International Transport Forum

Container Ship Size and Port Relocation

Discussion Paper

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Roundtable

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The International Transport Forum

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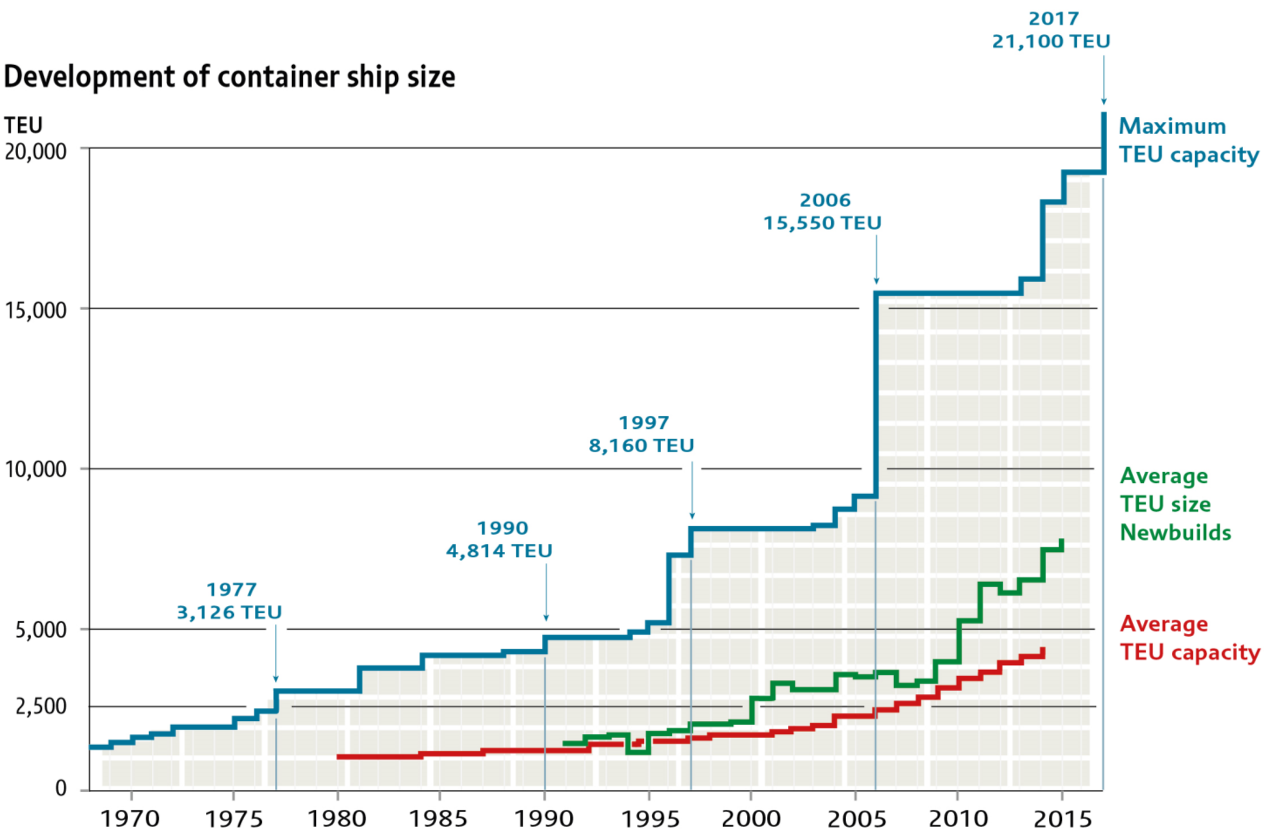
Impacts of ship size on the ports system

Container shipping is characterised by a constant search for economies of scale. Since the invention of the shipping container, the size of containerships has grown continuously in order to reap cost savings from decreasing unit costs related to larger ships. These cost savings have been substantial and contributed to a considerable decrease in maritime transport costs. As such they have facilitated trade. Over the last decade, the increase in containership size has accelerated. Over this period both the average and maximum size of container ships have doubled (Figure 1). Nowadays, the largest containership has a carrying capacity of around 20 000 standard containers (TEUs), with a length of 400 metres, a width of 60 metres and a draft of 16 metres. The development towards ever-larger container ships has large impacts on the port system and the dynamics between ports and cities, as will be developed in this paper.

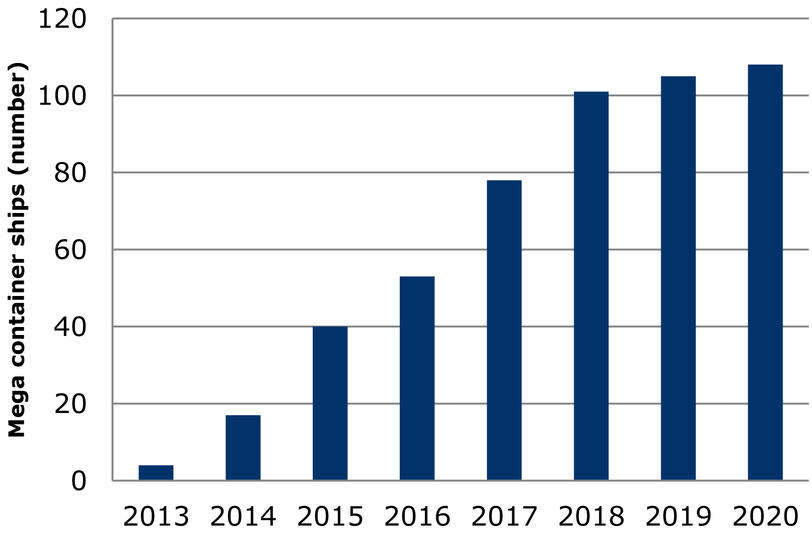
Figure 1. Development of container ship size 1970-2017



Source: ITF (2015).

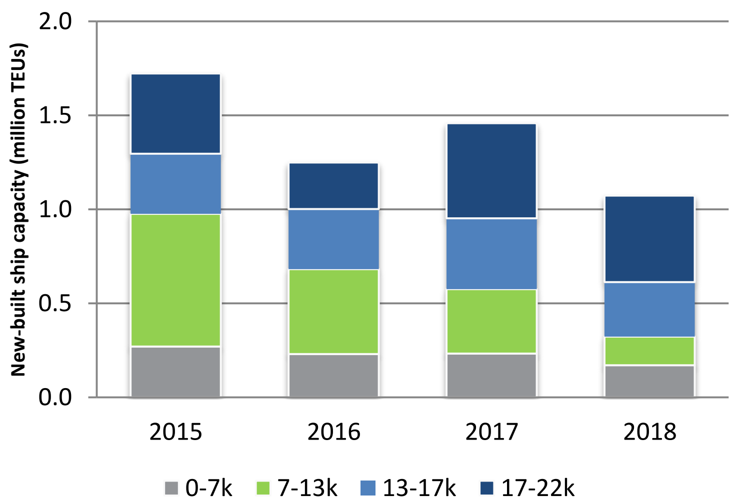
The impacts of the newest wave of container vessels only start to become visible, as many of these mega-ships have not been delivered yet. A mega-ship is here defined as a ship with a capacity of 18 000 TEUs or more. The first series of these vessels were the "Triple E" vessels of Maersk, several of which have been operational since 2013. Many other shipping companies have followed with orders for ships with similar dimensions and capacity. In the beginning of 2017 around 50 of such mega-ships were operational; more than double that amount of mega-ships will be available in 2020 when current orders will have been delivered (Figure 2). These mega-ships make up a large share of the container ship capacity that will be added in the coming years: around a third of new ship capacity in 2017 and 2018 (Figure 3).

Figure 2. Evolution of number of mega-ships deployed 2013-20



Source*:* ITF elaboration based on data from Clarkson Research.

Figure 3. New-built orders of containerships per size class 2015-18



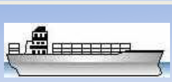
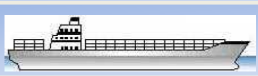
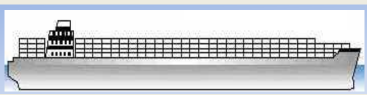
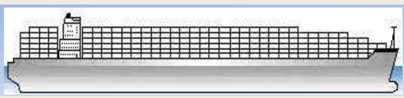
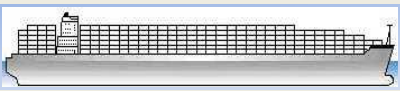
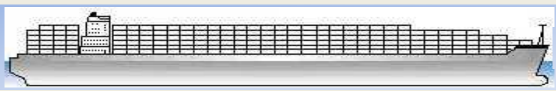
Source*:* ITF elaboration based on data from Clarkson Research.

Mega-ships have huge effects for ports in three respects. First, larger ship size requires adaptations in ports that have been constructed on the basis of smaller ship dimensions. Second, larger ships mean larger call sizes, that is: larger cargo volumes handled each time a ship calls a port. As such, it increases the peak-and-through-effects in ports. Third, increasing container ship size has contributed to consolidation of the container shipping industry.

Adaptations to ports

In order to be megaship-ready ports need to adapt maritime access, port infrastructure, equipment and hinterland transport connections. Larger ships are wider and have deeper drafts (Figure 4), so they need deeper and wider access channels, berth depth and rivers (in the case of estuary ports). This requires dredging. Larger ships are also longer, so they need larger turning basins and longer quays. Larger ships are wider, so they need container cranes with more outreach. Larger ships exert more bollard pull forces, so they need stronger quays and quay walls. Most port investments are usually last over a period of several decades, and thus on the basis of smaller ship dimensions. In many cases, these investments have not reached the end of their life-cycle, so they can take the form of retrofitting, e.g. of cranes. These investments can be substantial.

Figure 4. Evolution of containership dimensions 1972-2015

Generation (year)		TEU	Length (m)	Beam (m)	Draught (m)
1. (1972)		<= 1.500	225	24,5	9,0
2. (1980)		<= 3.000	275	27,5	10,0
3. (1987)		<= 4.500	300	32,2	11,5
4. (1997)		<= 6.600	320	40,0	14,3
5. (1999)		~ 8.300	347	42,6	14,5
6. (2005)		~ 9.400	340	46,5	15,0
7. (2006)		~ 15.500	397	56,4	16,0
8. (2015)		~ 21.000	400	59,0	16,0

Source*:* ITF (2017).

Peak effects

Larger ships create peaks in the different stages of the cargo handling process: at berth, in the yard and in hinterland transport movements. Our studies clearly show that the arrival of a mega-ship in a port is associated with higher yard occupancy, more feeder traffic, truck and train movements (ITF, 2015). In order to deal with the peak-effects of larger ships, ports feel required to load and unload ships as quickly as possible (berth productivity) to realise the shortest possible ship turn-around time, to reduce as much as possible to the time that containers spend in the yard (container dwell time) and to increase the speed with which trucks and trains are loaded or unloaded (truck and train turn-around times). In order to realise all this, more cranes and yard equipment might be needed, as well as larger yards and more flexible port labour forces (ITF, 2015).

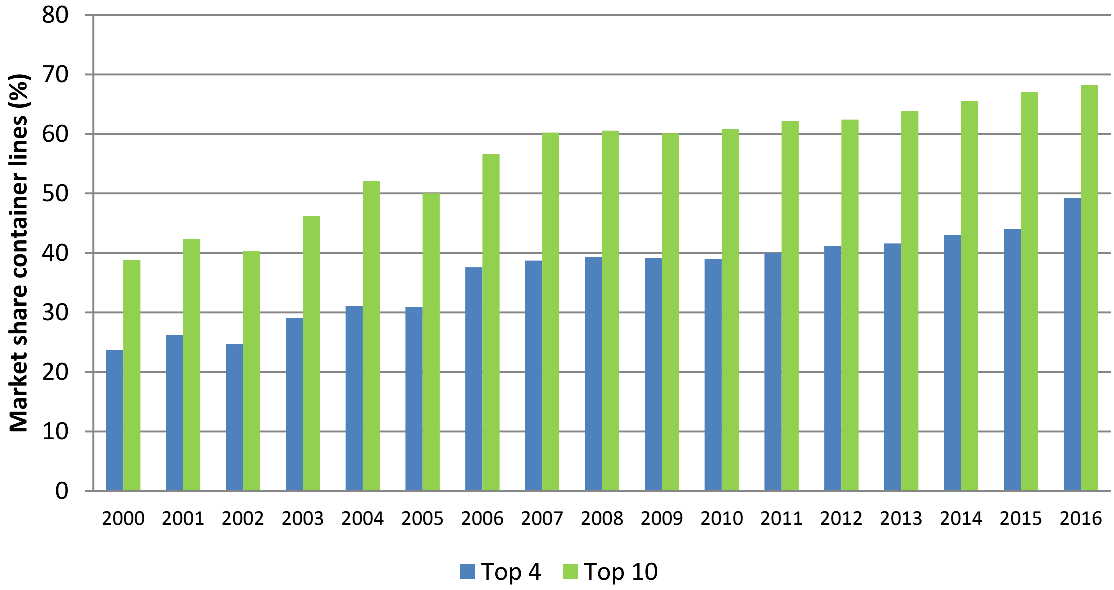
Industry concentration

Bigger ships have also generated industry consolidation and more intense co-operation via alliances. Both consolidation and alliances create the scale needed to finance larger ships and fill these ships. Industry consolidation has occurred via mergers and acquisitions; different waves of these have increased the concentration rate of the sector: whereas the largest ten carriers represented around 40% of total world container ship capacity in 2001, this was almost 70% in 2016 (Figure 5). Recent years have seen frantic merger activity, which means that the top seven carriers will have a market share of 77% by 2018 when all announced mergers are realised. Container shipping companies have also engaged in close co-operation via alliances. These are co-operation mechanisms to share vessels and slots on vessels, so they provide a way for smaller carriers to also finance and fill big ships. Although alliances have been a feature of the container shipping industry for quite some time, the order of mega-vessels has arguably stimulated a renaissance of these arrangements, with almost all major carriers currently tied up in an alliance. Whereas alliances covered around 48% of global container market share in 1995, this was 88% in 2016. The number of container shipping alliances will be reduced from four to three by April 2017. As a result, the market share on East-West container trade routes will be roughly a third for each alliance.

Alliances lead to a concentration of regional port systems. This can be illustrated by the changes of the port networks related to the transition down to three alliances by April 2017. The new port networks from April 2017 have considerably less direct port pairs, so less direct port-to-port connections. This is particularly the case for the Asia-Med trade route where the number of direct port pairs decreases with around 50 port pairs. This decline of port-to-port connections is part of a longer term development of declining port-to-port connectivity related to consolidation and larger ships: the number of direct Asia-Europe port pairs has been declining since at least 2013 (Figure 6). A similar tendency is visible with regards to the frequency of weekly services on major trade routes which has been declining due to larger ships: on Asia-Europe this service frequency has declined from 38 in 2013 to 33 in 2016 (Figure 7).

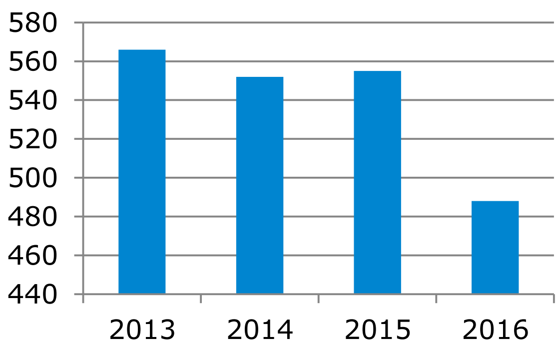
Many ports rely heavily on only one alliance. For example, in half of the main Mediterranean container ports only one alliance represented more than half of the traffic on a trade route in 2015, when there were still four alliances (Figure 8). Ports with a more balanced distribution of three or more alliances were fairly rare, and even in these cases decisions of alliances to shift ports have very significant impacts. This dependence is only increasing with just three alliances. This dependence means that alliances can exert large bargaining power in relation to these ports: they can negotiate favourable conditions and lower rates, because they might threaten to shift cargo to another port.

Figure 5. Container shipping industry concentration rates 2000-16



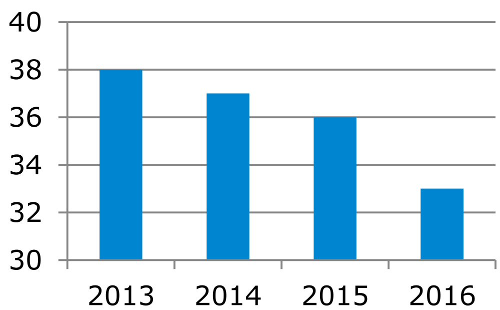
Source*:* ITF elaboration based on data from Alphaliner.

Figure 6. Number of direct Asia-Europe port pairs 2013-16



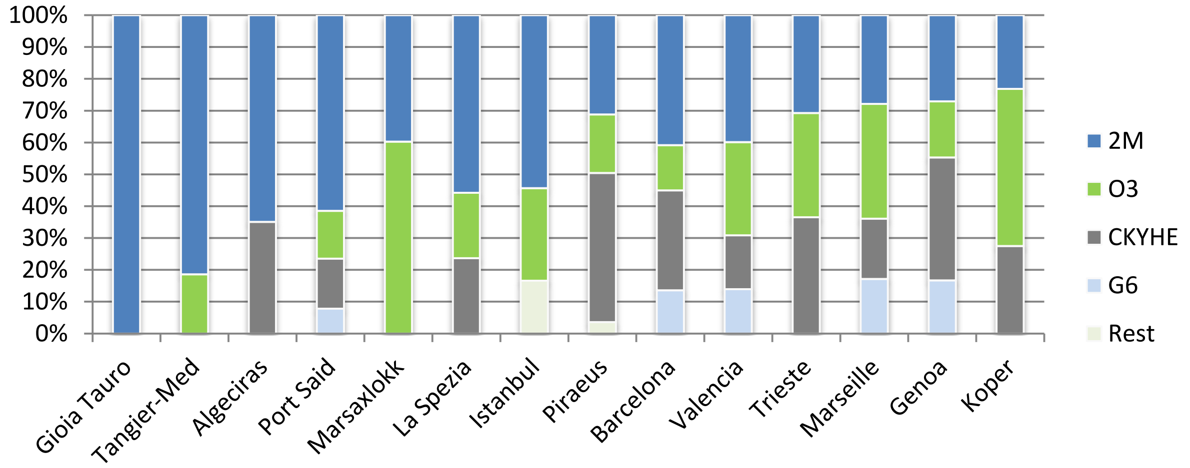
Source*:* ITF elaboration based on data from SeaIntel.

Figure 7. Number of weekly Asia-Europe services 2013-16



Source*:* ITF elaboration based on data from SeaIntel.

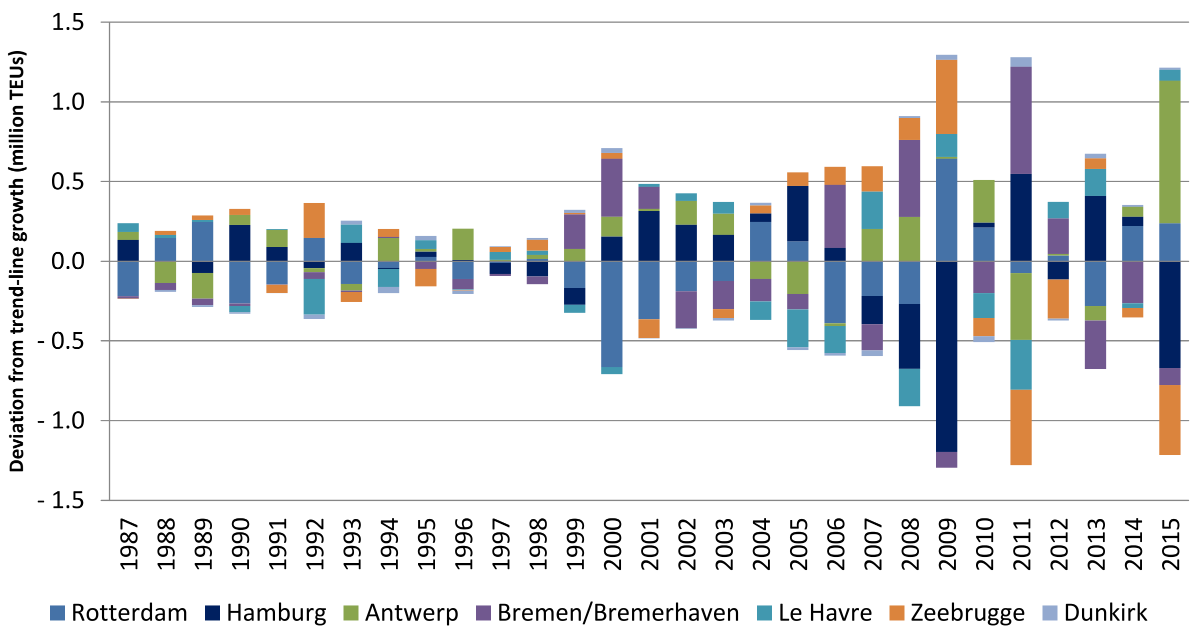
Figure 8. Main Mediterranean container ports and container alliances in 2016



Source*:* ITF elaboration based on data from Dynamar.

The risks of port shifts are not imaginary: they take place regularly. Our data on deviations from trend growth in the major North West European container ports suggests that the volatility and extent of port shifts have become much larger over the last years. Whereas deviations from the trend growth of the port range were fairly marginal and hardly exceeding 100 000 TEUs, this situation is strikingly different in the last decade, in which deviations of 1 million TEUs are no exception (Figure 9).

Figure 9. Port shifts between North West European ports 1987-2015



Note*:* The figure indicates the growth of a port above or below the trend growth for the entire port range. Considering that this is a competitive port ranges with contestable hinterland, this is considered a proxy for port shifts: so, a shift to that port if it is above the x-axis, or a loss from that port if it is below.

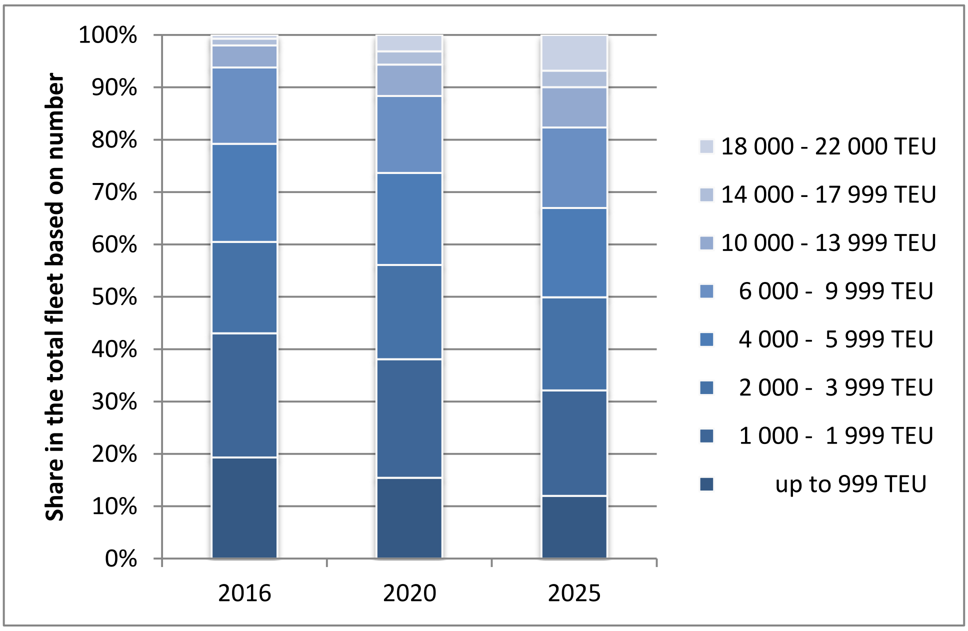
Source*:* ITF elaboration based on data from port authorities.

Trickle-down effects

The increase of containership size is pulled from above: the upsizing of ships used on the Asia-North Europe trade route. These new ships crowd out the ship types that were previously used on that route, which become deployed on other trade routes, in turn squeezing out the smaller ships used there. So the increase of ship size on one trade route has cascading effects across all trade routes. No region in the world escapes this dynamic; the scale effects are generally difficult to stop unless all ports in a region decide not to adapt their ports, but this hardly ever happens.

The global container fleet over the coming years will see an increase in larger container ship types. For 2020 this composition can be predicted with some accuracy considering the current ship order book that will take a few years to materialise into ship deliveries, since it takes some time to build ships. We assume that ship capacity after 2020 will continue to grow along similar lines, in part driven by overcapacity in the world's main shipping yards, the ambition of main shipbuilding nations to guarantee a certain utilisation rate of these yards and the result on ship prices that will make new ship orders attractive for shipping companies. Based on these dynamics, we assume that around 10% of all container ships in 2025 will have a capacity of 14 000 TEUs and larger (Figure 10).

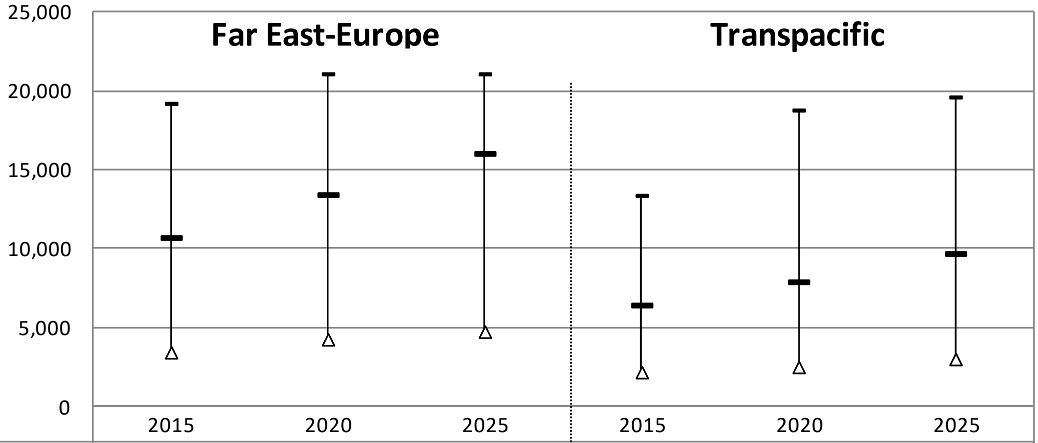
Figure 10. Container fleet forecast 2016-25 by size classes



Source: ITF (2016).

The increase of container ship size in the coming years will cascade throughout all container trade lanes. The first-order effect takes place on the Far East-Europe trade lane where the largest ships are deployed, resulting in an average predicted container ship size of around 16 000 TEUs by 2025 (Figure 11). On the Transpacific trade lane we predict the average size to rise to around 10 000 TEUs by 2025. Calculations for the trade lanes touching Latin America show similar dramatic increases: for Latin America-Asia the average ship capacity is expected to rise from 8 000 in 2016 to 12 000 TEUs by 2025. This will have huge effects on ports. For example, the number of ship calls with capacity of 10 000 TEUs or more represented just a few percentage points in the port of San Antonio in Chile; this might become around 30% by 2025 (Figure 12).

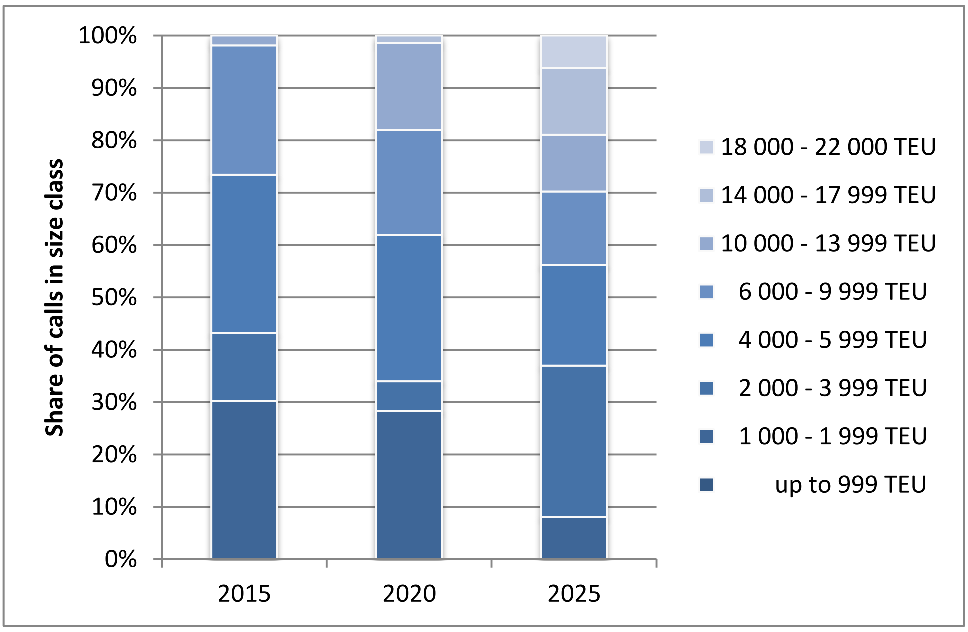
Figure 11. Forecast of ships deployed on major East-West trade routes up to 2025



	2015	2020	2025	2015	2020	2025
Minimum	3,429	4,252	4,738	2,169	2,500	3,003
Average	10,711	13,436	16,047	6,427	7,904	9,697
Maximum	19,224	21,100	21,100	13,386	18,800	19,630

Source: ITF (2017).

Figure 12. Forecast of ship calls in San Antonio (Chile) in 2015, 2020 and 2025



Source: ITF (2016).

Spatial port-city dynamics and ship size

Ports are at the origin of many cities. Many cities started as trading posts, with the port as the natural interface of land with its maritime connections. This allowed small towns to become cities, and fuelled urban development, thanks to the prosperity associated with trade. Ports are often still closely connected with their cities. This link has often been strong and persists in many emerging economies. So, many of the largest cities have the largest ports. This is particularly the case in Asia, where Shanghai and Osaka-Kobe rank not only in the 20 largest metropolitan areas worldwide but also among the 20 largest ports in the world. Other Asian metropolises with very large ports include Guangzhou, Shenzhen, Tianjin and Hong Kong. The link between metropolitan size and port size can also be seen in North America, with New York and Los Angeles as prime examples, and to a lesser extent in Europe, which has a more limited number of very large metropolises, some of which, including London and Barcelona, also have large ports (OECD, 2014).

When large ports are not located in cities, there are usually specific reasons for this. In many cases this is because they are close to natural resources or global shipping routes, or because of a deliberate decision to decongest urban ports. Ports located close to natural resources, such as coal, oil and ores, include Port Hedland (Australia), Richard Bay (South Africa), Corpus Christi (United States) and Novorossiysk (Russia). Large trans-shipment hubs close to intercontinental shipping routes include Salalah (Oman), Freeport (Bahamas), as well as those in the Mediterranean Sea: Gioia Tauro (Italy), Algeciras (Spain), Port Said (Egypt) and Marsaxlokk (Malta). Finally, the non-urban gateway ports that were in many cases deliberately created away from large cities in order to decongest the urban ports include Felixstowe (United Kingdom), Laem Chabang (Thailand) and Lianyungang (China) (Hall and Jacobs, 2014).

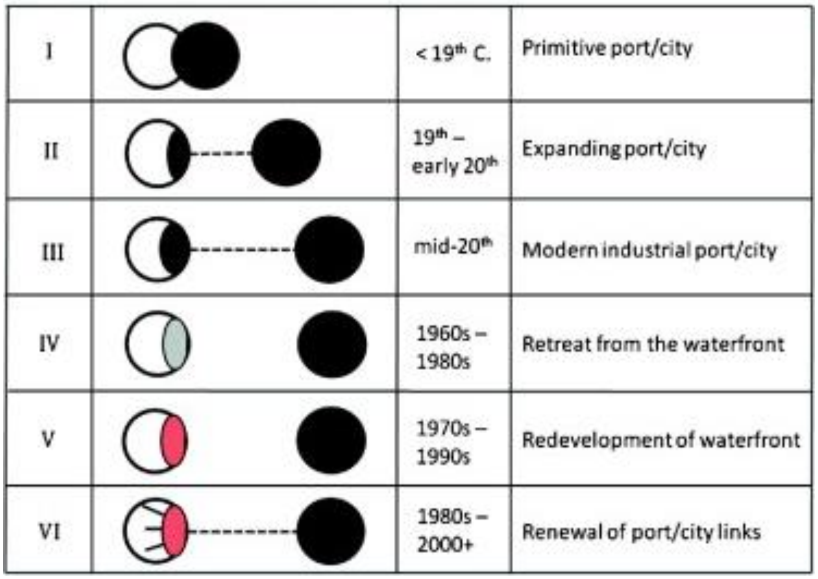
Spatial port-city dynamics

The relations of ports with their cities, and the evolution of these port-cities have been categorised in different typologies. A well-known typology of port-cities is based on the size of urban or regional population, in relation to the size of port traffic, in order to measure maritime dependence (Vigarié, 1968). Such a relative concentration index has been applied for typologies of Mediterranean port regions (Vallega, 1976), for US port-cities (Kenyon, 1974) and port-cities on a world-wide level (Ducruet, 2004). Depending on the relative dominance of port and city, Ducruet and Lee (2006) have developed a typology of nine different port-cities, ranging from coastal port towns to the world port city. The idea underlying the typology is that similar types of port-cities have similar challenges; e.g. port-cities with relatively small population size, but very large ports all face the challenge of an urban economy that risks being too port-dependent. They calculated relative concentration indices of 653 different port-cities between 1970 and 2005 which allows them to outline different port-city trajectories. Various additions to this general typology have been formulated, which stress the geographical differences that distinguish port-cities in Asia, the US and Western Europe (Lee et al., 2008), and differences according to economic specialisations of the region and commodities treated in the port (Ducruet et al., 2014).

The spatial evolutions of port development have been described in a separate set of typologies, expressing the development of port growth over time. An often-cited model in this respect is the Anyport-model developed by Bird (1963) to describe how ports develop spatially over time, from setting and expansion to specialisation. Extensions and additions to this model were provided by Taaffe et al.

(1963), Barke (1986), Hayuth (1981), and Notteboom and Rodrigue (2005). Other models of port development focus on the underlying commercial logic, from trade, industrialisation and globalisation to logistics (Van Klink, 2003). For the purpose of this paper, the most relevant evolutionary model refers to the port-city interface, as developed by Hoyle (1989). He distinguishes five different stages of port-city interactions that go from integration in primitive port-cities, to expanding port-cities, modern industrial port-cities, retreat from the waterfront and finally the redevelopment of the waterfront. This trajectory illustrates the disintegration of port and city in subsequent stages that are placed in time: the period of the modern industrial port-city being the mid-20th century, the retreat from the waterfront from the 1960s to the 1980s and redevelopment of the waterfront between the 1970s and 1990s (Figure 13).

Figure 13. Spatial evolution of the port-city interface

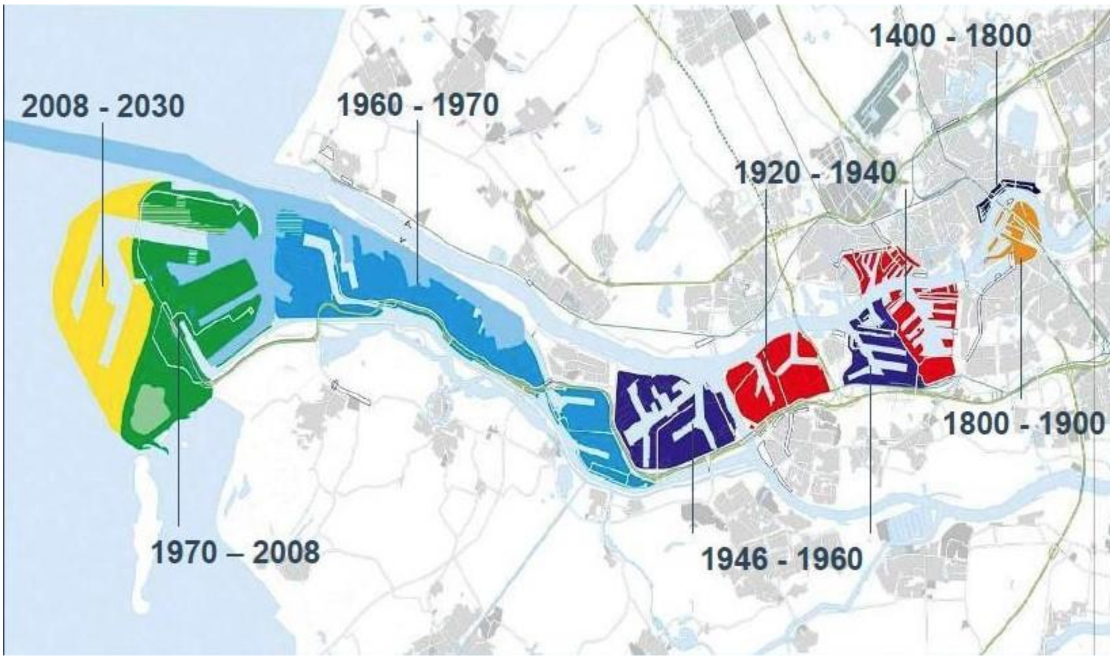


Source: Hesse (2013) based on Hoyle (1989).

Larger ships means that ports need more space, but space is something that is scarce in cities. Many cities are expanding and have a shortage of land for housing and other functions. This is especially the case in developing countries with rapid urbanisation (attracting people from rural areas) and in successful global cities (attracting people from other countries). Both instances intensify the need for urban land to accommodate population growth. The increasing scarcity of land translates itself into higher land prices, which means that port functions in these cities will be difficult to sustain, considering the opportunity costs of port land. So, there is an inherent conflict for land in port-cities. This conflict can be more or less explicit and has generally resulted in two different developments: relocation of the port, or part of the port, away from city centres; and the redevelopment of former port lands.

Ports have evolved spatially over time, generally away from city cores and towards the sea. This is the case of many estuary ports, such as Rotterdam, that originated upstream but that expanded downstream, in different phases throughout time with each additional expansion of the port. This spatial development of many upstream ports is a long-term development that was driven by industrialisation, requiring larger ports and by the on-going urbanisation that required more urban space to accommodate larger urban populations. This spatial evolution of ports has been amplified by containerisation that required more linear quays to the detriment of finger piers, and the related increase in economies of scale in shipping that required more spacious ports and terminals.

Figure 14. Spatial evolution of the Port of Rotterdam over time



Source: Merk and Notteboom (2013).

Gradual port relocation can take place if there is vacant land available for port development adjacent to the current port. This has been a natural development for estuary ports that have grown away from cities, towards the sea. This is not the case for all ports. Various ports are located in bays and completely surrounded by the city. In that case, the only place where new adjacent port development is able to take place is in the sea, via offshore terminals developed via landfill. An example of such a port that expanded via an offshore terminal is Genoa.

A more radical form of port relocation consists of creating whole new ports at considerable distances from the city centre. In this way, the port could be located where maritime access (depth) is favourable and where large land surfaces are vacant and cheap. In many cases, this development liberates valuable port land for urban waterfront development. Table 1 provides an overview of urban ports that have to deal with such new ports, in addition to the existing city-port. Two options could be distinguished. First, there are new ports that form part of (and are created by) the old urban port (e.g. Busan, Shanghai and Marseille-Fos). A second category is formed by new ports that are created independently of, and in competition with, the old urban port (Rio de Janeiro-Sepetiba, Kolkata-Haldia, St. Petersburg-Ust-Luga). Many of these new ports manage to capture a lot of the port traffic from the urban port, which could subsequently become more focused on port functions and more compatible with urban activities, such as passenger terminals, marinas, fisheries and other functions.

Table 1. Multi-site ports

Old city port	New port site	Country
Busan	Busan New Port	South Korea
Shanghai	Yangshan	China
Rio de Janeiro	Sepetiba	Brazil
Marseille	Fos	France
Kolkata	Haldia	India
Bremen	Bremerhaven	Germany
St. Petersburg	Ust-Luga	Russia
Tangiers	Tangiers-Med	Morocco

Source: Adaptation of OECD (2014).

Trade-offs for port location

Port location is often subject to a trade-off between maritime connectivity and hinterland connectivity. Many of the new non-urban ports are well suited to handle the largest ships, as they have deep sea access and enough space for large terminals, yet their Achilles' heel is often their distance or limited connectivity to main consumption and production centres. Urban ports, in particular estuary ports, often suffer from the opposite situation, located close to markets with good hinterland connectivity, but challenges with regards to river or berth depth and space constraints.

An extended form of this trade-off is provided by Notteboom (2016). He identifies the main forces of port migration away from upstream urban ports and the forces favouring port development at upstream urban port locations (Table 2). The first argument for port migration is a classical one: nautical accessibility. This is frequently cited as a disadvantage for upstream urban ports, sometimes impossible to solve, sometimes possible to solve only by engaging in intensive dredging, which might be prohibitive because of the budgets and environmental sensitivities. The second argument is the location with regards to shipping networks: downstream non-urban ports would offer better "intermediacy" in liner shipping networks, with the expectation that larger vessels will in the future primarily serve off-shore mega-hubs, avoiding physically constrained traditional container ports (Baird, 2003). The third argument is diseconomies of scale and land availability issues at upstream urban ports. Related to this is the issue of finding enough space to create new large-scale logistics zones in the framework of port-centric logistics. The fourth disadvantage of upstream urban ports are the port-city dynamics, in particular conflicts between existing land use as a port and proposed city land use, e.g. for housing or waterfront development. Such conflicts could become particularly intense if urban development encroaches upon port development, making it difficult for port companies to expand their activities, as taking place in cities like Amsterdam (Box 1). Such conflicts might accelerate port migration. The fifth disadvantage could be related to cost differentials of the port site and alternative port sites. These cost differences could refer to land prices (considering scare land availability in cities), but also costs for other production factors such as capital and labour, which could drive port developers and market players to look for alternative, less urban new port sites. Finally, a disadvantage for port development close to cities might relate to stricter environmental regulations close to cities. Impacts of noise, air quality, energy consumption, waste management and dredging could be scrutinised more closely in urban areas than in more remote areas (Notteboom, 2016).

Box 1. The port-city interface in Amsterdam

Amsterdam case is a prime example of how an expanding city and a growing port try to co-exist. The border area between city and port is subject to active spatial claims. Space is scarce so there are hardly any derelict or run-down zones in the whole port. Given the economic growth of the city of Amsterdam and the attractiveness of the area near the old town center, the pressure to consider the redevelopment of parts of the port near the city is strong. However, many of these parts are still in use for port activities, often by industries focusing on commodities and even manufacturing. The port is thus facing the city expansion policy of the Municipality of Amsterdam, the shareholder of the port: "In spatial terms, this means that the expansion of the port area has stopped, while the urban housing frontier is gradually encroaching on the existing, and now fixed, harbour area." (Wiegmans and Louw, 2011). The 2020 plan of the port of Amsterdam proposes the development of a "transition zone‟ between the port and the city. The activities in the Minervahaven, an area of 7 ha, are planned to change from port activities to city activities (in particular the creative industries). The development of new living areas in Amsterdam, very close to active industrial port areas, is a source of contention between stakeholders. Many of the new proposed housing developments would be very close to active industrial port activities. This could jeopardise the further developments of these companies given severe restrictions on noise and pollution levels. The Municipality realised this potential source of conflicts and reached an agreement in 2008 to restrict residential development in some older parts of the port (i.e. the Houthaven and NDSM-wharf area) and for the next 20 years to cease all new residential developments which might harm the companies concerned. After 2028 new developments would be possible (Wiegmans and Louw, 2011).

Source: Merk and Notteboom (2013).

Upstream urban ports also provide certain benefits to port users, which could explain why there are still so many. Three possible benefits relate to better hinterland connections, agglomeration economies and innovation originating from port-city constraints. The first argument relates to closer proximity and better inland connectivity in inland ports. The scale effects in cargo generation in cities make it possible to have efficient road, rail and barge networks, and could as such save environmental costs of land transport. As such, upstream urban ports can play a role in supply chain integration. Secondly, cities could provide ports with advantages that could not be found in non-urban environments, such as superior infrastructure, knowledge, innovation and decision-making capacities. Human agency and institutional capabilities could provide port-cities with dynamic tangible and less tangible advantages (Hall and Jacobs, 2012). Thirdly, the same constraints that make it challenging to run a port in an urban environment, such as congestion and environmental impacts, could be sources of innovation that might make the port more competitive: it is the urban ports that have been at the forefront of developing innovative policies related to greening port activities and decongesting port-city interfaces.

The resilience of upstream urban ports might also be explained by path dependence and politics. Path dependence means that port systems evolve by building on previous developments, and investments (Ng et al., 2014). As many local stakeholders have invested in a certain pathway, leaving that path could mean high material and immaterial "disinvestment costs". This could reinforce existing port hierarchies and favour established ports. Different mechanisms through which this works out are preferential attachment and embedding. Preferential attachment refers to the idea that actors in a specific port system with many ties are more likely to receive new ties in the future. The mechanism of embedding assumes that future ties form around existing strong ties by processes of trust. Such mechanism could reinforce the position of existing upstream urban ports and weaken the push for migration of ports to coastal locations (Notteboom, 2016). Closely related to these mechanisms are politics and collective action by local port communities. The position of upstream ports is influenced by power exerted by dominant groups and collective action by the local port community. A more cynical way to express this is that vested interests lobby governments and manipulate systems to keep upstream ports in place, for example by subsidies, even if their economic viability might be decreasing (Baird, 1997).

Table 2. Disadvantages and benefits of upstream urban ports

Disadvantages	Benefits
Nautical accessibility	Closer proximity to markets, inland connectivity
Location with regards to shipping routes	Agglomeration economies
Diseconomies of scale and land availability	Port-city constraints as sources of innovation
Port-city conflicts	
Cost differentials	
Stronger environmental restrictions	

Source: Notteboom (2016).

The optimal location of a port in any particular region depends on local circumstances. It is these local circumstances that determine if benefits of the upstream urban port still outweigh the disadvantages. It is difficult to generalise, but interesting to notice the resilience of traditional urban estuary ports, such as Hamburg and Antwerp in Northern Europe, against all odds and despite the existence of competing non-urban deep water ports such as Wilhelmshaven and Zeebrugge.

Container ship size and the port location trade off

Recent acceleration of container ship size is likely to shift the balance more towards non-urban ports. The main drivers will be the need for reduction of port times, deeper drafts and more spacious terminals. The logic of economies of scale in container shipping assumes very brief times in port: as a lot of time is lost in approaching ports, the business case of larger ships is based on fewer port calls, so larger call sizes per port. This development will play out in the coming years in which fewer ports will have to deal with larger cargo volumes at once, which will put enormous strain on port land availability, draft and port-city traffic interfaces. At the same time, such peaks create critical mass for hinterland transport modes, such as freight rail, that would limit the benefits of cities as cargo consolidation nodes. Increased ship size has been associated with calls for ongoing container terminal automation to reach required productivity levels, which might limit the need for port labour and thus for being close to cities to benefit from its advantageous pool of workers.

Ports could deal with these tradeoffs by adopting policies of other ports that are operating at efficiency or productivity frontiers. Container ship size requires ports to become more land productive. Land productivity rates among ports differ widely, indicating the potential that exists for many ports to become more land productive. For example, the average number of TEUs per hectare per year was 49 005 in South East container terminals run by international operators, while this was 9 303 in North America (Drewry, 2010). Calculations in Merk and Li (2013) indicate that the land productivity for Kwai Tsing Container Terminals in Hong Kong was over 60 000 TEU per hectare per year. These high rates of port land productivity have been reached through planning, regulation and the relocation of non-essential functions. In Hong Kong multi-story warehouses have been erected in order to rationalise space. With most of the port terminals located near very densely populated areas, there is a complex co-existence of port and urban functions.

This dynamic will not be conflict-free and depends on the extent to which the container shipping sector can impose its reality upon a world-wide system of port-cities. That is: if whole port ranges would not adapt, the shipping sector would not be able to impose its vision. For example, if no port at the East Coast of South America would be ready for 14 000 TEU ships and the increased call sizes that come with this, that would probably mean that shipping lines will deploy other ships or include more ports in their loops than they would have otherwise done. However, this only happens if all ports in a range adhere to this pattern. Due to competition between ports in most areas, lacking adaptation in one set of ports might lead to shifts toward those ports that are willing to adapt. Even if no port would adapt, there is always the prospect of offshore ports that might be developed by shipping companies, to circumvent the more traditional ports. All in all, it is not unlikely that a considerable amount of ports and port countries adapt to the new circumstances created by the container shipping sector, which might result in port relocations.

Port relocation

Ever larger ships might make non-urban ports with deep sea access more attractive. Yet, this does not necessarily mean that there is always a good case for port relocation. As we will argue, for port relocation to be effective there are various conditions to be met, in particular with regards to sunk investments. Even if port relocation might improve the attractiveness of the port for larger ships, it might also bring new challenges in particular if the old port continues to function simultaneously.

Conditions for effective port relocation

Port relocation generally makes more sense at the end of a life cycle of an urban port, when equipment and infrastructure are long written off and when opportunity costs of developing the urban port area. Such circumstances facilitated port relocation in Helsinki that shifted most of the cargo handling to a new commercial port in Vuosaari 16 km from downtown Helsinki, whilst maintaining passenger terminals (South and West Harbour) in the city centre. In this case, sunk investment was minimal, as infrastructure in the old port sites was old and already depreciated. The changed nature of the cargo over the years (from bulk to unitised cargo) also would have necessitated significant re-investments (Merk et al., 2012). Long-term planning could help to have new port sites ready at the moment when city terminals will be phased out. In Singapore, for example, the planning for the transformation of city terminals into an urban waterfront area is taking place at the same time as the planning for a new extra-urban port to the west of the city, the Tuas port.

There is also more pressure for port relocation if the opportunity costs of port land are higher, i.e. if the high value of using the land for other purposes outweighs the benefits of sunk investments in the old port. In a way urban ports are often the victim of global success of their cities: as cities become more attractive, land values go up which makes it more difficult to sustain port functions in urban centres. This explains port relocations in many of the global cities, such as New York and London, as well as the planned port relocation in Singapore.

Relocation of ports can be facilitated by land swaps, with ports giving up some of their land in urban cores in exchange for new land for port development. Such a land exchange was achieved in the context of Hamburg's urban development project of Hafencity. Port relocation discussions can quickly become a source of conflict if urban and port interests are not aligned, if ports are not convinced that they will be compensated for giving up certain port lands and if the port fears that firms located in the current port might move to other sites than the new port sites.

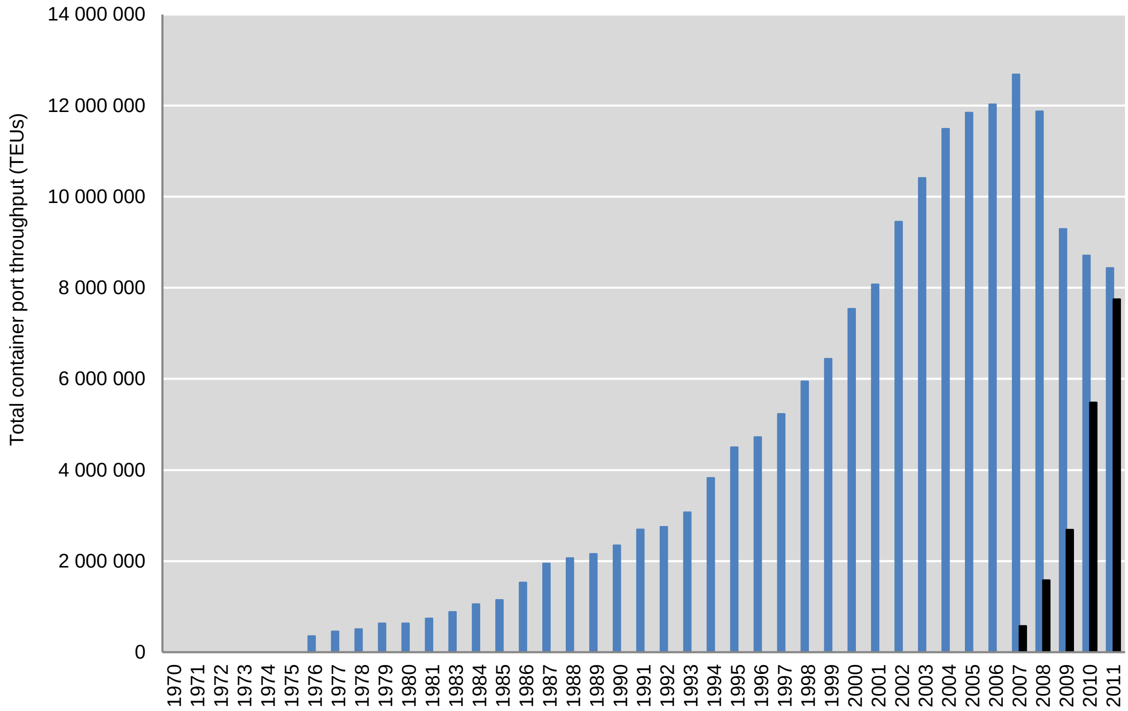
Challenges for the port relocation process

Port relocation can also bring new challenges. Port development often takes place as an addition to rather than an expansion of existing port capacity. The result is that many ports have multiple sites, sometimes located far from each other and that do not form part of one continuous area. So, in most cases, there is a transition period in which the two ports operate at the same time, which could give rise to problems, related to unequal competition, truck traffic between the two ports, and challenges related to the specialisation of the two ports.

Port relocation that leaves in place part of the old port sometimes leads to unfavourable conditions for incumbent terminal operators that have not been able to bid for new terminals. Acquiring concessions in competing ports could be a strategy of operators to increase their supply chain resilience, but might also be a way to pre-empt competing operators to get a stronghold in that particular region. In order to avoid these kinds of situations, some countries or ports prohibit incumbent operators from bidding from new concessions in the port, sometimes even in a competitor port. For example, in Sydney the incumbent operators Patrick Stevedores and DP World were barred from bidding for the third container terminal. In Chile, the concession framework prohibited the incumbent container terminal operator in Valparaiso, a joint venture led by the Chilean port operator Ultramar, to bid for the second container terminals in Valparaiso and in San Antonio, considered competitor port to Valparaiso. Such provisions can mean that the incumbent operator gets stuck with a terminal that is less suitable than the newer terminals. Rapid developments in ship size have meant new requirements for container terminals, in terms of equipment, quay length, berth depth and yard space. Considering space constraints, new container terminals are frequently located somewhere other than at the original port location. If incumbent operators are not allowed to bid for new terminals, they not only will end up with a terminal that is less suitable for the newest generations of ships, but might also end up being isolated from the new terminals, which undermines competition and creates additional complications. This is for example the case in Busan, where new container terminals where constructed at Busan New Port, resulting in the decline of the old port (North Port) and its remaining operator HPH (Figure 15).

So, the creation of a new urban port could raise "level playing field" issues. There are many examples of urban ports with new non-urban port sites (Shanghai-Yangshan, Rio-Sepetiba) where the share of the urban port site has lost ground to the new port site, even if the new site forms part of the same port authority. Along the same lines, urban ports have lost traffic shares to new ports that do not fall under the same port authority (Mumbai-JNP, Bangkok-Laem Chabang). Careful planning and phasing of expansion are necessary to preserve real competition and level playing field conditions.

Figure 15. Busan: The relationship between the old and new port



Source: OECD (2014).

A related issue is traffic flows between the old and new port. For example, there is considerable truck traffic between the old and new port in Busan (contributing to urban congestion), because the new port has important transhipment functions, whereas some of the feedering activity still takes place at the old port. Such moves between terminals are increasing with the intensified co-operation via alliances: this means that individual shipping lines share slots on container vessels, but still use the terminals in which they have stakes. In case a port has several of these terminals, one vessel could be obliged to call at all these terminals – or a container would need to be moved from one terminal to another terminal, increasing the number of (unproductive) inter-terminal moves. This is particularly a problem for container ports with many terminals controlled by shipping lines, such as Los Angeles, Long Beach and Hong Kong.

Multi-site ports also have to face the fundamental challenge to find a balanced division of functions between the different port sites. They often face recurring discussions on the future of the urban port, in particular on the question if all or most of the port activity should be moved to the out-port. Marseille is an illustration in case. The interface between the city of Marseille and the urban part of the port (East Basins) was for many years the source of fierce battles, resulting in creation of an impermeable port-city interface, closing off the access to and visibility of port functions to the population and generating recurring discussions on the viability of port activity on that site. The non-urban part of the port (West Basins) was further from the centre and invisible to most of the population of the city but all too visible for the local population, subject to severe environmental impacts. People living adjacent to the port did not feel empowered to influence decision making on port development (Merk and Comtois, 2012).

Even where cargo handling activities have been relocated, various old urban ports continue to have some port functions, for example for passengers, which means that some of the port-city interface conflicts will continue to exist. Decongesting the city was a driver of relocating the cargo port of Helsinki to Vuosaari. This was mostly successful: it shifted around 3 600 trucks per day from the city centre to the outskirts, helping to decongest downtown Helsinki. Yet a lot of RoRo traffic still uses the ferry terminals in the South and West terminals in the city centre. This terminal use is inevitable to some extent: cargo activities are necessary in the business model of ferry operators that depends on maintaining high frequency of ferries and low cost passenger tickets (Merk et al., 2012).

No generic answers

Larger container ships tend to make most upstream urban ports less appropriate because of required nautical accessibility and space. Some of these ports might compensate for their constraints by offering superior hinterland connectivity but the acceleration of container ship size increases raises the question of port relocation in many parts of the world. Port relocation is not a universal panacea: it makes most sense if an urban port has reached the end of its life cycle, if the opportunity costs of the port land are high and if there are attractive alternative port sites available. Much of this depends on local circumstances. Detailed assessment will be needed in each case to establish costs and benefits of port relocation. Attention to the process of port relocation requires serious consideration, as port relocation can bring about various additional challenges that could be minimised if well planned and co-ordinated.

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Container Ship Size and Port Relocation

This paper analyses the impacts of ever-larger ships on location choices for new container ports and examines when relocation of a port makes sense. Most ports are located close to cities, but have difficulties expanding. A number of new container ports have been built further away from urban centres, and existing ports may at some point feel the pressure to relocate.

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