – we will see how much 'control' this industry really has over its own destiny.

# Our recommendations

- **On regulation:** based on economic arguments related to offering regular services, the container shipping industry probably needs a certain degree of competition protection for cooperation through consortia. The CBER in Europe should be amended to become more transparent than it currently is, and should include environmental rules for those companies that would like to use the exemption. Given the strong call for abolishing the CBER, a fruitful path forward is probably to define a alternative regulation that includes the suggestions above.

- **On performance:** the legal framework for container shipping should be modernized in order to get more balance between the requirements for quality of service and the actual service performance of shipping companies. Supporting the ratification of the Rotterdam Rules in an number of European countries could be a step in the right direction. Another step could be to raise the awareness with shippers' organisations to challenge the shipping lines on their service performance.

- **On port operations:** our results clearly show detrimental effects of prioritizing large ships entering ports on the entire hinterland chain. Awareness of port authorities should be raised on this, as well as the understanding of hinterland operators that some of their problems are caused by the large ships entering ports.
- **On dealing with shipping companies:** the digest of our discussion on container shipping companies is that these are companies that are led according to rather simple guidelines: keep costs down, keep utilization rates high, and ignore any impact of this behaviour on other parties in the chain. Combined with an anti-trust exemption, these shipping lines have explored the extremes of economies of scale, and are quite superficial in their environmental strategies. Their counter-arguments for environmental regulation should therefore be treated with some scepticism. Shipping lines should be challenged to engage more with their customers on greening supply chains as well as on delivering performance, with their chain partners on optimizing operations, and with ports on providing connectivity, and investing in effective environmental measures. Their own narrative of facilitating trade comes with responsibilities that they should embrace fully.

# 1. Introduction

## Container shipping has evolved over the last half century into a crucial facilitator of international trade and economic development.

The proposition the industry offers to the world is regular, frequent transportation at reasonable rates. In an industry that is characterized by a specific cost structure with high fixed costs, such a proposition is not easy to maintain under unrestricted competition.

The industry has therefore benefitted substantially from regulatory arrangements that have helped it to maintain these scheduled, frequent transport services. This regulation essentially curbs competition and allows cooperation on capacity, schedules, and prices. While in many parts of the world collective price fixing has been abolished, anti-trust exemptions for other cooperation models, such as consortia, still exist. In Europe, this regulatory arrangement is known as the **Consortia Block Exemption Regulation for Liner Shipping (CBER)**. A side effect of the competition restriction is that liner shipping companies can freely realize the scale economies that are the consequence of their cost structure. This has led to a race towards bigger and bigger ships.

In this essay we aim to critically assess industry dynamics and the impact of scale in ocean container shipping. We specifically look at the relationship between scale and market power and the way in which market power is exerted on other parties in the global container transport network: ports, terminals, other transport services providers, and customers and consumers. For this purpose, the following components will be discussed:

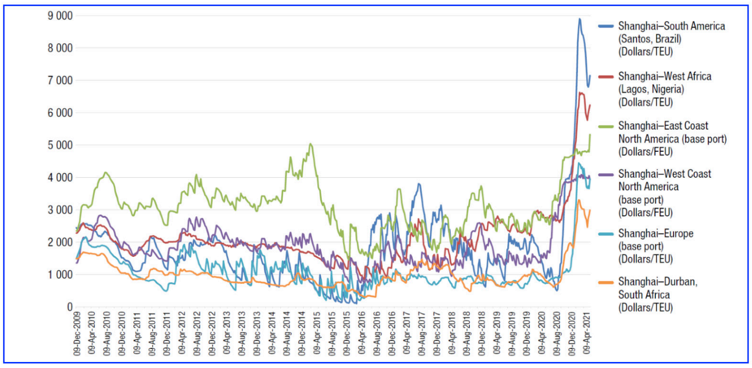
Table 1 Division of chapters

| | |
|---|---|
| Chapter 2 | *Historical development of liner shipping and its regulation* |
| Chapter 3 | *The economics structure of consortia in liner shipping* |
| Chapter 4 | *The orderbook and the future fleet* |
| Chapter 5 | *The mechanisms of shipping companies to deal with cyclicality in the market* |
| Chapter 6 | *The operational consequences of ocean ship scale on hinterland networks* |
| Chapter 7 | *Outlook on the viability of liner shipping as one of the carriers of international trade* |

Our analysis for this essay will allow us to draw conclusions on the way container shipping companies exert market power, as a result of the scale of their operation, and the way this creates inefficiencies in the global transportation of goods.

## Research Context

An important new development, or at least a series of events that has made a change visible, can be witnessed in recent years: COVID-19, the fallout as a result of COVID-19 in Chinese ports, a large container ship causing congestion in the Suez Canal, and, for example, labour unrest in European ports such as Hamburg. The consequence of this accumulation of events is that liner shipping struggled in recent years to fulfil its transport promise, empty containers for export cargo proved unavailable, transport prices went up by a factor of 5 to 10, and significant delays were the order of the day. We will see in this report that this development is not only the result of COVID-19, but reveals a more long term underlying trend. COVID-19 has just made this trend very visible. The most illustrative way to show the upheaval in the container shipping industry is by looking at the development of freight rates. This is what has made container shipping cross over from the specialized press to the mainstream media.




The price developments in Figure 1 show that a huge increase has manifesting itself in several key container routes. At the beginning of the COVID-19 crisis, rates very quickly more than doubled, and increased even further in the course of 2021. Finally, Baltic Freightos' container freight index reached a growth of a factor of 6 by the end of 2021. Meanwhile, prices have dropped back to pre-COVID levels in spring 2023.

While this quick peak of prices is not unexpected for maritime economists, it has revealed a structural problem with the standard promise of this industry: the extensive, competition reducing mechanisms that are in place to help the industry offer its regular, frequent, reasonably priced services to the global business community are not working if there is significant turmoil. This has not only raised question about the reliance of global shipping in board rooms, but it has also put the discussion on regulatory exemptions for global container shipping in a whole new light.

# 2. Historical development of liner shipping and its regulation

**This chapter discusses the historical development of liner shipping and its regulation, more specifically anti-trust exemptions. The main characteristics of the Container Block Exemption Regulation (CBER), as well as the review process of prolonging the exemption, is discussed.**

## 2.1 A brief overview

The classic term 'liner shipping' as we know it today in container transport came into being with the introduction of steamships that allowed reliable crossings between Asia, India and Europe. This development gained traction towards the end of the 19th century and introduced regular and reliable sailing schedules on the major trades.

Soon, however, the various shipping companies realized that this regularity also made them vulnerable to competition from irregular, or tramp, shipping. They, therefore, saw early on (in the late 19th century) the need to band together to cope with tramp shipping while continuing to offer regular services.

The mechanism that developed in these early years were called **conferences**. These are cooperation mechanisms that publish common sailing schedules, jointly allocate ships to these schedules, and set common tariffs for transportation. These conferences operated on a route-by-route basis, and as a result, several hundred developed over time. In an early discussion in the United Kingdom (the Royal Commission on Shipping Rings, 1909), the justification for this mechanism was established and commonly accepted.

These conferences have been the main way of working in liner shipping until well into the 1970s. A first attempt to break up the conference monopolies was the UNCTAD attempt to come up with a code of conduct for liner conferences in carrying cargo to and from developing countries[1]. This took place in 1973/1974. Eventually this code was never ratified or adopted, because the larger developed countries such as the USA did not underwrite it. Also the European Commission did not implement its provisions. It did, however, spark a discussion on market power of the conferences, which led in a rather roundabout way to the abolishment of the conferences in a large part of the world. In the EU, for instance, in the mid 1980s, the conferences were legalized, but with restrictions. Only in 2003 did the discussion begin to abolish conferences altogether, replacing it with more operationally oriented **consortia**.

Over the years, shipping companies have developed other forms to cooperate. Consortia replaced the operational coordination of conferences, but alliances were a new phenomenon. Consortia are route-based partnerships, mainly focused on the joint deployment of vessel capacity, procurement of terminal capacity and other necessities. Alliances are cooperation agreements between shipping lines, usually consisting of capacity-sharing agreements on ships and slots with global coverage, covering different services. The difference between consortia and alliances is rather vague to many people, which is why they are regularly treated (also in the discussion on regulations regarding cooperation in liner shipping) the same. However, alliances work at the sales side of shipping companies and allow them to offer global services, much in the same way as the alliances of airlines. Consortia are internal mechanisms that work at the cost side of companies, creating efficiency gains in sharing of resources and purchasing power.

## 2.2 Conferences, alliances and consortia

Container shipping lines have evolved from conferences to alliances over the past 100 years. To better understand this, we need to take a step back in time and look in a bit more detail at the early form of cooperation of liner shipping lines: the **conference**. A conference is defined in the UNCTAD Convention on a Code of Conduct for Liner Conferences (1974) as: "A group of two or more vessel-operating carriers which provides international liner services for the carriage of cargo on a particular route or routes within specified geographical limits and which has an agreement or arrangement, whatever its nature, within the framework of which they operate under uniform or common freight rates and any other agreed conditions with respect to the provision of liner services."

Liner conferences are trade agreements between shipping lines, which can legally fix prices and coordinate capacity on their respective shipping lanes. Examples of liner conferences that existed until the end of 2008 are the Far Eastern Freight Conference (FEFC) and the Trans-Atlantic Conference Agreement (TACA). These mechanisms are now defunct. However, as soon as the industry is confronted with periods of low rates, and attempts to increase the rates with a so-called General Rate Increase (GRI) is failing, industry representatives start calling for a come back of the price setting mechanism of the conference[2].

Liner conferences such as TACA tried not only to set prices for ocean shipping, but to jointly set intermodal rates for hinterland transport in Europe as well. The European Commission opposed such practices and decided that the broad block exemption from the usual ban on anti-competitive agreements for traditional liner conferences (EC Regulation 4056/86) could not be extended to hinterland operations[3]. In March 2003, an OECD report recommended that member countries remove an antitrust exemption for price-fixing and rate-fixing agreements. In the EU, a number of studies were conducted to assess the impact of such an intervention (see, for instance, Haralambides et al., 2003). The European Union eventually repealed Regulation (EEC) No 4056/86 in 2008 by Council Regulation (EC) No 1419/2006. This put an end to the antitrust immunity that liner conferences had enjoyed for a long time and ended the era of liner conferences in Europe. More on the current developments in this regulatory field will be discussed in **Section 2.3**.

A **consortium** is an operational cooperation agreement between two or more liner companies to provide a joint service in a trade or on a route. As such, consortia can be seen as the remnants of the conference activities that are still allowed.  Although a consortium agreement allows members to share space on the vessels used for the joint service, these members – the shipping lines - market their services separately (CLECAT, 2018). This also results in consortia being a relatively unknown and unseen mechanism in container shipping for the outside world. Consortia focus on a single maritime transport service and may include vessel or slot-sharing agreements. One could argue that a consortium is the mechanism to shape network cooperation like an alliance, in practice.

The more commercial part of the conferences has been incorporated in alliances. Through this mechanism, shipping lines seek to manage services in their networks, but mainly along the main east-west trade routes, by making slots on their vessels available to other alliance members (Notteboom, 2021). Service offerings are defined in terms of sailing schedules, strings of ports of call, departure days for particular vessels, and available capacity in certain ports. Freight rates are not set by alliances, and each alliance member is - or rather should be - free to negotiate its rates with its customer base.

## 2.3 Regulation

We have discussed the regulatory exemption that conferences have long enjoyed in large parts of the world. This exemption was repealed in the US and Europe towards the end of the 20th century and the beginning of the 21st century, respectively. In Europe, another exemption was put in its place to still allow shipping companies to cooperate and coordinate capacity. This mechanism became the Consortium Block Exemption Regulation or CBER. This regulation applies to consortia and is re-evaluated every 4-5 years. A review for either renewal or abolishment is currently (2023) running.

### 2.3.1 Main characteristics of the CBER

Cooperation between companies, in the form of cartels and or monopolies, has long been considered undesirable. Liner shipping, consequently, called for an exception to this 'rule' since the late 19th century. They were granted an exemption in the beginning of the 20th century[4]. The standard argument, which has been presented in several variants, is that regular shipping is of benefit to world trade and economic development, and that requires coordination and cooperation. Therefore, to some extent, an exception to the prohibition on such cooperation is necessary. Formal approval for conference operations, as well as price setting practices were established in 1986 with the so-called 4086-package (Council Regulation 4056/86 establishing the anti-trust exemption for liner conferences, but part of larger package containing some rules for prohibited practices). See an extensive discussion on the merits, or lack thereof, of conference in Haralambides et al. (2003).

The liner shipping industry has had this exception for a long time in all kinds of forms, in all kinds of places in the world. In the EU, after the repeal of the 4086 package, in 2006, a general exemption to competition law - the so-called block exemption - was created for containerised liner shipping, creating a competition exception for consortia. This exemption is still in place today (Summer 2023), although its future in uncertain.

The European Commission first adopted the **Consortia Block Exemption Regulation** in 1995 by Regulation No 870/95, with a five-year review cycle. As such, it ran parallel to the 4086-package for conferences. Until 2003, this CBER allowed these shipping lines to coordinate their services through conferences and also jointly set prices. In the first years of this century, the price exemption for these conferences was abolished, but the exemption to coordinate capacity in so-called liner consortia was allowed.

In 2006, by Regulation 1419/2006, the Council of the European Communities repealed Council Regulation 4056/86 (the antitrust exemption for conferences) from 31 October 2008 onwards. This meant that all joint price fixing ànd coordinated capacity management for services to or from the European Union and the European Economic Area were no longer exempt from antitrust scrutiny. Along with this repeal, the European Commission decided to amend the validity of the CBER and extend it until April 2015: one of the changes to the criteria was the lowering of the percentage threshold for market share for consortia from 35% to 30%. This limited threshold works on a route basis, since consortia, like conferences, work at a route basis. The new CBER was implemented by Commission Regulation (EC) No 906/2009 on 28 September 2009. In 2014, the expiry date was again extended to 25 April 2020 by Commission Regulation (EU) No 697/2014 of 24 June 2014.

From 2008, therefore, conferences were no longer exempt from competition law. The option that did remain for shipping lines was to engage in **'vessel sharing agreements'**. In 2009, the EU extended its block exemption for this type of cooperation. Shipping companies that are members of an alliance are not allowed to coordinate rates with each other nor to make capacity agreements (European Commission, 2009). In contrast, they are allowed to piggyback on each other's container ships via slots, which was welcomed by governments from an environmental perspective. After all, when there is insufficient cargo supply, shipping companies do not have to continue sailing half-empty but can pool capacity and take unused ships out of service (Jumelet, 2022b).

Table 2 Actions of consortia allowed and not allowed under the CBER

| Consortia are allowed to | Consortia are not allowed to |
|---|---|
| 1. Offer joint services | 1. Jointly fix prices |
| 2. Adjust capacity according to market demand | 2. Adjust capacity other than on market demand fluctuations |
| 3. Jointly operate or manage terminals | 3. Allocate markets and customers |
| 4. Engage in other joint support activities | |

Container liner shipping in Europe has been operating under this mechanism and its predecessors since the abolition of the pricing exception in 2003.

### 2.3.2 CBER under review in 2018

The European Commission last reviewed the CBER in 2018-2019. Following a multi-stage consultation process in which feedback from many different stakeholders, such as industry associations, Member States and other parties, was received and assessed, the European Commission finally decided in 2020 to extend the scheme by four years until 25 April 2024. The only concession to the heavy criticism from shippers, and representatives from international organizations, was that the extension was not five but four years. The 2018 online public consultation on the CBER revealed that the CBER has no negative impact on competition between carriers and is justified as an exceptional sector-specific regulation due to the special characteristics of the sector. The rationale for this decision was explained in a European Commission working document ("2019 SWD"). The document reveals that the CBER:

- facilitates consortia by making assessments under Article 101 TFEU easier and by providing greater legal certainty that reduces legal risk;
- reduces compliance costs for carriers;
- does not adversely affect competition between carriers;
- is justified as an exceptional sector-specific regulation due to the special characteristics of the sector, which relies heavily on cooperation; and
- provides guidance that can be better provided at the EU level than at the Member State level (and thus provides "EU added value").

### 2.3.3 CBER under review in 2023

Currently, the CBER is being evaluated by the European Commission against the backdrop of the corona pandemic and the problems it has caused. COVID-19 disrupted end-to-end intermodal supply chains worldwide, creating significant bottlenecks at sea terminals, inland warehouses and distribution centers. These onshore bottlenecks in turn caused vessel congestion outside ports, reducing effective vessel capacity. The frustration experienced by shippers due to service delays and higher costs was channeled to carriers and their consortium agreements. Regulatory instruments that facilitate such agreements, including the CBER, have thus received a whole new level of scrutiny.

With over 50 responses from the industry, this consultation round generated much more input than the round in 2018. The variety of parties sending responses is also greater: from shippers and shipping companies to anti-trust regulators, trade unions and seaports. While the arguments in favour of prolonging the CBER mainly focus on optimising economies of scale and a wider range of services, the counter-arguments are mainly found in the decline in service quality and the lack of transparency within the CBER and its oversight.

Almost all parties (competition authorities, importers, inland navigation, ship owners[5], trade unions and seaports) are against an extension of the CBER. The three main arguments emerging here are:

- An increase in mega ships, resulting in increasing peak volumes, have a disruptive effect on the overall quality of port operations, as well as increasing pressure on port employees.
- The reliability of intermodal containerised inland shipping is decreasing, resulting in cargo flows being shifted back to the road, which does not favour the development of modal shift and greening.
- The merging of liner companies into consortia promotes the formation of oligopolies, allowing consortia to play a dominant role.

Furthermore, we observe that there are not many arguments on the following two issues: cost of transportation and unequal market power. This is interesting because these are also powerful arguments against the extension of the CBER. Nevertheless, the large number of responses to the consultation shows that the issue is alive and well among industry parties, government agencies and worker representations. Whereas shipper groups and other parties have campaigned hard for an end to the CBER, the efforts of container liners to keep the exemption have been half-hearted. The EC emphasized the need to hear from small- and medium-sized lines about the benefits of the CBER, backed up by data (Baker, 2023).

### 2.3.4 Lack of transparency

Although the maximum percentages of consortia market shares in the regulations are very clear (i.e. a maximum of 30% per consortium), it is not so clear how and to which consortia these percentages should be applied. Recent work by Merk and Teodoro (2022) shows that identifying consortia is not straightforward and that this obscures the enforcement of market share rules in the CBER. This lack of transparency may also mean that the CBER, being a regulatory tool for consortia, actually facilitates coordination at the level of liner alliances. Of these liner alliances, there are only three, resulting in a firmly oligopolistic market structure on many major trade lanes. One of these three, 2M – involving Maersk and MSC – is expected to break up in 2025.

## 2.4 Final remarks

This historical setting clarified the existence of coordination mechanisms for a peculiar sort of transport service: regular, scheduled services. This is not a specific type of service for shipping alone. Much of public transport, and in some countries, commercial cargo transport, has the same characteristics. Only shipping, however, has long enjoyed anti-trust exemptions that allowed them to set prices, and cooperate and coordinate capacity.

We are now at a time where the opposition to this exemption has grown substantially. There is little support left to extend the CBER in the EU. At the same time, no party has a good understanding what the future of an unregulated container transport system looks like. This has put the European Commission in a complicated position to come up with a decision that may drastically impact world trade. It is not surprising, therefore, that this decision has not been forthcoming for some time.

# 3. Economic structure of liner shipping

**This chapter discusses the economic structure of liner shipping. The purpose is to explain the economic drivers for scale increases in container shipping. This discussion provides a another layer of understanding and insight concerning the development of the container liner shipping industry.**

Structural problems related to the economics of the global container industry, fall apart in three main problem areas. The first is the legal framework within which shipping, and in particular container shipping, operates. The second is the dependence on expensive assets in global container transport, not only at sea, but also in ports and hinterland transport. The third problem is related to the service offering of container shipping, that is characterized by a promise of regular, frequent services on a so-called common carrier basis. We will discuss each of these issues below. We will finish this chapter with a discussion on the development of market concentration.

## 3.1 Regulatory framework for shipping

The legal framework for ocean shipping is a system of contracts, the core of which is the liner shipping contract under the Hague-Visby Rules[6]. In essence, these rules describe the booking of a single shipment on a (container) ship, which can consist of one or more containers. This is complemented by commercial agreements for parties that ship containers on a regular basis, as well as contracts of the shipping company with service providers, such as terminal operators, but also ports, pilots, harbor towage services, etc. The commercial contracts for freight are usually quite simple agreements on annual volumes and price. As soon as there are actual bookings, the Hague-Visby Rules apply.

The Hague-Visby Rules date back to the 1920s with several changes. The last one dates from 1979. More modern rules were drawn up in the 1970s (the Hamburg Rules), which came into force in 1992 (UN, 1978). However, none of the world's major trading nations have ratified these rules. In the EU, only Austria, Hungary (both landlocked) and Romania have ratified these rules[7]. In 2009, a new attempt was made to modernize the rules for the transport of goods by sea: the Rotterdam Rules[8]. These have also not yet been ratified. The conclusion from this brief exposé is that the rules under which maritime container shipping operates predate the introduction and widespread use of the container, and do not provide guidance for the formulation of logistical requirements by shippers, such as on-time arrival or predictability of transit times (Boonk, 2010).

The Hague Visby rules are very much rules for shipping. This means that the shipowner is offered a lot of leeway as long as they provide a seaworthy ship. There are virtually no performance guarantees, and the cargo can be held as a bond to pay for all kinds of damages caused during the shipping operation[9]. The liability of the shipowner for the cargo is also severely limited (to 2 SDR[10] per kilo), which, in many cases, represents only a fraction of the real value of the cargo in containers.

In practice, this results in considerable problems. The most important of these is that customers have no real certainty about the actual regularity of service, frequency, sailing duration or accuracy of arrival. Shipping lines are free to make regular changes to their schedules, change routes, include or skip ports of call, incur delays, sail slower than planned (slow steaming), or cut routes on short notice (blanked sailing). We will see later that a slow deterioration of services can be observed over more than a decade, and this can be attributed at least to a certain degree to the introduction of larger ships. What is important here, is that the rules under which the shipping lines operate provides a lot of freedom to enact this deterioration of service levels.

Another issue is that for containerized shipping, a container is required to stuff the goods. This container is usually provided by the shipping line. This adds additional procedural burdens (booking cargo on a ship also means booking an empty container, which needs to be delivered back to the shipping line at destination). There are no real global rules for the arrangements around the provision of a container to a customer. These arrangements are, however, intricate.

While the shipping lines provide empty containers essentially free of charge (their hire is included in the freight costs), there are conditions for their use. Upon arrival of the container in the port of destination, there are a limited number of so-called free days in the terminal. If the cargo owner decides to leave the container in the port longer, they will be charged a daily hire by the shipping line. This first deadline is called the demurrage deadline. After the container is picked up, there is another limited period in which the empty container needs to be returned. Usually, the shipping line requires the container to be returned in the port of arrival, although a number of shipping lines have also allocated container yards in the hinterland to facilitate the process of returning empty containers. This second period is called detention. After this period, again a daily hire is charged to the customer. In practice, the demurrage and detention fees are charged to the transport operators who come and pick up the container, who then have to relay this bill to their customers. Shipping lines are not very quick with these invoices, and this also causes considerable challenges for the hinterland service providers. A final problem related to the deadlines associated with demurrage and detention is that these result in time pressure for hinterland transport service providers. This means that road transport is more often chosen than the more environmentally desirable rail or barge transport options.

During the congestion problems that ensued in the COVID-19 period, shortage of space of ships was aggravated by the shortage of the availability of empty containers, and very high fill rates in terminals of full containers. The shipping lines tried to mitigate this by raising the daily hire rates for demurrage and detention to very high levels: from the usual 40-80 dollars/euros per day to as high as 1000 dollars per day. Hapag Lloyd has recently settled a law suit with the FMC in the USA for $2 mln because it did not allow a transport company to return empty reefer containers to a congested terminal, but kept charging

$400 per day in detention fees. The transport company racked up a bill of $258.000 euro in total, which they disputed[11]. In this FMC settlement, Hapag Lloyd insulated themselves from further challenges to its detention policy.

## 3.2 Asset dependency

The second set of structural problems results from the heavy reliance on expensive assets in global container transport (vessels, terminals, hinterland transport) combined with an overall commercial strategy in many transport chains to maximise individual performance in parts of the chain. This applies especially to the part of the chain with the most expensive assets: the deepsea shipping part. In economic terms, all these operations are characterized by high fixed costs and relatively low marginal costs. Fixed costs do not fluctuate with the level of operations. Marginal costs, which are the basis for competitive pricing, are those costs that are incurred if a little bit more cargo is carried. In shipping, as soon as a ship is available, these marginal costs are very low. In tramp shipping, marginal costs are largely related to fuel costs. In scheduled transport, where the routing is fixed as well, marginal costs are virtually zero.

In this context, competition would work out disastrously since competitive pricing would drive pricing down to virtually zero. The shipping industry, in its early days, used the term destructive competition to indicate this problem: competition leads eventually the breakdown of services altogether. This means that after some time, all competing shipping companies would go bankrupt, would go bankrupt, and no transportation would be offered. This line of argumentation emerged towards the end of the 19th and the beginning of the 20th century, when some of this ruinous competition actually ensued. This sparked the discussion about some form of competition control that we already discussed in Chapter 2.

With a degree of competitive control in place, and a certain division of the market as a result, shipping lines still had to cope with their fixed costs. Shipping is characterized by a specific engineering economy of scale that allows cargo carrying capacity to grow faster than the cost of production of a larger ship[12]. Therefore, a bigger ship has almost always relatively lower average costs per unit of measurement. For container ships that unit of measurement is the space for containers, measured in standard twenty foot equivalent units (TEU). Since, with the regulation of the market, manipulating the cost structure is the only way to increase profitability, this results in a constant search for the benefits of scale and a preoccupation with load factors. As soon as it is possible to put a bigger ship in operation that could also be full, there will be more profit. The commercial strategy of container shipping is therefore: the ship must be as large as possible to achieve economies of scale and it must be full. Against a continuously growing market for containerized transport, this has long been a successful strategy. Growth, or the expectation of growth is therefore the main driver for decision-making in container shipping.

This seems like common sense, but it has perverse consequences. During COVID-19, there was virtually no incentive for shipping companies to reject shippers' transportation requests, even if those requests seemed excessive, ill-advised or irrational. In other words, if shippers, wanting to control their uncertainties, behave very strategically by claiming all available ship capacity, the shipping companies will not be the party to slow them down and influence their booking behavior. This is one of the main reasons why shippers, during COVID-19, faced with the uncertainties of consumer behavior and shortages of components such as computer chips, have resorted to overbooking shipping lines, pushing far too many products through their transport chains very early on and storing these unnecessary goods in container terminals (deepsea and inland) and warehouses, with all the congestion problems as a result.

Apart from pursuing economies of scale, shipping lines also have other strategies to control costs. The consortia regulation often explicitly allows them to join their purchasing power. The majority of the spending of shipping lines, apart from personnel, is on ports and handling at terminals, on fuel and on ships. Especially for terminal handling and fuel, shipping lines use their combined purchasing power to arrange lower tariffs.

### The development of scale

The development of scale is often illustrated by diagrams showing the record largest ship for various years. We reproduce one of these diagrams here.

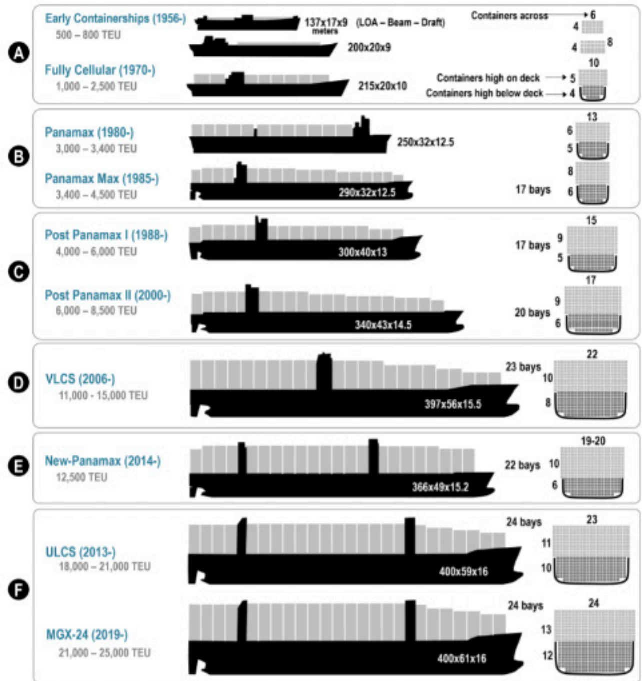



Figure 2: Evolution of container ship size
Source: Rodrigue (2020)

Identifying the largest container ship is a bit of an international hobby, so all the vessels in the above figure can be named as well. For instance, the first fully cellular container ship was the Encounter Bay (1.530 TEU), while the first ship to reach 18.000 TEU was the Maersk McKinney Moller.

There are some interesting ways to look at this diagram. Apart from the start, the doubling time of the ships are surprisingly stable over time: from from 4000 to 8000 teu took about 13 years, and from 10.000 to 20.000 teu took some 12 years. The latter was a much bigger jump in capacity, of course. Another way to look at the data is to compare TEU capacity with dwt capacity of the ships. TUE capacity can be translated in dwt capacity by setting an average weight for a TEU container. Conventional wisdom sets this at about 12 tons. As an example: the Regina Maersk has 6.400 TEU, and 84.500 dwt cargo carrying capacity. At an average of 12 tons, the required cargo carrying capacity translates in 76.800 dwt. The current largest vessel is the MSC Irina is 24.346 TEU with 240.000 dwt. At 12 tons, its required cargo carrying capacity is 292.152 dwt. Note that this number of considerably larger than its actual dwt. This means that, relatively speaking, this ship cannot carry as many full containers of average weight as the Regina Maersk. In other words, the increase in size also represents a relative reduction in cargo carrying capacity. This can be attributed to the relatively light types of cargoes being carried in containers, but also to the apparent urge to increase TEU numbers without really adding cargo carrying capacity to the market.

## 3.3 Schedules services

The third structural problem is that container liner shipping is supposed to play a specific role in facilitating world trade by providing stable, predictable services at a reasonable price, but at the same time, this industry is subject to the economic mechanisms of each shipping market. We have already discussed the point that scheduled services are at the core of the anti-trust exemption debate for container shipping. Here we will discuss some of the economic issues related to a shipping that is offering regular services. We will focus primarily on network or service performance.

A shipping market is a specific market in the sense that short term supply shortages are always present. This is the result of the time delay involved in building new ships. If the market is tight, new ships will be ordered, but delivered with, on average, a two-year delay, and this will temporarily drive prices up. This is depicted in the figure below.

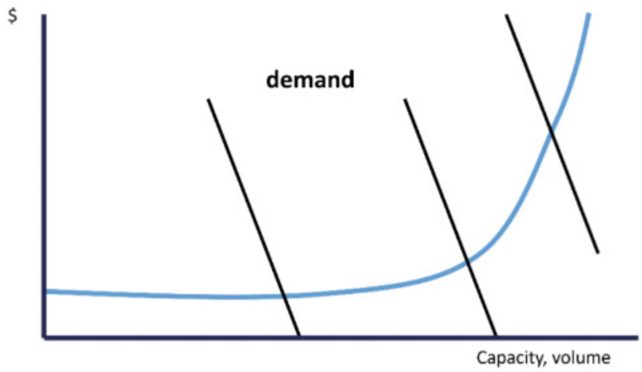


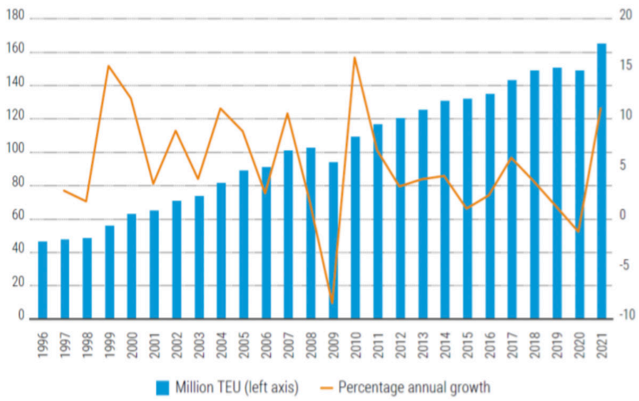

Figure 3: Short term supply and demand curve in shipping
Source: Stopford (2008)

As a result of this general mechanism in shipping, it is not surprising at all that in the short term, freight rates can go up – and down – very quickly and very considerably. Price increases of a factor 5 or 10 are not unheard of in shipping. This applies equally to bulk shipping, and container shipping.

If this happens, the theory of shipping economics predicts that most shipowners, who are earning a lot of money, will spend it on building new ships. This is exactly what has been observed in recent years: the order books for new container construction are very full. The more advanced shipping economics theory subsequently predicts that the shipping companies also often tend to overorder ships, and thus have a strong negative impact on the market in the mid to long term (see for example: Veenstra 1999).

The consequence of these structural problems is that there are few self-regulating mechanisms when the sector is confronted with shocks. The only mechanism available to the sector is capacity reduction by scheduling ships for maintenance jobs at yards, scrapping old capacity, slow steaming and so-called blank sailings (cancelling services). These mechanisms worked very effectively during the financial crisis of 2008-2009, which was accompanied by a crash in demand for transport services. During the COVID-19 crisis, the industry seemed to think this crisis was of a similar nature and started playing the supply reduction card early on. However, the opposite was true: demand rose to an all-time high and alongside the high demand for transport, underlying labour shortages, very poor performance in container shipping, shortages of technical components and materials and transport services (trucking) in many parts of the world came to light. The capacity reduction strategy of the liner industry has only made the impact of these problems (much) higher.

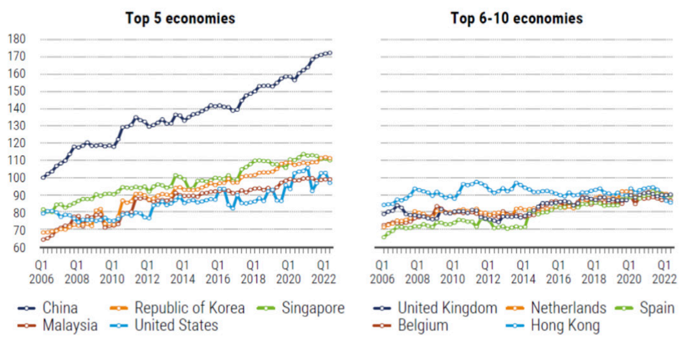
In the remainder of this section, we provide a brief review of public data on service performance of liner shipping. As background for this review, we start with an overview of the long-term growth trend in containerized trade depicted below. Note that this almost linear upwards trend has two notable bumps: around the financial crisis in 2009 and in the first year of COVID-19 (2020).




*Source:* UNCTAD secretariat, based on data from MDS Transmodal (MDST), World Cargo Database, September 2022. https://www.mdst.co.uk.

Figure 4: Global Containerized Trade 1996-2021 (mln TEU and % change)
Source: UNCTAD Review of Maritime Transport (2022)

A general indicator of service performance that was developed by UNCTAD is the liner shipping connectivity index. This index indicates the level of connectivity of specific countries with the rest of the world. Such an indicator is in line with the generic promise of the liner shipping industry to facilitate trade around the world.

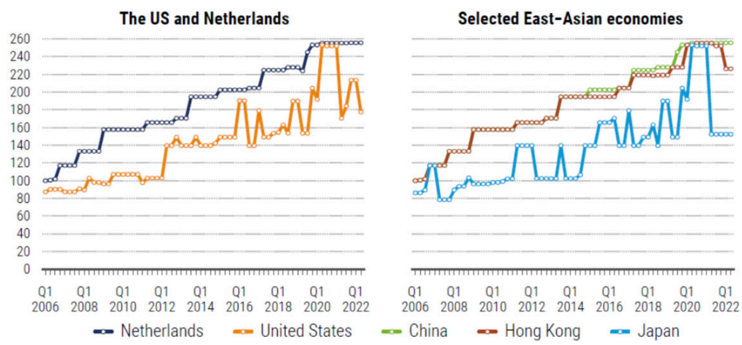



*Source:* UNCTAD, based on data provided by MDS Transmodal. For the complete data set for all countries, see http://stats.unctad.org/LSCI.
*Note:* Index is based on 2006Q1 = 100 in China. Top 10 economies as of the second quarter of 2022.

Figure 5: Liner Shipping Connectivity Index 2006-2022
Source: UNCTAD Review of Maritime Transport (2022)

Note that in Figure 5, the largest economies are associated with the largest number of connections to the rest of the world. China is by far the best-connected country, in terms of services, with some other Asian countries and the US at some distance. Several European countries, such as Belgium, and the Netherlands have seen some growth in connectivity in the recent decade, but Hong Kong's connectivity is on the decline. At the other end of the scale (not shown here) are the developing countries (in areas such as Africa, Latin America, Caribbean), who are losing connectivity, primarily due to COVID-19 (UNCTAD 2022). Container flows were directed to Asian countries, especially China, to take advantage of the very high profits on East-West trade lanes.

Another way of looking at this connectivity is to assess the capacity of container ships coming into ports. This is depicted below. Note that the Netherlands is able to match countries such as China and Hong Kong in terms of the largest shipping capacity that is coming into its ports. A country like Japan, as well as the USA, show a much less regular development in terms of large ships entering its ports. Again the decline of Hong Kong is clear here as well: some of the largest ships are no longer going to Hong Kong.




*Source:* UNCTAD, based on data provided by MDS Transmodal.
*Note:* Numbers are normalized by setting the maximum value across countries (i.e., value for China) as of the first quarter of 2006 to 100.

Figure 6: Largest ship capacity 2006-2022
Source: UNCTAD Review of Maritime Transport (2022)

To complement the discussion on connectivity and capacity, we also report figures on capacity usage, or utilization, for the world fleet and for container ships specifically.

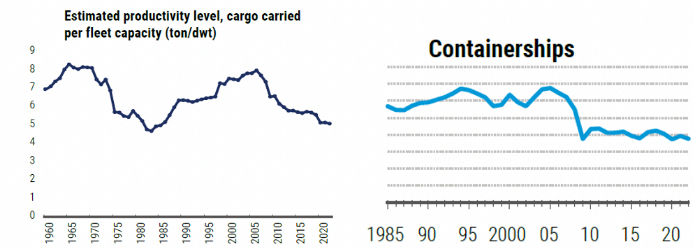


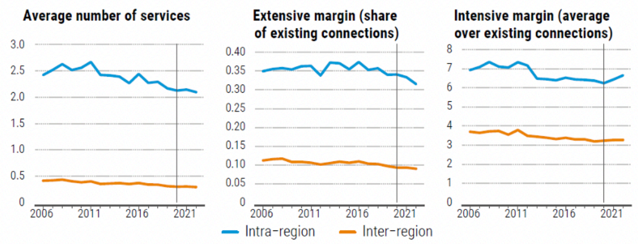

Figure 7: fleet utilization levels 1960-2022

Source: UNCTAD Review of Maritime Transport (2022)

*Source:* UNCTADstat for fleet capacity for 1980-2022 and cargo carried for 1970–2022. Data before 1980 for fleet capacity and before 1970 for cargo carried are retrieved from earlier issues of *Review of Maritime Transport*.
*Note:* Fleet productivity (tonne per dwt) = cargo carried (tonne) / fleet capacity (dwt). Fleet capacity is in the opposite sign in the right-hand chart. Fleet capacity is as of 1 January of each year. Cargo carried in 2022 is forecast by UNCTAD.

Figure 7 shows that overall fleet utilization has been steadily declining for almost 20 years. In the context of the continuous growth of containerised trade (Figure 3), the explanation is that the industry has been overinvesting in tonnage for quite some time. For containerships, the development is similar, although not entirely the same. Since about 2008, fleet utilization in container shipping has been at a relatively low plateau. We attribute this to the continuous influx of large(r) vessels.

UNCTAD, in its annual Review of Maritime Transport reports some other liner shipping performance data. The total number of services offered is such an indicator.




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

Figure 8: Number of Liner Shipping Services 2006-2022

Source: UNCTAD Review of Maritime Transport (2022)

These three diagrams show that, first of all, the total number of services in the world offered by liner shipping companies is declining, and has been declining for years. The second insight (from the middle figure) is that there is a concentration of services towards the connected country pairs (extensive margin). Finally, the righthand figure shows, in another way, that the existing connections have attracted more services. Taken together this shows that services are declining and concentrating towards the already well-served routes. Less connected countries are losing out on direct liner shipping services to other parts of the world.

As a final point, we show two views on the operational performance of the liner shipping sector. The first is an overview of development of time of alliance schedule reliability, in Figure 9. We have chosen to report the period 2015-2018 here to show that scheduling reliability has not been perfect for some time. During COVID-19, the performance became even poorer, as a result of congested ports, closed terminals and other COVID-19 issues.

The Figure illustrates, first of all, that alliance structures changed over time. We will get back to this in the next section. Observe the general downward trend, as well as considerable fluctuations in the scheduling reliability in the period 2015-2018. This does not easily accord with a promise of regular services. An industry that offers performance levels as low as 60-70% most of the time, and below 50% some of the time can not really be called a well performing industry.

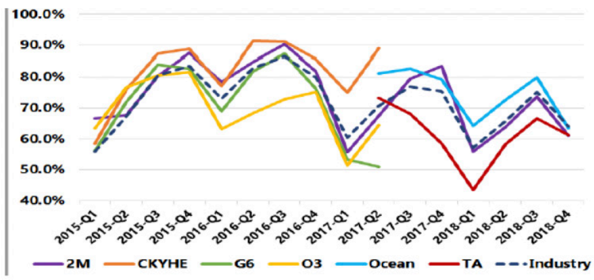



Figure 9: Alliance schedule reliability

Source: Sea-Intelligence (2019).

Second, we report some data on blanked sailings. This is a market control mechanism that shipping lines employ to deal with short term demand and supply balance problems. However, the data in Figure 10 shows that this mechanism is deployed quite widely and on a regular basis. We know from other sources that the total number of sailings on the Asia – Northern Europe and Asia to Mediterranean routes is about 18 and 14 respectively mostly with daily departures. In the most positive view, a quarter then has about 90 sailings, but 65 sailings if weekdays are counted only. From the figure, we can observe that in recent years, sometimes, about a third of these sailings were 'blanked'.

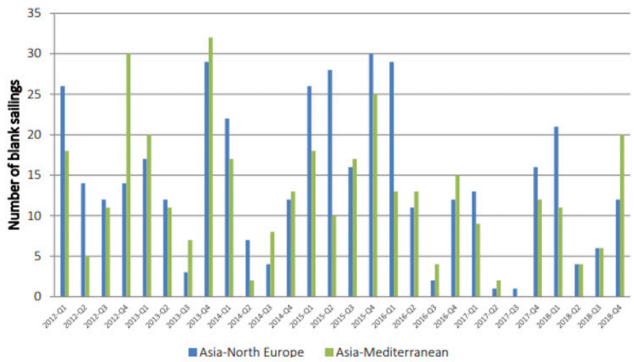



Figure 10: Number of blanked sailings on Asia – Europe trade lanes 2012-2018
Source: ITF (2019)

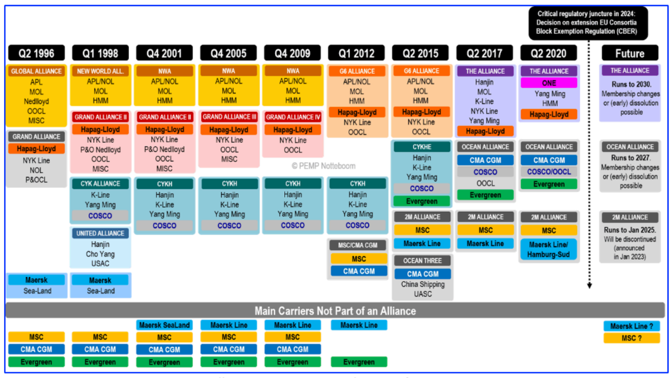



Figure 11: Alliances in container shipping from 1996 to 2023
Source: Notteboom (2023)

## 3.4 Developments of market power

Above we have already highlighted a major consequence of the economic structure of liner shipping: the search for economies of scale. There is another consequence of the economic structure that has developed over time. This is the concentration of capacity in the hands of a limited number of entities.

In this section, we will explore and illustrate this industry concentration.

We start with a preliminary remark. To measure market share in shipping is not so easy. While data on fleet capacity is abundant, this offers only a limited view on market share for two reasons: (1) it is unknown how the ships are utilized (and as such, this measure implicitly assumes constant productivity); and (2) services are offered by collectives of shipping companies (either consortia or alliances). Nevertheless, ship capacity is often used for this purpose.

Operational cooperation between container shipping lines occurs in many ways. The first strategic alliances between shipping lines date from the mid-1990s and coincided with the introduction of the first post-Panamax container ships in the Europe-Far East trade. In 1997, about 70% of the services on the main East-West routes were provided by the four main strategic alliances, see Figure 12. Several things stand out in this figure. MSC, CMA CGM and Evergreen are shipping lines that only joined alliances in 2009 or 2012. Maersk also stayed out of alliances for a period (2001-2012). There seems to be some industry preference of parties working together in the same alliance. For instance, the CYK Alliance (later CYKH and CYKHE) has almost always had Yang Ming, Cosco and K-Line in the alliance.

In 2013, Maersk, MSC and CMA CGM unfolded plans for a giant alliance, 'P3'. The EU and the US agreed, but China saw a concentration of too much market power and did not agree, after which Maersk and MSC concluded their '**2M**' alliance in summer 2014. CMA CGM responded by forming 'Ocean Three' together with UASC and China Shipping, two shipping companies that have since been absorbed by Hapag-Lloyd and Cosco respectively. CMA CGM then formed a larger alliance in 2017, the **Ocean Alliance**, together with Cosco and Evergreen, after which the Japanese shipping lines (ONE), Hapag-Lloyd and Yang Ming huddled together in the **THE Alliance**.

Even though the resulting subdivision of the container market has remained in place to this day, small cracks in the relationships of alliances have been showing in recent months. At the beginning of this year, Maersk and MSC announced to discontinue the 2M Alliance in 2025 (Maersk, 2023). Over the past two years, MSC has effectuated massive fleet expansion with 411,000 TEU slots (+10,7%) added in 2021 and another 321,500 TEU (+7,5%) in 2022 (Alphaliner, 2023). This expansion of capacity has been described as a strategic move of MSC to leave the alliance and operate as a stand-alone carrier in the major deep-sea trade routes. At the same time, Maersk has developed a strategy that will move the company away from pure ocean shipping, and into global supply chain services. The announcement on the termination of 2M could kick-start an industry-wide reshaping of existing agreements.

While the tracking of cooperation agreements is a national sport in shipping, the assessment of market shares is still considered a more objective way of assessing market power. Observe the following figure.

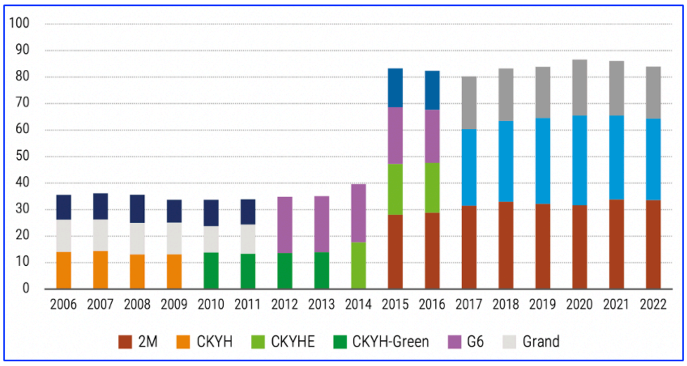



Figure 12: Overview market shares container alliances
Source: UNCTAD (2022), based on data of MDS Transmodal
*Note that the legend in the original source was not complete. The bars on the right-hand side represent The Alliance, Ocean and 2M, from top to bottom.*

Figure 12 shows that in recent years, the role of shipping lines that are not part of alliances has been marginalised. Major container flows are now handled by three alliances (2M, Ocean, The Alliance) that include the world's 10 major shipping companies and control 84% of the market. UNCTAD (2022) attributes this concentration to economies of scale and network, efficiency gains by sharing and pooling capacity, deregulation in various parts of the world, that removed cargo reservation restrictions for local carriers, and port privatization.

As we have already discussed above, the underlying mechanisms for the alliances are consortia, capacity pooling and slotsharing agreements between the carriers. The visibility on these agreements differs around the world. In the USA, the FMC records all relevant agreements for trades to and from the US. In Europe there is no such register. Merck and Teodoro (2022) describe an attempt to reconstruct liner consortia from ship tracking data and liner service schedule information. Their conclusion is that there must be more than 1500 consortia, not all of which are within alliance boundaries. So, in fact, the consortia tie the biggest liner shipping companies together across alliance boundaries. Their analysis shows that, conditional on the accuracy of their liner consortia reconstruction, market concentration in the industry is underestimated.

## 3.5 Final remarks

If we summarize the analysis in this chapter, a picture emerges of an industry that operates under an archaic legal framework that does not offer its customers much guarantee in terms of performance and quality of service, and a cost structure that drives a continuous search to lower average costs. This industry operates in an environment where some limitations on cooperation and competition restriction have been absent.

These factors together have created an industry in which the main strategy to control costs has become the building of bigger ships, even if demand developments do not fully justify this. The cooperation mechanisms also work towards a standardisation of ship sizes in specific services, as soon as one of the members introduces a bigger ship. As a consequence, the industry has been rationalizing its capacity allocations for quite some time, which results in a concentration of ships on busy routes, and a deterioration of service levels across the board, but especially in the more peripheral regions in the world.

A second observation is that the mechanisms that this industry is allowed to use do not safeguard it from significant shocks in the short or the long term. As a result, this industry reacts in line with established maritime economic theory when it comes to short term supply shortages. This point can be interpreted in two ways: first, it can be argued that this proofs that the anti-trust exemption is clearly not distorting competitive forces in container shipping, but second, it can also be argued that the anti-trust exemption is also clearly not working as a stabilizing mechanism the industry purported it to be.

# 4. The orderbook and the future fleet

We have already introduced the almost automatic spending of the industry's considerable profits in the period 2020-2022 on ships. Such orders for new ships are recorded in the orderbook, for which quite detailed data is available. From an economic perspective, the orderbook is a very complete and informative variable, because it records not only the outcome of ordering but also the complete agenda of the shipbuilding industry for years to come. So the orderbook, and its dynamics is a good indicator for economic dynamics in the industry itself, and it has a forward looking quality as well.

This chapter delves into the expected fleet expansion, as measured by the current orderbook of container ships. This is an important issue, since shipping companies in general tend to invest their profits primarily in ships. This new capacity will come into the market, and impact the supply and demand balance. We have also learned that shipping companies tend to overinvest, and have been doing this for almost two decades. Finally, the introduction of larger and larger ships can also be associated with a more and more concentrated service offering of liner shipping. As a result, it is interesting to investigate the ordering behaviour of shipping lines in a bit more detail to understand, for instance, if the industry is changing its attitude towards bigger ships.

Specifically for container shipping, this premise of investing in new ships is still largely true. There are, however, exceptions. Maersk, for instance, has been developing a portfolio of other transport and logistics activities, in order to transition into a global supply chain service provider. Their profits are therefore spent on logistics companies, air transport and forwarding.

## 4.1 Orderbook of the major alliances

Table 3 shows the capacity in existing and ordered ships for the three major alliances. Notice that all alliances have a combined owing/chartering strategy: this is to some degree another mechanism to limit fixed costs and create some variable costs. The effect of this, in a scheduled service setting, however, is limited. Another reason to charter vessels is to reduce assets on the balance sheet.

Both in existing and ordered capacity, 2M is the largest. THE Alliance is a lot smaller compared to the other two alliances, but is keeping pace with its ordering activities. The three alliances are mainly active on the east-west trades, in which they had a 100% market share across market segments by mid-2022 (Dynamar, 2023).

Table 3: Orderbook three biggest alliances (TEU)

| | Owned | Chartered | Ordered | Total (existing) | Total (future) |
|---|---|---|---|---|---|
| 2M | 4.904.184 | 4.866.152 | 2.268.531 | 9.770.336 | 12.038.867 |
| Ocean Alliance | 4.271.027 | 3.810.172 | 2.315.679 | 8.081.199 | 10.396.878 |
| THE Alliance | 2.680.039 | 2.265.810 | 1.185.941 | 4.945.949 | 6.131.790 |

Source: adjusted from Alphaliner (2023) and Clarksons (2023)

Figure 13 displays the division within the big container alliances concerning ordered, chartered and owned ships. Thus, as mentioned earlier, MSC is characterised by a large number of ordered ships, which in the future will increase the number of owned ships from 759 to 882 ships of MSC alone (an increase of 16%). The difference with the Maersk strategy, however, is clear. Within the 2M alliance, ZIM is also adding more capacity: with a 28% increase, capacity will go from 128 to 177 ships. Within the Ocean Alliance, CMA CGM has a thick order book with 103 new ships, bringing the total to 732 ships in the future (a 16% increase). Within this alliance, Evergreen is also growing considerably in capacity, with 49 new ships., this is a 23% growth. The smaller shipping companies within THE Alliance also have relatively large numbers of ships on order. HMM goes from 73 to 99 ships (an increase of 36%), ONE goes from 212 to 250 ships (18%) and Hapag Lloyd has an increase of 15 ships.

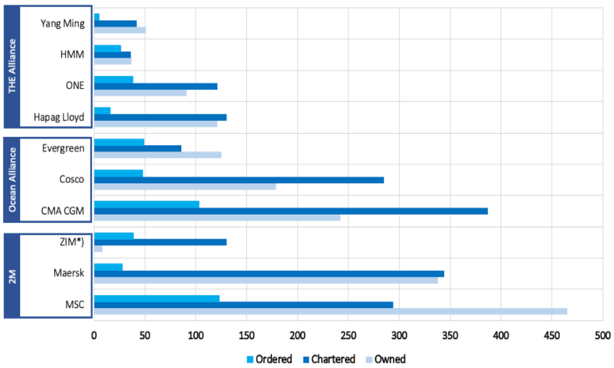



Figure 13: Division of ships between different container shipping companies (own composition, adapted from Alphaliner [2023] and Clarksons [2023])
*NB. ZIM cooperates with 2M on the cross-pacific and cross-Atlantic routes, but not on the Europe-Far East route. So ZIM is not a full member of this alliance.

According to BIMCO, 4.9 million TEU will be delivered throughout 2023 and 2024. Of this fleet growth, 65% will be concentrated in the segment of ships with a bigger capacity than 15.000 TEU, whereas the fleet of smaller ships (<3.000 TEU) will reduce. The fleet forecast in Figure 14 shows that in 2025 the total fleet will consist of 29.6 million TEU.

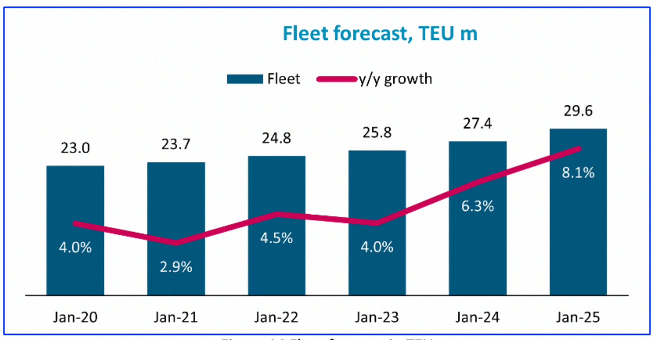



Figure 14 Fleet forecast in TEU
Source: BIMCO (2023)

## 4.2 Development of the container orderbook

The current order book, that is all the container ships currently on order and being build, consists of 895 ships and accounts for 7.310.532 TEU in total. Figure 15 displays the size division of the current orderbook in comparison with the deliveries of 2023. In both cases it is observable that the smaller ships, ranging from 1.000 to 3.999 TEU, has a large peak as compared to the other ship sizes. The fact that the peak in the orderbook is below the peak in deliveries shows that the increase or replacement of this feeder category of ships has been going on for some time.

Furthermore, there is a peak in the current orderbook in vessels ranging from 13.000-16.999 TEU. We will look into this in a bit more detail below. Of the biggest size vessels it is important to note that of the current orderbook, 55 vessels on order have a carrying capacity of 23.000 TEU or bigger. In this size class alone 49 vessels were delivered this year. This indicates a steady policy and no acceleration towards the largest vessel size class.

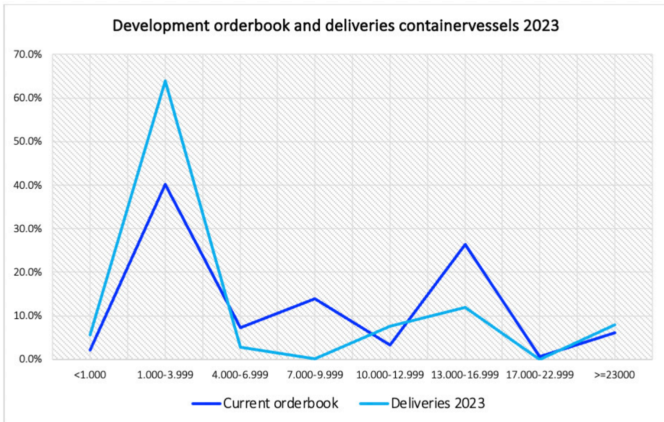



Figure 15: Size division in TEU of current orderbook and deliveries in 2023
Source: data adapted from Clarksons SIN (2023)

In previous chapters we have discussed that the industry reaction to large profits is almost automatic ordering of ships. This can also be observed in the present time. However, a further analysis of the orderbook is interesting to see if the industry is adapting its ordering behaviour to reflect their outlook on the future development of the market. For this purpose, we present the development of deliveries and orderbook over the period 2018-2028. In this period up to mid-2023 ships have already been delivered, and the rest of the period, ships are in the orderbook, with expected delivery dates.

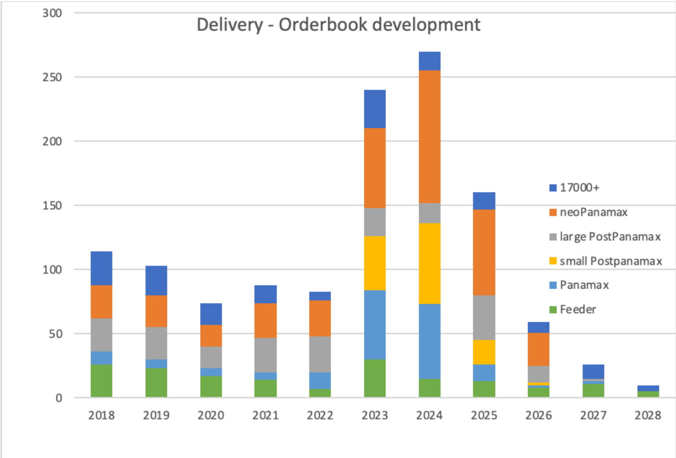



Figure 16: Delivery – Orderbook development 2018-2028
Source: data adapted from Clarksons database (2023)
Size categories are: feeder 100-2999 teu, panamax 3-5999 teu, small post panamax 6-7999 teu, large postpanamax 8-11999 teu, neopanamax 12-16999 teu and the large ships 17000+ teu.

Figure 16 shows that indeed the orderbook for delivery in 2023 and 2024 is very high compared to earlier years. Also, deliveries in 2025 are still significant. The division into size categories shows that the largest categories of ships currently in the orderbook are panamax (3000-5999 teu), small postPanamax (postpanamax 6000-7999 teu), and neopanamax 12-17000 teu. In many trades, nowadays, the neopanamax (12-16999 teu) is the primary work horse. The smaller postpanamax vessels are used as feeders, in addition to the classic, smaller, feeder category. This is partly a consequence of the concentration of services we have already identified in an earlier chapter. The neopanamax is a category vessels that can still not transit the enlarged locks of the Panama Canal. This last category currently dominates the orderbook.

We see in this a turn of shipping lines towards the second largest category of vessels (neopanamax) with an average size of about 14.500 TEU (which is in the middle of this size category). There are still ships on order in the largest category, but these numbers, especially for delivery in 2024 and 2025 are small. What is interesting, however, is that the average size of the ships on order in the largest ship size is close to 24.000. So if large ships are ordered, it is 24.000 TEU, but if not, then owners choose 14.500 as there preferred size. This is quite a gap, and points at the power of the facilitation by the few ports and terminals where these large 24000 TEU vessels can be served. But this large ship is not developing into a real work horse for the industry. This will be, for some time to come, ships in the 14-18.000 TEU ship.

## 4.3 Alternative fuels and scrubbers

The orderbook also provides an insight in the fuel options, shipping lines are considering. Figure 17 displays the readiness of ordered ships for alternative fuels. In the orderbook, two different words are used: ‘ready’ and ‘capable’. We take this to mean: the ship can immediately run on some fuel, and, after some major or minor adjustment, this ship can run on some fuel, respectively.

It must be noted that some of the ordered ships show a combination of fuels, for example ammonia ready – methanol ready or LNG capable – or methanol ready. We can observe that especially in the neoPanamax category, e.g. the second biggest ship size, most investment for alternative fuels has been made. Especially the capability and readiness for LNG and methanol are large in this category. In the biggest vessels on order, all investments are done in LNG and methanol as well. Battery hybrid propulsion, ammonia and hydrogen can mostly be found in the smaller ship size categories.

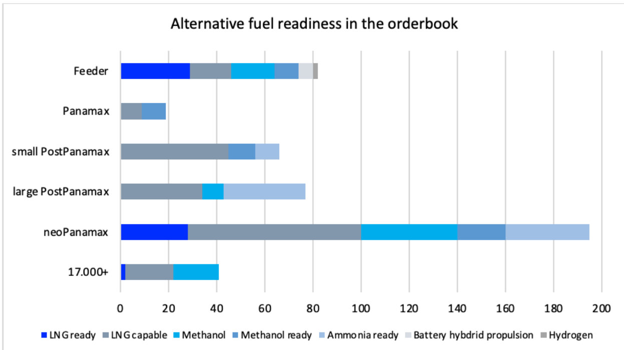



Figure 17: alternative fuels readiness of the orderbook
Source: data adapted from Clarksons database (2023)
Size categories are: feeder 100-2999 teu, panamax 3-5999 teu, small post panamax 6-7999 teu, large postpanamax 8-11999 teu, postpanamax 12-16999 teu and the large ships 17000+ teu.

Besides alternative fuels, new ships in the order book may also have SOx scrubbers installed. By scrubbing, the vessel’s exhaust gas through a cloud of water, thereby removing sulphur-oxide and reducing the harmful emissions generated by burning fuel. Table 4 displays the status of scrubbers on the different newly ordered ship sizes. For the small, large and neoPanamax, it can be observed that more or less half of the ordered ships will have scrubbers installed. Within the biggest vessel size category, this percentage is slightly smaller (38%). The smaller ships falling within the Panamax and feeder categories, have the lowest percentage of installment of scrubbers, e.g. 22 and 21%.

Table 4 Availibility of scrubbers in newly ordered ships

| Ship size (TEU) | Sox Scrubber Status | Total on order | % |
|---|---|---|---|
| >=17.000 | 23 | 61 | 38 |
| NeoPanamax | 115 | 238 | 48 |
| Large PostPanamax | 31 | 63 | 49 |
| Small PostPanamax | 49 | 106 | 46 |
| Panamax | 24 | 110 | 22 |
| Feeder | 67 | 317 | 21 |

Source: data adapted from Clarksons database (2023)

On a final note, while only half the ships in the orderbook has a positive scrubber status, the installation of scrubbers is definitely not the final solution for making ships more environmentally friendly. Scrubbers come with filters that need to be cleaned, and this washwater may also be discharged directly in the sea. As such, air pollutions is just transferred to the ocean environment. See for this, for instance, Osipova (2021).

# 5. Mechanisms of shipping companies to deal with cyclicality

In previous chapters, we have discussed a number of economic characteristics that explain to a considerable degree how liner shipping has developed. There is one more dimension that deserves to be discussed and that is the characterization of the commercial environment in which liner shipping provides its services. Economists would call this the analysis of the structure of demand for  ontainerized shipping services. Since the industry is always selling itself as the reliable, predictable, regular common carrier, it is often assumed that the demand for this service is regular as well. In practice, of course, it is not. The demand for all types of shipping is cyclical, and this is not different for containerized transport. In this chapter, we will therefore illustrate what cyclicality shipping lines have to deal with, and what mechanisms they have developed to cope. We remind the reader that, due to the short term supply and demand structure, temporary shortages and surpluses of capacity will result in wild fluctuation of freight rates. In this chapter, we will discuss short term cyclicality.

## 5.1 Cyclicality in global freight/transport markets

The arena for shipping is a global arena. That means that if shipping is impacted by the way our earth functions: we have seasons, which differ depending on the hemisphere, there are continental land masses that allow long distance transport over land, and there are areas and connections that have to cross bodies of water. Shipping also takes time because large distances are covered with transport means that do not travel very fast.

Taken together, these conditions by themselves create cyclicality: certain products are only available some parts of the year, of the travelling distance for some products changes considerably over a year. Cultural differences in terms of holidays and festivities differ, and the need for transportation  throughout the year reflects this. The build up of inventories for Christmas in Europe is such an example, the impact of the Chinese new year is another one. The cyclical nature of fruit and vegables transported in reefer containers also results in challenges for deepsea terminals, usually having a limited number of reefer plugs available.

Of course, cyclicality does not have to manifest in demand only. Cyclicality can also be present in cost items, such as fuel costs or in local sailing circumstances (ice, water temperature) which cause temporary restrictions on cargo carrying capacity, or access to ports. This is also an area where climate change impacts shipping at sea and on inland waterways.

While cyclicality is a topic that is central to maritime market analysis in liquid and dry bulk markets (see for instance the seminal work of Stopford, 2007), in container shipping it has not received much attention. A major reason for this was the consistent growth trend that dominated container shipping demand, and obscured the effects of seasonal fluctuations (see Figure 4).

In addition to this 'external' drivers of cyclicality, the shipping industry has its own internal driver of cyclicality. This was observed as early as Koopmans (1939), who pointed out that the interaction of the shipping and the shipbuilding market is characterised by a so-called delayed supply reaction. This is a standard mechanism in systems dynamics analysis, that introduces cyclical patterns even in a system that does not have a cyclical environment. Koopmans therefore advocated an integrated analysis of shipping and shipbuilding markets for a proper understanding of the shipping industry.

The large profits that shipping lines made in the years 2020-2022, and the decision to spend much of this profit on ships is going to impact the liner shipping industry. It will create fluctuations in capacity availability, and in profitability of shipping lines and this will have consequences for world trade. There is not much anyone can do about this anymore, since the shipping lines are autonomous in their ordering of ships. The only limiting factor is ship yard capacity. Hopefully our analysis, in the previous chapter and the present chapter, contributes to the awareness about this phenomenon.

While this 'internal' cyclicality goes largely unchecked, outside cyclicality is not. The container shipping industry has developed a host of mechanism to cope with undesirable fluctuations in their environment and we will discuss a number of these mechanism in the next section.

## 5.2 Mechanisms of shipping companies to deal with cyclicality

In this section, we will discuss measures to reduce capacity in the short term, measures to control for cost related fluctuations, measures to control geographical and seasonal disturbances. As we will see, the liner shipping companies resort to only a few types of measures. In addition to capacity reduction, they will often translate fluctuations and disturbances into fees or penalties to be borne by customers. We will discuss the consequence of this approach at the end of this section.

### 5.2.1 Capacity reduction

The consequence of cyclicality is that the sector is forced to adjust to temporary shortages or surpluses of capacity. In the short run, there are only few self-regulatory mechanisms when the sector faces shocks, since the most effective mechanisms – adding new shipping capacity – is not available in the short run. A capacity shortage could be addressed by increasing fleet and ship productivity. In bulk shipping this can be an effective strategy, since speed is not high, and there is considerable idle capacity at certain points in time. In liner shipping, where the ships carry out optimized schedules, there is not a lot of slack in the system. Ships are already sailing at almost double speed compared to bulk shipping, so speeding up also is not easily possible.

The only solution available to the industry is therefore capacity reduction through the following mechanisms:

- scheduling ships for maintenance jobs in yards,
- scrapping old capacity,
- slow steaming and,
- blank sailings (cancelling services).

The latter two of these can be done on a moment's notice, and have the additional benefit that they save operational costs as well. It is perhaps not surprising therefore, that these two mechanisms are a favourite strategy for liner shipping companies, whatever the market shock. See for some illustration on the magnitude of blanked sailings, Figure 10 above.

### 5.2.2 Cost related fluctuations

There are a number of cost items in a shipping company's cost structure that are driving profitability and, more importantly, cash flow. These are capital costs, manning costs, maintenance costs and fuel and port costs. Manning and maintenance costs do not really fluctuate much once they are fixed, but there is a considerable choice to set these costs at a certain level. This depends on the choice which regulatory regime is applicable on the ship. While this is an interesting topic, for now we focus on the fluctuating costs.

Fuel costs, as well as other local costs that shipping lines incur can fluctuate. Fuel costs are tied to oil prices, and exhibit largely the same dynamics. Since liner shipping companies have to make business case calculations on the basis of sailing schedules that have to be fixed for at least a number of months, they have developed a mechanism to transfer a large part of the fuel cost fluctuation to the customer. This mechanism is called the Bunker Adjustment Factor (BAF). With this BAF, that translates into an additional fee on top of the freight bill, unexpected changes in fuel costs are not borne by the shipping line, but by the cargo owner.

All shipping lines use slightly different formulas to calculate the BAF. The company Maersk, for instance, incurs a fuel bill of about $2 bln per annum, and uses the following formula: BAF = fuel price per ton x 'trade factor'. This trade factor reflects market and operational circumstances, such as average fuel consumption per trade lane, transit time, fuel efficiency, trade imbalance[13]. Almost all liner shipping companies use some sort of 'trade factor' to determine their BAF. The public information is too vague to actually verify what the shipping companies calculate.

Some scientific work was conducted to assess the degree to which the BAF actually reflects the underlying dynamics in fuel prices. Cariou & Wolf (2006), for instance, analysed this relationship, and observe that BAFs seem to follow bunker price fluctuations, but react in an over-elastic manner. In addition, BAFs more often go up as a result to bunker price increases than that they go down.

Another cost driver for shipping companies is the currency in which local costs, such as port dues and other port costs needs to be paid. Since all revenue is paid in dollars, paying local costs in another currency creates a currency risk for shipping companies. Also, for this risk, an adjustment mechanisms was developed: the co-called Currency Adjustment Factor. While the world has become much more integrated, and a limited number of currencies (dollars, euros) are accepted everywhere in the world nowadays, this CAF still exists, and is still a part of the charging structure of container shipping companies.

Finally, a new element that will create fluctuating costs is the selective introduction of emission control regulation. In Europe, for instance, ocean shipping will fall under the Emission Trading Scheme (ETS), which means that CO2 emissions on traffic to and from the EU common market will be 'taxed', based the price for CO2. Several shipping lines have already published the fees they will charge to their customers for these charges. Maersk, for instance, has announced they will charge €319 for a reefer container coming from Chile to Europe[14].

### 5.2.3 Geographical and seasonal disturbances

The way in which cyclicality resulting from seasons, geography or cultural events, works out is that certain areas or ports, in certain parts of the year are busier than others. A busy, or even congested, port means the ship may take more time to enter the port and load and unload cargo, which results in risks for the reliability of the schedule. Adjustments of the schedules are periodic (usually every six months), and therefore, these kinds of disturbances should be avoided and discouraged as much as possible.

The mechanism that shipping lines developed for this is the so-called surcharge. Any cargo that travels to or from a busy or congested port, to an area where ice might be a problem, or to an area in which political uncertainty might influence reliability, will incur a surcharge. Slack and Gouvernal (2011, Table 1) record a number of these charges: war surcharge, seasonal surcharge, winter surcharge, logistical imbalance fee, piracy, water level, congestion surcharge. They calculate that on some routes, the total addition or surcharges may make up 50% of the total freight bill.

### 5.2.4 Pricing mechanisms as a control strategy

From the above discussion, it is clear that shipping lines resort to two specific mechanisms to handle cyclicality: capacity reduction and pricing strategies. To complete this picture, we also briefly introduce some of the remaining pricing components and then reflect briefly on what this means for transport pricing in container shipping.

One of the most important surcharges container shipping companies charge their customers is the so-called Terminal Handling Charges. These charges cover the costs the shipping lines incur in terminals for handling, storage and other services to containers. Similar to the discussion on BAFS, there is some evidence that the THCs do not really reflect underlying costs (EU Commission 2009).

A second set of surcharges have to do with the nature of the cargo: some cargo requires special handling, is very heavy, contains dangerous goods, need to be loaded directly on a chassis, and so on. All these aspects also result in separate charges.

The overview of special charges is completed with the demurrage and detention charges. We have already introduced this mechanism in section 3.1. Demurrage and detention are conditional charges for the hire of the container that depend on decisions of the cargo owner. If the cargo owner carries out the container pick-up and delivery within the so-called free days, there are no charges. If these deadlines are violated, then charges will be levied by the shipping line.

The consequence of this way of working is that container shipping invoices are usually complex invoices which contain a dozen or more items that are charged to the customer for the same service, and that can substantially increase the bare cost of shipping a container. Shipping lines are in the habit of charging for demurrage and detention separately on a periodic basis, and they usually send this invoice to the company involved in actually picking up and dropping off the container at the terminal. This company then has to transfer these costs to their customer and are often forced to advance these costs to the shipping line. There is little or no room to discuss the relationship between some of the fees and the underlying risk or cost development.

## 5.3 Residual market fluctuations

We end this chapter with a brief review of the residual market fluctuations in container shipping. A way to look at this is to consider that shipping lines, with all their charges and fees, strive for a stable income throughput the year. The market price is then the only remaining indicator of any remaining market fluctuations.

In this section, we will look at the way container freight rates have developed over time. Even though there is a long tradition of price fixing and collective price setting, this practice has been abolished in large parts of the world. In addition, in some of the main shipping centers, actual freight rate data is collected for containerised shipping. We will examine some of this data to see if there is evidence of remaining fluctuation.

This is relevant, because again, the industry puts forward their narrative of a regular, predictable affordable service for global trade. In this context, all the mechanism we have discussed above could be justified as necessary control mechanisms to achieve this regular service. It is still interesting, however, to see to what extent the industry succeeds in 'regulating' itself.

An early attempt to analyse liner shipping price stability was part of the 'Erasmus Report', which was commissioned by the European Commission to aid with the consultation for the abolishment of the 4056/86 package (Haralambides et al 2003). Around that time (2002/2003), there was still conference price fixing to and from Europe, but that exemption had been lifted in trades to and from the USA since 1994, while the Ocean Shipping Reform Act (OSRA) in 1999 allowed shipping lines to enter into confidential long-term contracts. For the analysis, PIERS data was used. The study drew attention to the growing imbalance of trades eastbound and westbound, in all three major markets: transatlantic, transpacific and Europe-Far East. The study noted a marked downward effect of OSRA on rates and market concentration in the trans-Pacific and trans-Atlantic trades. These effects seemed to have sparked more fluctuations in rates, as is to be expected, when markets become more competitive. In that report, this was interpreted as some weak support for some form of market organisation, if the aim was to stabilize the market. The commissioner of the report was not exactly happy with this outcome, since it weakened the resolve to do away with conferences in the European arena.

In fact, this discussion points at a complicated issue with regard to the assessment of (rate) stability in liner shipping: in general, a more competitive environment results in more fluctuation in freight rates, but the standard narrative of liner shipping prefers to concentrate on stability and the absence of fluctuation as much as possible. As a result, it becomes difficult to differentiate between the absence of rate fluctuation due to a lack of competition, or due to the effectiveness of control mechanisms. This can also result in overconfidence in the shipping industry in its own fluctuation controlling ability.

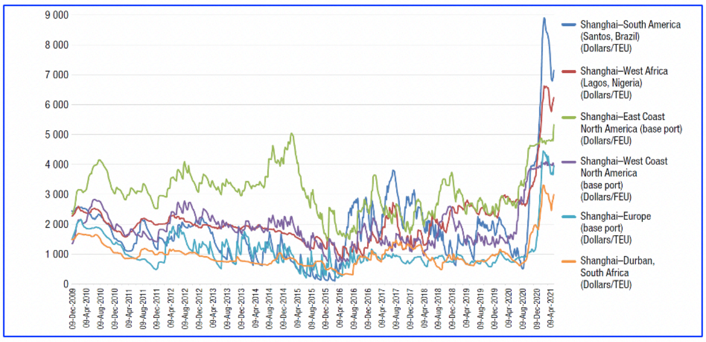


Figure 18: Shanghai containerized freight index, various routes 2009-2021

The above freight rate data are the Shanghai Containerized Freight Indices, which is an index published by the Shanghai Shipping Exchange. It is one of the most comprehensive freight rate indicators for global container shipping. The index shows, until mid 2020, some fairly stable trades, such as the Shanghai – Europe, which bumbles along between about $200 and $2200 for most of the period of the figure (2009-2020). While this is a very competitive tradelane, offering predictable rates on this trade lane can be considered a success. During COVID-19, prices peaked as high as $4500 and later to $7000.

A much more unstable environment is another not so competitive tradelade: Shanghai – East Coast North America. Here prices moved between $1.500 and $5.000, where prices during COVID-19 initially peaked at $5000 euro as well. Later in 2021/2022, however, they doubled once more, to $10.000. A much more stable trade, and more competitive, is Shanghai – US West Coast, which fluctuated between about $800 and $2.800 and then jumped in two steps from $4.000 to $5.500.

This presents a contrast to the early study in the ‘Erasmus Report’, where competiveness was associated with fluctuating freight rates. In the period of the Shanghai Freight Index, the opposite is true: the bigger the volumes, the more effective the rate control mechanisms apparently are. The thinner trade lanes: Shanghai – Africa, Shanghai – South America seem to show relatively more volatility before COVID-19 and as a result of COVID-19.

One the whole, however, rates do fluctuate and this in itself could be considered a sign of some level of competitiveness. Given that there was considerable overcapacity, no real short term capacity shortage has ever materialised in the last fifteen years or so, and as a result, rates have not peaked dramatically. Until COVID-19, that is. During COVID-19, as we have already discussed, the sudden demand increase combined with inappropriate capacity reduction measures of the shipping companies, a short term capacity shortage materialized, and this has led to, again, not unexpected rate hikes.

This results in a nuanced review of the effect of consortia and their stabilizing effect on trade. In situations when the market is not very volatile, on large tradelanes, such as Europe-Far East (westbound) and trans-Pacific (eastbound), the shipping lines are able to manage stability. On thinner trades, and in case of economic and geopolitical shocks, these mechanisms do not really work, and the outcome is closer to pure competitive market economics.

There are also other sources, such as the Drewry World Container Index (WCI). While this index shows the same development as above, this picture also includes capacity utilisation (on the righthand axis).

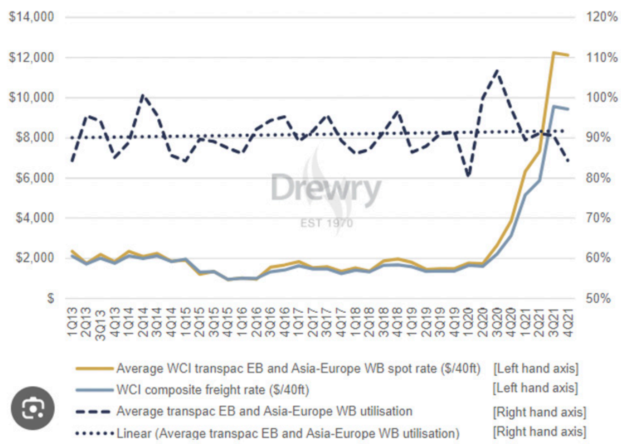


Figure 19: Drewry World Container Index 2013-2021

Observe that this representation shows a smoother freight rate development (apart from the 2020-2021 period). At the same time, capacity utilisation (averaged over trans-Pacific and Europe-Far East) shows a marked fluctuation. The relatively low utilisation in Q1 of 2020 sparked the capacity control measures that led to the rate hike (because blanking sailings coincided with an unexpected demand increase). This indicates two things: first, liner shipping companies regulate market fluctuations with their capacity. The result is a reasonably stable freight rate. Second, this explains why consortia may actually work to some extent: these are also capacity regulation mechanisms, and they allow the companies to coordinate their capacity regulation with a larger shipping capacity volume.

A final observation on freight rate fluctuations: if we look again at the Shanghai Freight Indices, there seems to be a structural break in the graphs around 2015. Before the rates look more stable than after. 2015 is a bit of an auspicious year, because it was the year around which gradual increase towards the 24.000 teu ships got started. This was a change in the sense that previous ship size increases were jumps, while from 2015 onwards, ship size almost continuously increased. It was also the year where a major reduction of sulpher emission was enforced in so-called emission control areas (ECAS) (most of the US coastal area as well as most of northern Europe were such ECAS).

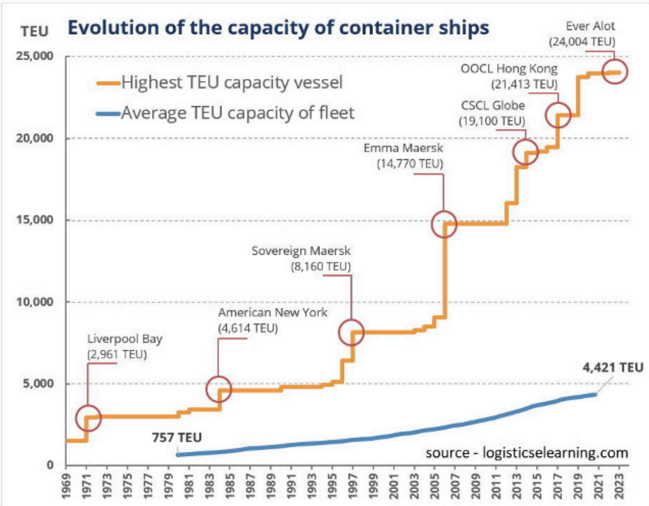



Figure 20. Container ship size evolution
source: logisticslearning.com

So again, we can conclude that the liner shipping industry apparently cannot effectively cope with changes that impact the industry (introduction of larger ships, emission control regulation). These changes result in a less stable ocean transport environment for containerized cargo.

# 6. Operational consequences of ocean ship scale on hinterland networks

**This chapter discusses the operational consequences of ocean ship scale on hinterland networks based on our recent simulation studies. The emergence of very large container vessels is often accompanied by a ‘negative modal shift’; shift towards road transport instead of inland waterways or rail – modes with much more favorable environmental characteristics.**

## 6.1 Aim and model

The aim of this study is to present some specific effects of economies of scale in container transport by sea. In doing so, we mainly look at effects on operations in container terminals, and within these, especially the handling capacity of other modes such as truck and barge. We leave out the more detailed aspects of terminal operations, such as stacking crane efficiency, and efficiency of the transport system between quay and stack, because we mainly want to look at the knock-on effects of maritime developments on the other modalities, through the terminal switching point. We use the TBA/Portwise model TRAFALQUAR for the simulations. This is a powerful model for simulation studies, in which ship arrivals, quay operations, and quay and quay crane productivity can be modelled. More specifically, for different ship arrival scenarios, the model provides insight into quay occupancy, crane deployment, and stack occupancy. Simulations typically cover a year, providing a good picture of the long-term effects of certain choices.

## 6.2 Assumptions

### 6.2.1 General assumptions

In the model analysis, we look at a few different developments:

- Different pro-forma arrival patterns, in which we distinguish at least one arrival pattern with relatively many smaller vessels, and one scenario with (fewer) very large vessels;
- ifferences in the accuracy of arrivals, measured by the deviation from the communicated ETAs;
- Variations in quayside crane productivity.
- The typical Rotterdam phenomenon of the double call, where large ships first come to unload alone and then come to load alone a few days later.

The characteristics that are measured are: the number of quay cranes deployed, docking at their scheduled place at the quay, the density, or occupancy of the stack, peaks on the landside of the terminal (truck handling), waiting time of ships before docking, how often smaller ships cannot dock at their scheduled time because an ocean-going vessel arrives, the difference between scheduled and actual quay cranes deployed, and the increase in quay crane cycles due to the size of ships.

### 6.2.2 Terminal assumptions

For the study, we chose to take a general terminal as the study object, basing the design on a typical Western European terminal. For various operational processes, we take Western European average throughput times and distributions. The terminal has the following characteristics:

- Capacity of 2.5 million TEU
- Quay length of 1,200 metres
- Three berths
- 12 quay cranes

A more precise terminal configuration would be needed if the processes at the terminal were to be modelled in more detail. For such a model, either a rail mounted gantry crane design should be chosen, or a design using automated guided vehicles. Realistic dynamics have been built into the model: if the terminal and stack are busy, the gantry crane productivity goes down.

### 6.2.3 Ship assumptions

The ship arrival scenario considers a mix of ships. Here, two scenarios are distinguished: one with more relatively smaller ships, and one with a few relatively large ships. This is based on a standard classification of ship types and size in the TRAFALQUAR model. In this, the largest vessel is a containership that can generate a call size of 8,500 containers. This is comparable to the current largest container ships of 24,000 TEU. This call size requires:

- a desired service time of 43 hours
- a loading and unloading productivity of 200 containers per hour
- an average crane productivity of 32 containers per hour

Such a vessel will be served with 6 cranes, while a maximum of 8 is possible in the model. The modelling of ETA deviations takes into account a difference in reliability of large ocean-going vessels, compared to smaller ships and barges. Here, the larger ships are more unreliable in their arrival. In the latter case, a large proportion of ships arrive some 24 to 48 hours late. This is in line with the average performance in the sector (although much worse performance has been observed in recent years).

### 6.2.4 Technical and dwelltime assumptions

A few more technical assumptions are:

- The loading/unloading ratio is 50/50 (except in the situation with two calls)
- The transshipment ratio is 40% (in line with the situation in Rotterdam)
- The TEU factor used is 1.7
- We only use ‘normal’ containers
- The dwell time in the terminal is on average 7 days.

As for the dwell time, this is a given in this model. Investigating the evolution of dwell time due to the operational impact of larger call-sizes requires analysis with a more detailed simulation model (which also requires much more far-reaching choices to be made regarding terminal design). For the current study, this takes it too far for the time being. The truck arrival process is adapted to the different ship arrival scenarios, by linking the desired number of trucks to dwell times of containers. This will show the impact of larger call-sizes in the peaks at the truck gates.

## 6.3 Results

### 6.3.1 General results

The core of this research is to analyse, through a simulation study, the impact of larger call sizes on European container terminal operations. Two core scenarios were distinguished:

- One where most of the volume is associated with 3 very large vessels (call size up to a maximum of 8500 containers per vessel).

One in which several smaller vessels handle the volume on and off the terminal (call size up to 5500 containers per vessel) resulting in the terminal handling more small vessels.

For each scenario, there are several options:

- 12 quay cranes versus 14 quay cranes;
- Fixed or dynamic quayside crane productivity;
- Different deviations in vessel ETAs;
- Increase in dwell time at the terminal;
- Single visit versus split visit with separate unloading and loading calls.

Dynamic crane productivity reflects the phenomenon that when multiple cranes are deployed, the overall productivity of the quayside cranes declines. This is because the cranes get in each other's way, or because the landside system cannot fully track the cranes' production. The model incorporates this as follows:

| Deployment cranes | Productivity |
|---|---|
| 1-8 | 100% |
| 9 | 97% |
| 10 | 94% |
| 11 | 91% |
| 12 | 88% |

The deviations from the ETA work through because the simulation model works with a schedule with times when certain ships are expected to arrive. A deviation in the ETA means the ship arrives at a different time. It is clear from Figure 21 that the model takes into account a larger ETA deviation for the larger ships. The scenario analysis considers the impact for different deviations.

The TRAFALQUAR model includes dwelltime as a fixed value. This was chosen because co-modelling dwelltime requires the terminal model to be worked out in much more detail. In this study, this was desirable because of time and resource constraints, but also because it required a more specific choice of terminal design, giving the results a much more specific, and limited, character. However, a scenario was included, in which the effects of a longer dwell time were included as part of the sensitivity analysis. In the base case, the dwell time is on average 7 days with a maximum of 14 days. Alternatively, a dwell time averaging 8.5 days and a maximum of 17 days was used. The alternative scenario of a split call has worked with one split call per week, so an unloading and loading call are included in the schedule. The terminal simulation runs for a year, so that means 52 of these calls on an annual basis. These elements of the study were added as additions to the scenarios or as sensitivity analysis. Below, we discuss the results of the experiments. If special additions have been made to them, we will always explicitly mention that.

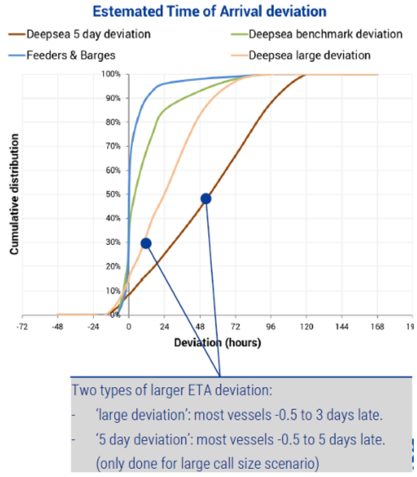



Figure 21 ETA deviation in the simulation model
Source: TBA/Portwise model report 2022

### 6.3.2 Bigger calls versus smaller calls

The large call size scenario assumes 30 barges, 4 feeders and 7 ocean-going vessels per week. The largest ocean vessel generates a call of up to 8,500 containers. The small call size scenario assumes 30 barges, 4 feeders and 12 ocean-going vessels, with the ocean-going vessels generating calls of up to 5500 containers per vessel. The results are summarised below.

| KPI | Scenarios | | Comparison |
|---|---|---|---|
| | Large calls | Smaller calls | Gap in favour of large calls |
| Vessel waiting time for berth of deepsea vessels - % exceeding 8 hours | 1% | 3% | 2% |
| Vessel waiting time for berth of feeders - % exceeding 8 hours | 6% | 22% | 16% |
| Vessel waiting time for berth of barges - % exceeding 8 hours | 8% | 17% | 9% |
| Average berth occupancy | 53% | 61% | 8% |
| Quay crane peak deployment: % of time more than 10 QCs in operation | 28% | 24% | -4% |
| Quay crane balanced workload: % of time 5 to 10 QCs are in operation | 43% | 52% | -9% |
| Peak storage occupancy | 29,300 bx | 28,100 bx | -1200 bx (4%) |
| Peak gate workload (98% busiest day threshold) | 2230 bx/day | 2160 bx/day | -70 bx (3%) |
| Average deviation of required vs planned number of cranes per shift | 2.36 | 2.21 | -0.15 (6%) |
| Maximum deviation of required vs planned number of cranes per shift | 6 | 5 | -1 (17%) |
| Average deviation of the planned berth position | 142 m | 214 m | 72 m (51%) |

Figure 22 call size analysis results
Source: TBA/Portwise model report 2022

The results show that there are positive outcomes for handling large ships: less waiting time for all ships, better quayside utilisation and better realisation of quayside planning (ship in the right place). There are also negative outcomes: peak load of quay cranes increases, peak load in the stack increases, peak load at the truck gate increases and there are some effects in quay crane allocation to ships. This is an interesting outcome: the scaling-up of ocean-going vessel leads has positive as well as negative effects on a terminal operation. This is also to be expected: planning in large chunks (read call sizes) is easier than more fragmented planning, so this has a positive effect. In addition, the concentration of container flow leads to all kinds of peaks. This has a negative impact.

### 6.3.3 Dynamic crane productivity

As described above, including dynamics in crane productivity is more realistic than assuming that cranes always run at 100% productivity. The model was therefore run for both scenarios (large and small call sizes) taking into account the decrease in crane productivity as shown in the table above. The results of this analysis are as follows:

| KPI | | Scenarios | | | | Comparison | |
|---|---|---|---|---|---|---|---|
| | | Large calls benchmark | Large calls Dynamic QC | Smaller calls benchmark | Smaller calls Dynamic QC | Gap in favour of large calls benchmark | Gap in favour of large calls Dynamic QC |
| % Vessels with waiting time for berth exceeding 8 hours | Deepsea vessels | 1% | 1% | 3% | 4% | 2% | 3% |
| | Feeders | 6% | 8% | 22% | 25% | 16% | 17% |
| | Barges | 8% | 14% | 17% | 21% | 9% | 7% |
| Average berth occupancy | | 53% | 56% | 61% | 63% | 8% | 7% |
| Quay crane peak deployment: % of time more than 10 QCs in operation | | 28% | 36% | 24% | 30% | -4% | -6% |
| Quay crane balanced workload: % of time 5 to 10 QCs are in operation | | 43% | 37% | 52% | 49% | -9% | -12% |
| Peak storage occupancy | | 29,300 bx | 28,540 bx | 28,000 bx | 28,180 bx | -1300 bx (-4%) | -380 bx (-2%) |
| Average deviation of required vs planned number of cranes per shift | | 2.36 QC | 2.36 QC | 2.21 QC | 2.25 QC | -0.15 (-6%) | -0.11 (-5%) |
| Maximum deviation of required vs planned number of cranes per shift | | 6 QC | 6 QC | 5 QC | 4 QC | -1 (-17%) | -2 (-33%) |
| Average deviation of the planned berth position | | 142 m | 154 m | 214 m | 226 m | 72 m (51%) | 72m (47%) |

Figure 23 Results call size analysis with dynamic crane productivity
Source: TBA/Portwise model report 2022

This analysis shows that due to lower quay crane production, the benefits of the larger call size are somewhat different. Barges in particular face somewhat lower waiting times, while the waiting times of ocean-going vessels and feeders are somewhat higher due to the loss in crane productivity. The peak loads all increase somewhat, except for the peak load in the stack. This decreases somewhat because the inflow from the quay is somewhat slower. All in all, these are results that were to be expected, although it is interesting to see that the productivity effects work out differently on barges, feeders and ocean-going vessels.

### 6.3.4 Deployment of more cranes

With the deployment of more cranes (from 12 to 14) also comes the objective of having more cranes on a ship. This is expected to speed up the handling of ships and reduce quay occupancy. An important reason why more cranes are needed is that in the base case, the full number of cranes is occupied more than 10% of the time. A rule of thumb for adequate terminal layout is to keep this percentage below 10%. The outcome of this analysis shows that there is not much impact on the differences between large and low call sizes. The effect of the larger number of cranes affects both scenarios roughly equally, so the difference between the scenarios remains the same. However, the overall production of the cranes is obviously better: the number of hours in which a productivity of 200 moves per hour is achieved doubles. Vessel waiting time decreases and quay utilisation also decreases.

### 6.3.5 Larger deviations in the ETA

Deviations in the ETA means that a ship arrives at a different time than it is scheduled to. Generally, this means that the ship arrives later than planned, but it is also possible that the ship is a bit earlier. This is expected to lead to more scheduling adjustments, shifts in the allocation of cranes, shifts of ships at the quay, and the resulting time losses involved. The analysis takes into account that crane productivity is dynamic. The results of the experiments on ETA shifts are as follows:

| KPI | | Scenarios | | | | Comparison | |
|---|---|---|---|---|---|---|---|
| | | Large calls (dynamic QC performance) | Large calls large ETA deviation (&5-day) | Smaller calls (dynamic QC performance) | Smaller calls large ETA deviation | Gap in favour of large calls | Gap in favour of large calls large ETA deviation |
| % Vessels with waiting time for berth exceeding 8 hours | Deepsea vessels | 1% | 4% (8%) | 4% | 7% | 3% | 3% |
| | Feeders | 8% | 16% (18%) | 25% | 35% | 17% | 19% |
| | Barges | 14% | 23% (27%) | 21% | 30% | 7% | 7% |
| Average berth occupancy | | 56% | 58% (58%) | 63% | 64% | 7% | 6% |
| Quay crane peak deployment: % of time > 10 QCs in operation | | 36% | 40% (40%) | 30% | 33% | -6% | -7% |
| Quay crane balanced workload: % of time 5 to 10 QCs in operation | | 37% | 30% (29%) | 49% | 42% | -12% | -12% |
| Average deviation of required vs planned number of cranes per shift | | 2.36 QC | 3.19QC (3.22) | 2.25 QC | 2.48QC | -0.11 QC (-5 %) | -0.71 QC (-22%) |
| Maximum deviation of required vs planned number of cranes per shift | | 6 QC | 7QC (7QC) | 4 QC | 6QC | -2 QC (-33%) | -1 (-14%) |
| Average deviation of the planned berth position | | 154 m | 209m (235m) | 226 m | 256m | 72 m (47%) | 47 m (22%) |

Figure 24 ETA shift results
Source: TBA/Portwise model report 2022

In this experiment, it is interesting to look at the impact of the larger ETA deviation for both call size scenarios separately. What is striking is the large impact on all KPIs of larger ETA deviations: waiting times for all types of ships, but especially for feeders, increase, quayside utilisation increases, crane allocation deviates more from planning, and balanced crane utilisation is less common, and finally, there are larger deviations in the number of times a ship is at the quayside at the planned spot. All in all, quite an impact of the piece of information that terminals need from ships to be able to carry out their planning properly.

This effect also seems to be particularly pervasive in the small call size scenario. The large call size scenario seems to be somewhat more robust to deviations from planning for ocean-going vessels. Especially the very large ships do not suffer much from ETA deviations. This is another proven advantage of the large call size scenario. There are more differences in how ETA deviations play out for the small and large call size scenarios. From this, we infer that the quality of vessel information is a crucial and perhaps under-researched issue for terminals. Given the impact, in the experiment we added to it by looking at an even more extreme ETA deviation: a deviation of 5 days, applied only to the large call size scenario. In this case, we also see roughly double the effects for the largest ships on the waiting time for docking.

### 6.3.6 Increase in dwell time

As stated earlier, the TRAFALQUAR model contains a fixed dwell time distribution. To still look at the effects of increased dwell times, we conducted an experiment with an alternative dwell time distribution averaging 8.5 days and a maximum of 17 days. The simulation study shows mainly two effects:

- The stack occupancy increases by about 20% on average over the year. The peak occupancy also increases by 20%.
- The peak occupancy at the landside gate increases on certain days, and as a result the occupancy on less busy days. Increased dwell time leads to more peaked behaviour at the landside gate.

For all other KPIs, there is no significant impact from this experiment.

### 6.3.7 Effects of split calls

The starting point for this experiment is: ships can split their call into an unloading call and a loading call a few days later. This leads to a greater claim on terminal capacity. The way we implement this is that two calls are linked in the model. The unloading call is scheduled with the disruptions we analysed before (mainly ETA deviation). The ship with the load call then arrives somewhere between 5 and 7 days later. It is interesting to note that we assume three large ships per week in the large call size scenario. If we split two of these, this scenario is not much different from the small call size scenario in terms of the calls to be handled. In other words, one might expect the difference between the large and small call size scenarios to be greatly reduced. The results of this experiment are as follows:

Split calls of deepsea vessels comparison (1&2 split-calls per week)

With 2 split-calls in large call size scenario, the delays are closer to the benchmark small call size scenario

| KPI | | Scenarios | | | | Comparison | |
|---|---|---|---|---|---|---|---|
| | | Large calls | Large Split calls (1 & 2 calls/wk) | Smaller calls | Smaller Split calls (1 & 2 calls/wk) | Gap in favour of large calls | Gap in favour of split large calls |
| % Vessels with waiting time for berth exceeding 8 hours | Deepsea vessels | 1% | 1% & 3% | 3% | 4% & 5% | 2% | 3% & 2% |
| | Feeders | 8% | 12% & 15% | 25% | 33% & 30% | 17% | 21% & 15% |
| | Barges | 14% | 17% & 20% | 21% | 27% & 27% | 7% | 10% & 7% |
| Average berth occupancy | | 56% | 57% & 59% | 63% | 64% & 64% | 7% | 7% & 5% |
| Quay crane peak deployment: % of time more than 10 QCs in operation | | 36% | 35% & 36% | 30% | 29% & 28% | -6% | -6% & - 8% |
| Average deviation of required vs planned number of cranes per shift | | 2.36 QCs | 2.49 & 2.56 QCs | 2.25 QCs | 2.24 & 2.39 QCs | -0.11(-5%) | -0.25 & -0.17 |
| Peak storage occupancy | | 28,540 bx | 28,700 & 29,600 bx | 28,180 bx | 28,200 & 28,000 bx | -360 bx (-1%) | -500 bx & -1600 bx |

Figure 25 ETA shift results
Source: TBA/Portwise model report 2022

This experiment shows that the effect for feeders and barges is much larger than for ocean-going vessels. The largest seagoing vessels (whose calls are split) are themselves hardly affected by splitting. If we look at splitting two calls, the results show that we indeed arrive at the performance level of the small call scenario for the large call size scenario. This means that the benefits of the large call size scenario, which we had previously identified, disappear when calls are split. Waiting times for the loading call are often higher than for the unloading call. This is partly caused by the uncertainty in the arrival of the unloading call.

At the same time, we see that the disadvantages of the large call size (efficient use of cranes, quay and stack) continue to exist, or worsen slightly for the large call size scenario. Again, the effects are different depending on the large or small call size scenario. We had also noted this complexity in the experiments on ETA deviations.

## 6.4 Concluding remarks

Our aim with the simulation study was to estimate the effect of increasing call sizes on terminal operations and hinterland transport. The study results show that such effects do exist. We summarise the main insights again below.

- We see that larger call sizes have both positive and negative effects on terminal and hinterland operations. The simplicity of scheduling ships in larger blocks has benefits especially on waiting times of smaller ships. At the same time, larger call sizes generate peaks at different places in the terminal.
- Deviations in the arrival planning of ships, as reflected in inaccurate ETAs, lead to an increase in the waiting times of all ships and increase inefficiencies of the terminal operation (cranes, quay, stack, gate). The effects for feeders and barges are generally larger than for ocean-going vessels.
- Splitting calls ultimately results in the advantages of the larger call size scenario disappearing, while the disadvantages remain.
- In a number of experiments, the effects on different KPIs turn out differently as a result of a small or a large call size scenario. This kind of complexity makes it complicated to find simple solutions to some of the drawbacks of scenarios that we examined in this study.

# 7. Outlook on the viability of liner shipping

## This chapter provides an outlook on the viability of liner shipping as one of the carriers of international trade going forward into the future.

In the summer of 2023, container shipping met with challenging conditions: a continuous wave of orders for new container ships resulting in a very strong capacity increase and at the same time a weakening global economy, partly due to the slower-than-expected recovery of the Chinese economy. In addition, concerns about the fragmentation of the global economy as a result of the trade dispute between the US and China are leading to increasing economic uncertainty and lower than expected – or possibly negative – growth for the container industry. This means that the usual capacity-reducing measures as indicated in this report – maintenance, scrapping, slow steaming and blank sailings – will not suffice in the coming years. This could lead to a serious downturn in container markets and possibly painful events such as a new round of mergers or even bankruptcies. Due to the weakening global economy, very large container ships (24,000+ TEU) will only be partially loaded and have a low utilization rate, preventing the shipping lines from benefiting from the economies-of-scale these ships bring.

In addition, the uncertainty in the container markets could further increase with regard to the evaluation of the CBER by the European Commission due to expire on 25 April 2024. In chapter 2 we indicated that almost all parties – competition authorities, importers, inland shipping, shipowners, trade unions and seaports – are against extending the CBER. "At the same time, no party has a good understanding what the future of an unregulated container transport system looks like." (Chapter 2.4) A major breakthrough, however, was the announcement of the breakup of the 2M alliance. Its members Maersk and MSC each opted for their own strategy that made further collaboration difficult. Maersk is developing an "integrator of the seas" strategy, with a focus on supply chain management, with container shipping as a backbone, and a focus on IT-services and customer relations. MSC invested heavily in shipping capacity and became the largest container operator. Maersk's supply chain-driven strategy focuses on the end customer, high reliability and pricing throughout the supply chain. MSC has traditional 'asset-driven strategies' characterized by high capacity utilization and economies of scale, where service quality is not a priority (Fransoo & Lee, 2012). In addition to Maersk, CMA CGM and – to a lesser extent – COSCO also have a supply chain-driven strategy and can also choose to leave the alliance or adapt the Ocean Alliance to these principles.

It is therefore a bit cynical that Maersk, the container carrier that – with the Emma Maersk in 2006 and the Triple E class in 2012 – started the advance towards much larger container ships in order to outperform the competition on the basis of economies-of-scale, now has a relatively underdeveloped position in the race to ever-larger ships and recently ordered a class of 16,000 TEU methanol-powered ships.An important factor in the container industry is the demand for supply chain greening from key global container services customers. These shippers prioritize reducing the carbon footprint of their operations and are extending this requirement to their suppliers, including logistics service providers. It is therefore not surprising that container carriers that have built direct relationships with these global shippers, such as Maersk, are leading the way in investing in alternative fuels for their ships, for example methanol. In addition, other parts of the container supply chain can still be seriously improved in the field of greening shipping, such as introduction of the practice of just-in-time shipping, onshore power supply, electrification of deepsea-terminals and decarbonisation of hinterland transport. However, shipping costs are expected to increase in the future due to higher costs associated with alternative fuels and emissions trading schemes.

Based on a simulation, we have concluded in this report that larger call sizes of 24,000 TEU vessels have both positive and negative effects on terminal and hinterland operations. A very clear positive effect of the emergence of 24,000+ TEU ships is the environmental benefit, which mainly takes place at sea. These very large vessels use less fuel per TEU transported than smaller container vessels and the amount of bunker fuel oil per port visit of a large deep-sea vessel is on average less than that of a medium-sized deep-sea vessel, according to information from the Port of Rotterdam. But due to the possibility of low load factors associated with the economic conditions presented above, these environmental impacts may be limited. The compound negative impact of these large container ships still receives limited attention.

All in all, we have analysed a crucial industry for international trade, that has grown accustomed to its own illusion of control over markets, chain partners, fluctuating costs and profitability. The next few years will show if this industry has indeed sufficient control over its own operations to keep pace with the environmental demands and the continuing requirements of international trade.

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2 See for a recent signal https://theloadstar.com/conference-system-could-return-sanity-to-asia-europe-shipping-after-gri-failures/ in 2015.

3 This goes back to the earliest days of the European Community: this same ambition of getting rid of all discriminatory continental transport pricing practices was one of the aims of the European Coal and Steel Community established in 1952.

4 Note that this coincides more or less with the ruling of the US Supreme Court in 1911 to break up the Standard Oil, since it was considered an illegal monopoly.

5 These are primarily shipowners of coastal shipping operations and feeder services for containers.

6 The Hague Rules stem from 1924, with amendments by the Brussels protocols of 1968 (Hague-Visby rules) and the 1979.

7 See https://uncitral.un.org/en/texts/transportgoods/conventions/hamburg_rules/status

8 https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/rotterdam-rules-e.pdf

9 There is a more precise legal formulation for this, but that is not the purpose of this paper.

10 SDR = special drawing rights, the IMF currency. 2 SDR is about 2,5 euro.

11 https://www.freightwaves.com/news/hapag-lloyd-will-pay-2m-to-settle-detention-and-demurrage-case

12 The reason is that while cost of production is related to the amount of steel in a ship, which is related to the surface of the hull, the cargo carrying capacity is related to the volume of the ship, which grows in three dimensions.

13 Source: IHS Markit 2019, liner market analysis.

14 Some back of the envelop calculations on CO2 emissions of reefer containers and container ships show that there is positive margin between the actual CO2 rate and the surcharge per container of about 10% of the surcharge.

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