Introduction to global container shipping market

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1. Introduction: Containerization and global logistics

In 26th April, 1956, an American land transporter named Malcom McLean started competing with freight railway companies on inter-state long distance transport in the US. He first navigated a hopped-up container ship from Newark, New Jersey, to Houston, Texas, along the US East Coast by his shipping company (later named Sea-Land). Maritime containers were acquired for two main purposes: 1) to reduce port handling costs by unitization (container "box") of cargo and 2) to reduce truck transport cost on long-distance delivery. Indeed, the container ship permitted cargo to deliver cargo through intermodal transport on land and sea (Levinson, 2006).

The strongest advantage of containerization was to provide a more efficient cargo handling on the docks. At this time, a container was mounted on a wagon for land transport, or current roll-on/roll-off (Ro-Ro) shipping. However, because the system was initially inefficient due to the weight and space of wagons, container ships used cranes to handle the box between ship and yard. Finally, the Sea-Land company launched a modern full-container ship without crane onboard in 1966 to cross the Atlantic, as European ports such as Antwerp became able to handle containers in the late 1960s (Morel and Ducruet, 2015). After certain technological progress, gantry cranes were placed on berths to carry containers between ship and terminal, while chasee and trailer moved containers inside the container terminal.

Containerization helped reducing handling time on both sea and land sides. At the time of early containerization, the total duration of a round-trip in the Pacific Ocean between East Asia (e.g. Kobe, Japan) and North America (NA) (e.g. San Francisco, US East Coast) by conventional ship (general cargo) was about eighty days (35 days on sea, and 45 days on land) in 1956. However, in 1968, after full-container ships were launched, the total duration of a round-trip decreased to thirty days (23 days on sea, and 7 days) between Tokyo and Los Angeles (Hoshino, 1995). Containerization had contributed to delete temporal gaps between origin and destination along supply chains, while accelerating global trade and horizontal division of production. In 2017, because of slow steaming and multi-stops at hub-ports, most of round-trips' duration are currently

35 days (five weeks) or 42 days (six weeks) on the route (International Transportation Handbook, 2017), as explained below.

Finally, maritime transport business had changed from labor-intensive to capital-intensive industry. For example, global major ports heavily invested in new gantry cranes for faster handling operations. In addition to container terminal development, container ships grown in size to achieve economies of scale. Indeed, after the introduction of over-Panamax[1] vessels in 1988, shipping lines built ever-larger container ships (Table 3). Such vessels again needed investments on the terminal side to accommodate ship calls all over the world. Deeper container berths, mega-gantry cranes, and larger container yards became the norm for terminal operations. For instance, such cranes must be cover 24 lines for the beam of 18,000 TEUs class container ships today.

Such operational and technological changes are both causes and consequences of wider global economic (e.g. manufacturing shifts) dynamics affecting the global port hierarchy, as seen with Table 1 for the period 1975-2016. In 1975, most of the top ranked container ports were North American, European and Japanese due to the provision, in the "Triade" (Ohmae, 1985), of container berths with gantry and terminal cranes that were still lacking at developing countries. However in 2016, seven ports are Chinese (including Hong Kong) within the top ten, following high economic growth and rapid port development since the 2000s. The other three ports are also Asian, like Singapore, Busan, and Dubai.

Despite their initial domination within Asia, Japanese ports, and especially Kobe, had been taken over by other East Asian ports, especially by Busan due to networks effects and the Hanshin Earthquake in January 1995 (Xu and Itoh, 2018). In a similar vein, and after playing a crucial role as a gateway and hub for mainland China due to its pre-1997 status as an independent city-state with Western trade practices, lost cargo in the last decade to Shenzhen, which is adjacent to Hong Kong. By contrast, Singapore maintained its port growth as the transit point between Pacific Ocean and Indian Ocean connecting Asia with Europe, and highly frequent feeder services with neighboring Southeast Asian countries. Yet, competitors started to emerged such as Tanjung Pelepas in Malaysia (2000), Cai-Mep Thi-Vai in Vietnam (1996), and Jakarta / New Priok in Indonesia (under construction) to provide alternative transit points and enhance their respective local economies.

[Table 1]

In this chapter, we discuss the changes of maritime and port logistics affected by containerization in the last 50 years. In section 2, we show the impact of containerization on the

[1] Based on the ship size which can navigate on Panama Canal, the size which cannot navigate on the canal is defined as Post (Over) -Panamax.

world economy and global maritime networks including supply chain. Section 3 discusses the function of container terminal enhancing maritime transport and connecting the land and sea transports, especially in this section about the constraint and challenges of port development for larger ships and about the port management and terminal operation. In section 4, we present operational logics of shipping lines and alliances while providing concrete empirical evidences on changing patterns of global container flows. As reference, next Chapter 2 discusses port hinterland which is the connection to port on the land side with shippers.

2. Economic growth and container cargo movements

The innovation of containerization in maritime trade cause a rapid expansion of global trade (see also Bernhofen et al., 2013). Figure 1 compares the evolution of different maritime trades in the last four decades (the handling level of 1990 is base-line). Most of goods shipped in containers being general cargo, or intermediate and finished goods, container traffic had expanded much quicker than general cargo, especially after 1998 (see also Figure 4). Indeed, a growing share of general cargo had become containerized in the last two decades. In addition, the impacts of global recession for maritime trade were much bigger on container than on general cargoes.

[Figure 1]

The relationship between maritime trade, especially containerization, and economic activities, Figure 2 shows the increasing rate changes of container handlings volumes (TEUs) and dry cargo (ton base) compared to Global Domestic Product (GDP) in the last four decades or so. Except for 1998 and 2009, the increasing rate of container handling volumes was higher than the ones of dry cargo and GDP. The average growth rate of container handling is about 9.6% as compared to 4.1% for dry cargo and 3.0% for GDP. On the other hand, the standard deviation of container handling growth rates is 5.8, compared with 5.0 and 1.3 for dry cargo and GDP, respectively. Several factors can explain such a result. First, handling items in containers are mainly high value added goods (i.e. consumption and intermediate goods), so that the demand of container transport is less stable than for general cargo and natural resources (i.e. bulks). Second, container handling is highly connected with economic circulation. For example, the correlation coefficients of the growth rates with GDP are 0.66 with container and 0.47 with dry cargo. Third, slowing trade, or increasing global GDP is higher than for global trade, as the Lehman shock is said to have finished in 2017 (CPB Netherlands Bureau for Economics Policy Analysis, 24th November, 2017).

[Figure 2]

When observing the growth rates of container handling volumes and GDP by countries (see Appendix, Table A1), again, the growth rate of container handling has been higher than that of GDP. However, the current Chinese growth rates of container handling remain rather moderate, while the one of Hong Kong had been negative in the last five years. The center of gravity of economic expansion had, indeed, shifted towards South Asia, like Indonesia and Vietnam (Itoh, 2012).

Figures 3 (a) and (b) show the relative scales of container handling volumes and value added (GDP) by regions/countries (see Appendix, Table A2). Until the mid-1990s, most of container traffic was handled in advanced economies and regions as mentioned above, until Chinese ports increased their share after 1995, and especially 2001 (entry of China in the World Trade Organization (WTO)). Nowadays, the total Chinese share including Hong Kong is more than 30%, while European ports witnessed a decrease from 30% in 1975 to 12% in 2015. Although Hong Kong had increased their global share until the middle of 1990s, their share was taken by the mainland Chinese ports by the container terminal developments, turning into a global financial and value-added center instead of a cargo handling hub (see Wang and Chen, 2010).

On the other hand, the relative shares of GDP have been changing more smoothly than for container handling. For example, although the Chinese economy including Hong Kong occupies about 12% in 2015, the advanced economies, like NA, Europe (Germany, UK, and France) and Japan still take their position to some extent. This result is partly due to the fact that container handling volumes are sometimes inflated by official statistics because of large transshipment volumes, leading to double-counts of each container move.

[Figure 3]

Until the end of 1990s, the relative changes of economic activities (GDP) and cargo movements (containers) had maintained relatively tight linkages. In Figure 4, the correlation coefficients between the relative shares of GDP and container handling on countries (see Appendix, Tables A2) had been increasing until 1999. The decrease after 2000, including China's entry in the WTO and the global financial crisis effects, can be explained by the rapid progress of supply chain development in emerging economies (i.e. BRICS countries), especially in Asia, and a growing imbalanced international horizontal division of production (see Table 2).

[Figure 4]

Tables 2 (a) and (b) show the inter- and intra-regional container movements in 1998 and 2016. As discussed above, the distribution of container and economic activities had been tightly connected until 1999. However, they are less connected in the 2000s. The center of gravity of container movements have been shifting to intra-regional activities in Asia in a context of increased regional integration, thereby concentrating more than 25% of global container movements. Nowadays, the impact of economic growth on container movements is amplified and imbalanced on routes, or highly weighted inside Asia. Containerization had increased the speed of economic growth at emerging economies and expanded the imbalance of cargo movements on routes and regions throughout the world.

[Table 2]

3. Port development and terminal operations

3.1 Terminal development and new ports opening

The first ship in 1956 by McLean delivered 58 boxes. Containerships expanded through economies of scale (see Table 3) as underlined by Cullinane and Khanna (2000). For instance, although ship capacity was less than one thousand in the 1960s, nowadays the world's largest containership "MOL Triumph" of the shipping line MOL built in 2017 reaches more than 20 thousand Twenty-foot Equivalent Units (20,170 TEUs), 400m length, and 59m width. As a consequence, such "mega-ships" require high-standard container terminals in terms of both berth length and depth (see Ducruet and Berli, 2018 for an empirical analysis of the global distribution of mega-ship traffic). These facilities affect port operational efficiencies (Tongzon, 2001; Itoh 2002) and leads to a debate on whether ports and nation-states should follow such a trend. Previously already, so-called "Post-Panamax II" ships carrying about 8,000 TEUs needed the container berth with 16-18 meters water depth and 18,000 TEUs capacity on the terminal (ULCS).

[Table 3]

Larger-size container ship imposes the expansion of container terminals. Except the ports of Marseilles and Barcelona in Europe, Los Angeles and Long Beach in NA, numerous ports are located upstream rivers and estuaries as a reflection of their historical background of port development, so that their expansion faces important limitations, with Antwerp and Hamburg as exceptional cases (Notteboom, 2016). This explains why larger ships increasingly call at deep-water ports, the exemplary case being London, mainly served by Felixstowe (operated by Hong

Kong- based Hutchinson Whampoa), 250 kilometers away, although recently the global operator Dubai Ports World (DPW) developed the new London Gateway container terminal with the slogan “ship closer, save money”. Rotterdam is a special case as it has been relocating its container terminals by sea reclamation through the Maasvlakte projects. Most of nowadays ports and container terminals have to invest in mega gantry cranes, or longer arm of crane, for lifting on and off the containers inside a width ship.

In East Asia, the ports of Shanghai and Busan also had constructed new container terminals through sea reclamation (i.e. Yangshan deep-water port in 2005, Busan New port in 2006). Elsewhere, Laem Chabang in Thailand (1991) and Cai-Mep Thi-Vai in Vietnam (1996) were newly constructed for containerization away from their old river ports (i.e. Bangkok and Ho Chi Minh, respectively). Lastly, the new port of Tanjung Pelepas in Malaysia (2000) was constructed for competing with Singapore (see Table 1). At its opening, APM Terminals, the main terminal operator of Maersk, shifted from Singapore to Tanjung Pelepas, it’s the direct effect of decreasing Singapore’s traffic by 30%, for the sake of competition but also as a way to bargain port costs. Following Maersk, Evergreen also shifted their hub-port to Tanjung Pelepas. Although Maersk returned to Singapore less than a year later, Tanjung Pelepas has been increasing its container throughput in the last years.

3.2 Port management and terminal operations

Although the port logistics industry before containerization was more labor-intensive, container terminal activity remains a highly capital-intensive industry. As discussed above, larger-size container ships needs high-standard container terminals, handling facilities and equipments. Most of the global major container terminals are operated by (public and private) port operating companies and terminal operators instead of (central and local governmental) port managers (Figure 5), because the operation and management of container terminal needs massive investments and management technology, and has been making profits with the growth of container transport.

[Figure 5]

In general, port management is classified amongst the following four types; 1) central government management, 2) local government management, 3) public enterprise management, and 4) private company management. Types 3) and 4) are consolidated as port operating company as seen in Figure 5. In Type 1), central government management, due to the lack of reliability, agility, and efficient management, is not so much common, except in the case of Hong Kong before the handover to China (1997). However, central governments are concerned by the development of basic facilities on the sea and port side (waterways, breakwater, and infrastructure). Most ports are managed by Type 2) local governments (European major ports, the ports of Los Angeles, Long Beach, Miami, and Everglade, Japanese major ports) and Type 3) public firms because of the large local economic impacts of port activities. Type 3) public businesses are divided into some cases based on the independence of budget and decision making on port business and planning. For example, local governments established public firms (i.e. government-affiliated firms, such as Korea Container Terminal Authority and Singapore Port Authority - PSA, before privatization), which manage port operation. They often establish public corporations under specific activity framework at the region level (e.g. Kaohsiung, Keelung, Seattle, and Tacoma). Lastly, a firm, which has public elements and constraints, is established under (general) company law. As the example of Type 4) private company, the ports of United Kingdom (UK) and New Zealand are managed by fully private companies (Doi, 2003).

Port operating types are thus classified into four types based on the construction, ownership, and operation of infra-and super-structure between port manager and port (terminal) operator. In addition, leased home is divided into two types for port facilities (infra-structure and super-structure) (Table 4). About term-leased land, port operator constructs not only super structure (gantry and yard cranes, container yard, shed, and warehouse) but also infra-structure (berthing facilities). For example, most Western ports (i.e. Europe and NA) are leased home without super-structure type. However, the port of Hong Kong is term-leased land without no-profit infrastructure type (or, waterway and breakwater). The terminal operator at Hong Kong pays concession money of terminal development to Hong Kong government, and develops new terminal including landfill, terminal facilities' construction and their equipment procurements. Although new terminal developed by the operator belongs to Hong Kong government, the operator borrows terminals and operates the terminal. The port of Singapore was also managed by the central government. However, all its terminals were transferred to PSA by privatization in 1997. UK ports were also privatized in the second half of the 1980s (Kurihara, 2014).

[Table 4]

Terminal operators are classified into two types; 1) global stevedores' terminal operator and 2) global carrier's terminal operators (Table 5). The first type (1) is a pre-play company focused on port service business. Most of stevedores mainly operate at their home-base and neighboring areas focusing on competitive and efficient operations. For example, although HPH has 52 terminals in 26 countries in 2017, they have 9 terminals in China and Hong Kong. The second type (2) is divided into two sub-types. On the one hand, terminal operation is focused as profit center inside their group company working for other shipping lines. On the other hand, the second case is focused as cost center for more efficient operations inside their group company's shipping network. In the past, major carriers had been making their global terminal operation supporting maritime business of their mother companies (or, cost center). However, under difficult situations in a sensitive shipping market (cf. Figure 2), port service business' profit has become more stable than maritime business. Therefore, some shipping lines changed their terminal service not only for own shipping lines but also other (competitive) shipping lines and group at their own / dedicated terminals for getting lower handling charges. Nowadays, about 80% of total container throughput at terminals are handled by global operators, and this share has been increasing (78.8% in 2015, cf. Table 6).

[Table 5]
[Table 6]

4. Global maritime container shipping

It is now well-known that horizontal integration pushed shipping lines to deploy global networks by the principle of merger and acquisition, such as Maersk (Frémont, 2007) and CMA-CGM (Frémont, 2015), although there are variants in the way this process had taken place among companies and among regions (Slack and Frémont, 2009). Global maritime container flows are currently transported by a handful of large companies, often through alliances, with a growing concentration that accelerated after the 2008 Financial Crisis (see Table 7), which led to important turmoil in the shipping industry until the bankruptcy of Hanjin Shipping in 2017. Other companies adopted the strategy of slow steaming, defined by decreasing travel speed and increased vessel size, to increase economies of scale, save fuel and money, and at the same time, send to scrap their older or smaller vessels. Certain shipping, to avoid financial losses, even reincorporated favorable sailing winds in their route operations to save even more fuel and money. In the meantime, other costs are trying to be levied through China's efforts to build a round-the-world Maritime Silk Road (Wang et al., 2018), trying to bypass Panama Canal costs through the project of a new Nicaragua Canal, and to bypass the Suez Canal through a railway land bridge through Israel, as well as a through Myanmar to avoid the Malacca Straits. The pattern of global shipping is thus still changing very fast and a lot of research remains to be done to foresee what will be routes of the future. For the rest, the Arctic passage, should it be Canadian or Russian, is still not yet a reality and is a very minor priority for container shipping given all the geopolitical, technical, and financial issues not resolved yet.

[Table 7]

A glimpse of what the current (or recent) world pattern of maritime container flows is proposed in Figure 6, where we can see the major routes and trunk lines' distribution across the globe. Regional integration in East Asia and the major link between Europe and Asia are responsible for the concentration in these parts of the world, notwithstanding an important share of Trans-Pacific trade, bur which is more imbalanced due to the large proportion of boxes returning empty from NA to Asia (see also Table 2).

[Figure 6]

The aforementioned changes and dynamics are examined in this section in two ways. First, we recall the main operational aspects of shipping lines to give a better understanding on how they design their various liner shipping services. Second, we provide some empirical evidence on how these economic and operational aspects have affected the distribution of global shipping flows in the last decade.

4.1 Operational aspects of liner shipping services

Apparently very complex, the way shipping lines organize their services is based on numerous factors but a few key principles, as seen in Figure 7. All is a matter of business profitability, but with the exception, compared with other businesses, of geographic aspects that shipping lines cannot avoid. They thus analyze the route along which ships should be deployed (fleet), and in the meantime, zoom on the route to select the best ports of call according to multiple criteria that are so much researched in the literature. Why this port and not another is not a straightforward question, which has to do with efficiency, performance, technical quality and capacity, handling costs, and presence of specific arrangement with terminal operators, finally the proximity or not to the end markets (Tiwari et al., 2003; Tongzon, 2009). Shipping lines are often said to be "footloose" in terms of port selection because they keep a certain margin in the case of disruption in transport chains (Achurra-Gonzalez et al., 2017), due to many causes (dockers' strikes, natural disasters, etc.). Then come the choice of service shipping lines offer to their customers (mainly, shippers) to satisfy their needs. Volatility, freight rate fluctuation, and seasonality also come into play.

[Figure 7]

The main configuration is based on "bundling" as a key driver of container service design. This can take place at two levels: individual liner service or bundling by combining/linking two or more liner services. The first aims to "collect container cargo by calling at various ports along the route instead of focusing on an end-to-end service" (Ducruet and Notteboom, 2012). This service is a set of several roundtrips of several vessels having in common calling patterns (i.e. order of port calls) and time intervals (i.e. frequency) between consecutive port calls. The overlap of all these roundtrips provide an optimal calling frequency. It is important to note that bundling can be symmetric or asymmetric; in the latter case, different ports of calls are used on the way back. In general, carriers select about five ports of call per loop, keeping in mind that increases in vessel size may have even decreased the number of ports of call. Two extreme forms of line bundling are round-the-world services and pendulum services.

Another option is to bundle container lines by combining two or more liner services as follows: hub-and-spoke network (hub/feeder), interlining, and relay. On their side, governments and port authorities invested heavily in the development of specific redistribution nodes to make it happen, called "intermediate hubs" (Rodrigue and Notteboom, 2010). Such hubs should provide good nautical accessibility, proximity to main shipping lanes and ownership, in whole or in part, by carriers or multinational terminal operators, most of those being located along the East-West circumterrestrial trunk line, "in-between" main producer or consumer markets. Their pivotal role complements the one of so-called "gateway ports" within those markets to access final consumers through hinterland services. Container carriers use both gateways and hubs to design their services in the most efficient way possible, but it was demonstrated that the same node is often "dedicated" to one main shipping line (Frémont and Soppé, 2009), just like terminal operators, through concession agreements (Notteboom et al., 2012). Another strategy of shipping lines is to focus on a preferential corridor development by investing gateways and inland ports (Franc and Van der Horst, 2010), often through vertical integration, especially in countries where the transport sector is more liberalized (Ducruet and Van der Horst, 2009).

4.2 The evolution of flow patterns

One simple and classic way to investigate how have container port traffic patterns evolved under the aforementioned circumstances is to look at two famous concentration indices, namely Gini coefficient and Herfindahl-Hirschman Index (HHI) (Figure 8). The latter index exhibits a clear tendency towards a de-concentration as many more ports are constructed and adopt the "container revolution" through successive diffusion waves across the world (Guerrero and Rodrigue, 2014). Thus, the bulk of global container port traffic is less and less concentrated in the top of the world hierarchy overtime. In opposition, but without being contradictory to the previous observation, there is a tendency (cf. Gini coefficient) for this traffic to be increasingly concentrated across space, despite a less clear-cut trend and several fluctuations. For example, although the concentration (Gini coefficient) of port traffic in Asia had been stable between 1985 and 2005, the gaps inside Southeast, South and West Asia, or containerized backward regions, had been expanding (Itoh, 2012). We cannot observe a paramount concentration but this is the trend until the early 2000s as containerization has been highly selective and concentrated around large hubs and gateways, until a process of de-concentration occurred, already exemplified by the pioneering work of Hayuth (1981) on the matter. The global shift of manufacturing from the Western to the Asian world is also responsible for such a mixed evidence, including the "China effect", especially since its integration in the WTO in 2001.

[Figure 8]

Another but complementary way to understand the evolution of the global pattern of container flows is to apply one of the simplest graph-theoretical algorithms to the unweighted inter-port matrix of vessel flows (Figure 9), namely the Gamma index, often coined "density" in the network-analytical literature, i.e. the proportion of observed links (or "edges") in the maximum possible number of links in the network (see Ducruet and Lugo, 2013 for a review of transportation network measures). The clear decline proves that at least until the late 1990s and early 2000s, global container flows went through a process of rationalization and simplification, i.e. a lesser number of linkages compared with the number of ports, resulting in a star-like configuration, or hub-and-spokes, as a consequence of the aforementioned strategies of shipping lines when designing their networks and selecting large hubs. Despite a revival and re-densification of the network afterwards especially just after the global financial crisis, the latter shifted again towards centralization so that the last value of 2016 is the lowest of the time-series. This means a lot about global trade and connectivity in terms of vulnerability vs. robustness, as the routes of the past have been replaced by ever-more efficient and optimal routes centered around large hubs and gateways, but at the expense of smaller, medium-size ports that cannot access the rest of the network without passing through this recently installed redistribution platforms.

[Figure 9]

5. Conclusion

This chapter recalled and demonstrated deep changes in the way maritime transport had been reorganized with the ongoing advent of containerization in the past decades up to nowadays. This multifaceted approach to containerization is not so common as often, specific aspects are well covered and analyzed by scholars and professionals but without offering an all-encompassing view. Reviewing the complex and changing relationships between containerization (technological change) and economic development, port and shipping line operations, and related impacts on former ways of doing things is necessary before widening the approach to other segments of the global value and supply chain, such as hinterlands and shipping networks, as seen in the following chapters. We wish this book to become a useful if not a key reference to scholars, students, but also experts and practitioners for a better understanding of past, current, and future transformations of transport and logistics systems serving our world as a whole.

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Table 1: The container handling ranking changes at ports (unit: thousand TEUs)

	1975		1980		1985		1990		1995	
1	NY/NJ	1,730	NY / NJ	1,947	Rotterdam	2,655	Singapore	5,220	Hong Kong	12,550
2	Rotterdam	1,079	Rotterdam	1,901	NY/NJ	2,367	Hong Kong	5,100	Singapore	11,846
3	Kobe	905	Hong Kong	1,465	Hong Kong	2,289	Rotterdam	3,670	Kaohsiung	5,232
4	San Juan	877	Kobe	1,456	Kaohsiung	1,901	Kaohsiung	3,490	Rotterdam	4,787
5	Hong Kong	802	Kaohsiung	979	Kobe	1,857	Kobe	2,600	Busan	4,503
6	Oakland	522	Singapore	917	Singapore	1,699	Busan	2,350	Hambrug	2,890
7	Seattle	481	San Juan	852	Yokohama	1,327	Los Angeles	2,120	Yokohama	2,757
8	Baltimore	421	Long Beach	825	Antwerp	1,243	Hambrug	1,970	Los Angeles	2,555
9	Bremen	410	Hambrug	783	Long Beach	1,172	NY / NJ	1,900	Long Beach	2,390
10	Long Beach	391	Oakland	782	Hambrug	1,159	Keelung	1,810	Antwerp	2,329
11	Tokyo	369	Seattle	782	Keelung	1,158	Yokohama	1,650	NY / NJ	2,276
12	Melbourne	365	Antwerp	724	Busan	1,115	Long Beach	1,600	Tokyo	2,177
13	Keelung	246	Yokohama	722	Los Angeles	1,104	Tokyo	1,560	Keelung	2,170
14	Hambrug	326	Bremen	703	Tokyo	1,004	Antwerp	1,550	Dubai / Jebel Ali	2,073
15	Antwerp	297	Keelung	660	Bremen	986	Felixstowe	1,420	Felixstowe	1,898
16	Virginia	292	Busan	634	San Juan	882	San Juan	1,380	Manila	1,668
17	Sydney	262	Los Angeles	633	Oakland	856	Seattle	1,170	San Juan	1,593
18	London	260	Tokyo	632	Seattle	845	Bremen	1,160	Oakland	1,550
19	Yokohama	329	Jeddah	563	Felixstowe	726	Oakland	1,120	Shanghai	1,527
20	Le Havre	232	Baltimore	523	Baltimore	706	Manila	1,039	Bremen	1,526
	2000		**2005**		**2010**		**2015**		**2016**	
1	Hong Kong	18,100	Singapore	23,192	Shanghai	29,069	Shanghai	36,537	Shanghai	37,130
2	Singapore	17,040	Hong Kong	22,427	Singapore	28,431	Singapore	30,922	Singapore	30,900
3	Busan	7,540	Shanghai	18,084	Hong Kong	23,699	Shenzhen	24,204	Shenzhen	23,979
4	Kaohsiung	7,426	Shenzhen	16,197	Shenzhen	22,510	Ningbo	20,620	Ningbo	21,560
5	Rotterdam	6,280	Busan	11,843	Busan	14,194	Hong Kong	20,114	Busan	19,850
6	Shanghai	5,613	Kaohsiung	9,471	Ningbo	13,144	Busan	19,469	Hong Kong	19,580
7	Los Angeles	4,879	Rotterdam	9,300	Guangzhou	12,550	Guangzhou	17,625	Guangzhou	18,885
8	Long Beach	4,601	Hamburg	8,088	Qingdao / Tsingta	12,012	Qingdao / Tsingta	17,510	Qingdao / Tsingta	18,000
9	Hambrug	4,248	Dubai / Jebel Ali	7,619	Dubai / Jebel Ali	11,600	Dubai / Jebel Ali	15,592	Dubai / Jebel Ali	14,772
10	Antwerp	4,082	Los Angeles	7,485	Rotterdam	11,146	Tianjin	14,100	Tianjin	14,500
11	Shenzhen	3,994	Long Beach	6,710	Tianjin	10,080	Rotterdam	12,235	Port Kelang	13,183
12	Port Kelang	3,207	Antwerp	6,482	Kaohsiung	9,181	Port Kelang	11,890	Rotterdam	12,385
13	Dubai / Jebel Ali	3,059	Qingdao / Tsingta	6,307	Port Kelang	8,870	Kaohsiung	10,264	Kaohsiung	10,465
14	NY / NJ	3,050	Port Kelang	5,716	Antwerp	8,468	Antwerp	9,654	Antwerpen	10,037
15	Tokyo	2,899	Ningbo	5,208	Hamburg	7,900	Dalian	9,450	Dalian	9,614
16	Felixstowe	2,853	Tianjin	4,801	Tanjung Perapus	6,530	Xiamen	9,183	Xiamen	9,414
17	Bremen	2,712	NY / NJ	4,793	Long Beach	6,263	Tanjung Perapus	9,120	Hamburg	8,910
18	Gioia Tauro	2,653	Guangzhou	4,685	Xiamen	5,820	Hamburg	8,821	Los Angeles	8,857
19	Tanjung Priok / Ja	2,476	Tanjung Pelepas	4,177	NY / NJ	5,292	Los Angeles	8,160	Tanjung Perapus	8,029
20	Yokohama	2,317	Laem Chabang	3,766	Dalian	5,242	Long Beach	7,192	Laem Chabang	7,227

(Data) *Containerization International Yearbook* (-2009), and UNCTAD Stat (2010-2016).

Table 2: World Container Movements (unit: thousand TEUs)

(a) 1998

Origin/Destination	North America	Europe	East/Southeast Asia
North America	-	2,036 (5.7%)	3,338 (9.4%)
Europe	1,509 (4.2%)	-	2,296 (6.5%)
East/Southeast Asia	5,938 (16.7%)	4,246 (12.0%)	5,873 (16.5%)

(Note) The estimated total container handling volumes are 35,528,000 TEUs.
(Data) MOL Research Institute (1999).

(b) 2016

Origin/Destination	North America	Europe	East/Southeast Asia
North America	482 (0.3%)	2,048 (1.3%)	7,252 (4.7%)
Europe	3,913 (2.6%)	6,928 (4.5%)	7,022 (4.6%)
East/Southeast Asia	16,708 (10.9%)	15,049 (9.8%)	39,214 (25.6%)

(Note) The estimated total container handling volumes are 153,270,049 TEUs.
(Data) Japan Maritime Public Relations Center (2017).

Table 5: The classification of global/international terminal operators

	Classification	Management type	Ex.
Stevedores	Profit center	Public company	PSA International, DP World, HHLA
		Private company	Hatchison Port Handling (HPH), Eurogate, SSA Marine, Dragados, Crup TCB, ICTSI
Carriers	Cost center	Public company	Terminal Investment Limited (TIL)
		Private company	CMA/CGM, Evergreen, APL, Hanjin, K-line, MISC, MOL, Yang Ming, Hyundai (HMM)
	Profit center	Public company	COSCO Pacific
		Private company	APMT, NYK

(Source) Mori (2018).

Table 6: Global/International terminal operators' throughput

	Operator	Million TEU	Share (%)
1	China COSCO Shipping	85.5	12.2%
2	Hatchison Ports	79.1	11.3%
3	APM Terminals	71.4	10.2%
4	PSA International	67.3	9.6%
5	DP World	62.4	8.9%
6	Terminal Investment Limited (TIL)	37.7	5.4%
7	China Merchants Port Holdings	28.5	4.1%
8	CMA CGM	16.6	2.4%
9	Hanjin	14.0	2.0%
10	Eurogate	11.9	1.7%
11	SSA Marine / Carrix	10.6	1.5%
12	NYK	9.6	1.4%
13	Evergeen	9.4	1.3%
14	ICTSI	8.7	1.2%
15	OOCL	6.7	1.0%
16	China Shipping Terminal Development	6.4	0.9%
17	MOL	5.9	0.8%
18	Yildirim / Yilport	5.6	0.8%
19	Yang Ming	4.4	0.6%
20	Bollore	4.3	0.6%
Global/International Operators Total		**555.1**	**79.4%**

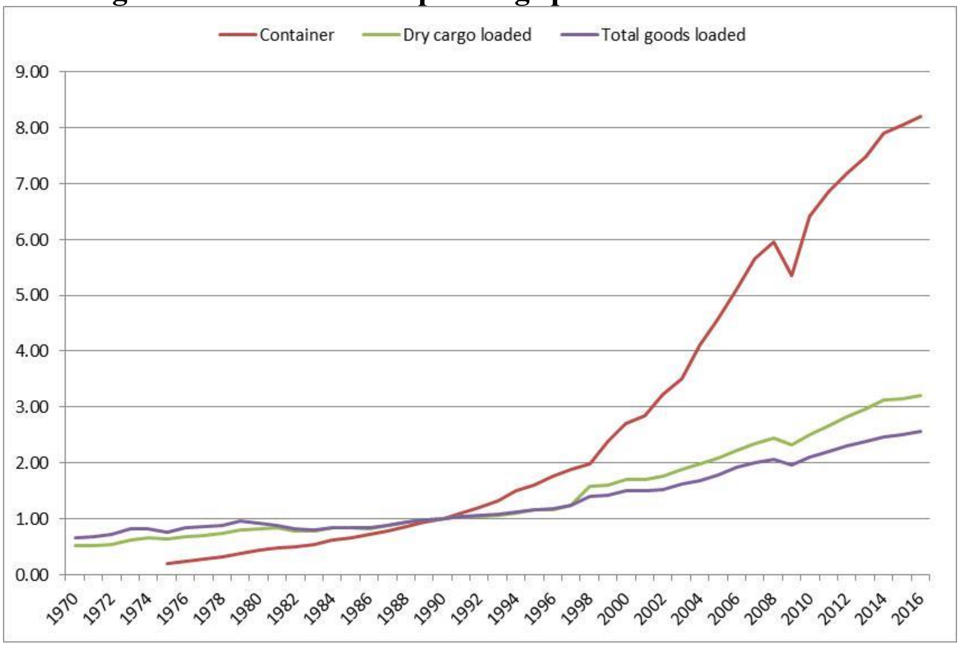
(Data) Drewry (2017), *Global Container Terminal Operators: Annual Review and Forecast*.

Table 7: The four major alliances on the east-west trades in 2015

Source: Frémont (2015)

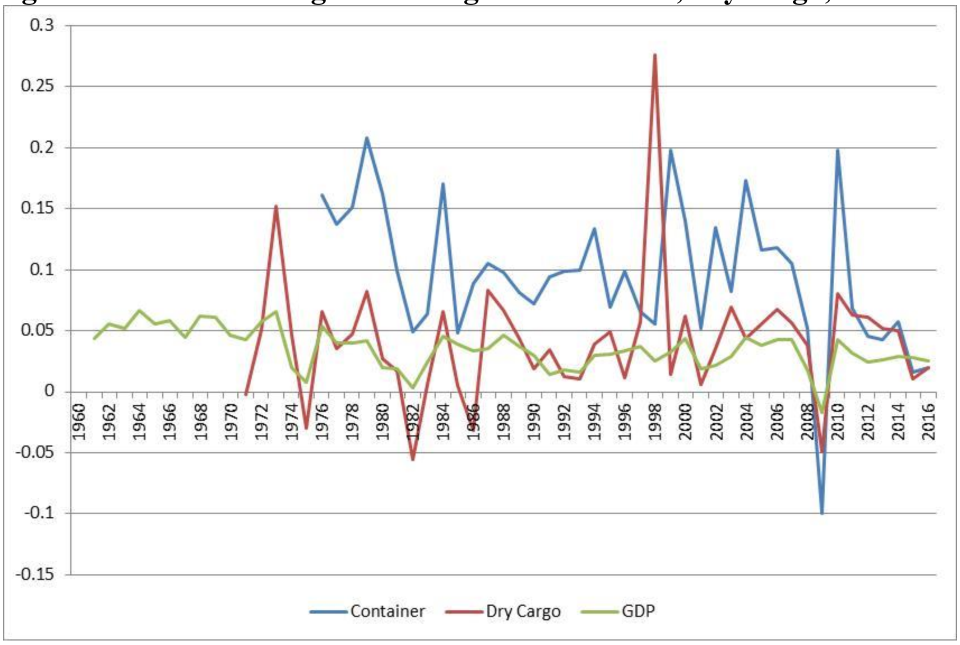
Alliance	**Carriers**	**Country**	**Market share (%) on the Asia-North Europe trade**
G6	American President Line	Singapore	24
	Hapag Lloyd	Germany	
	Hyundai Merchant Marine	South Korea	
	Mtsui OSK Line	Japan	
	NYK Line	Japan	
	Orient Overseas Container Line	Hong Kong	
CKYHE	COSCO	China	24
	K Line	Japan	
	Yang Ming	Taiwan	
	Hanjin Shipping	South Korea	
	Evergreen	Taiwan	
2M	Maersk	Danemark	31
	MSC	Switzerland	
Ocean Three	CMA-CGM	France	21
	China shipping (CSCL)	China	
	UASC	Qatar	

Figure 1: The relative expanding speeds of maritime trade



(Data) World Bank Open Data, and UNCTAD Stat.

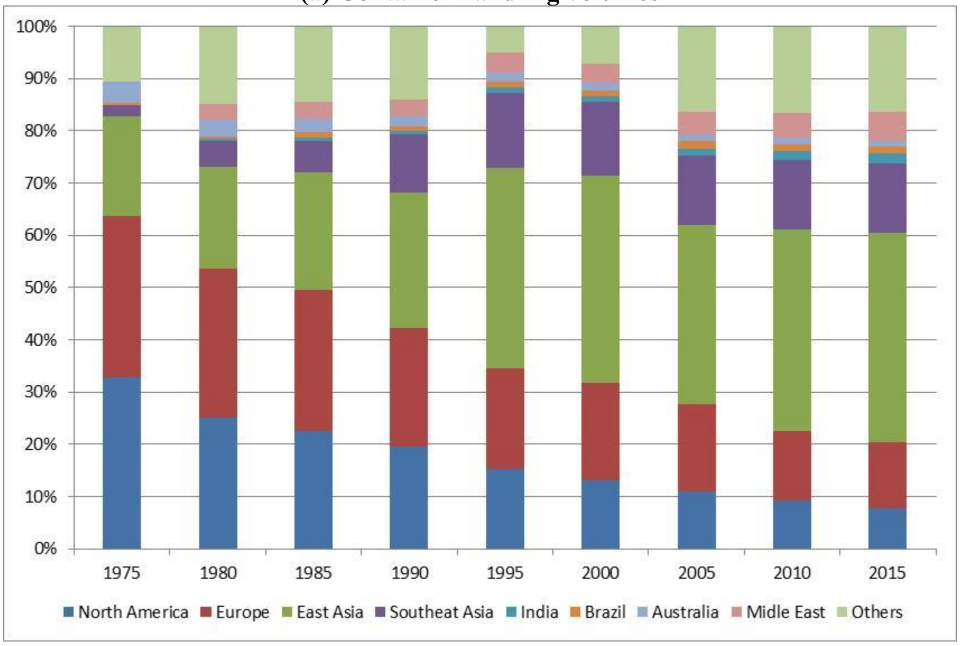
Figure 2: The increasing rate changes of container, dry cargo, and GDP



(Data) World Bank Open Data, and UNCTAD Stat.

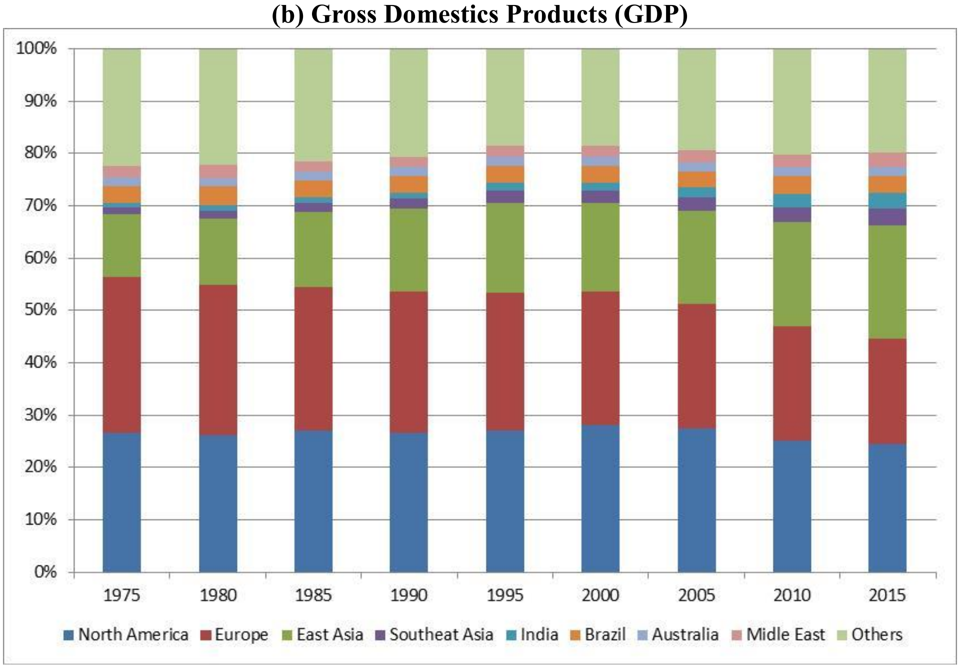
Figure 3: The shares for global total by countries/regions

(a) Container handling volumes



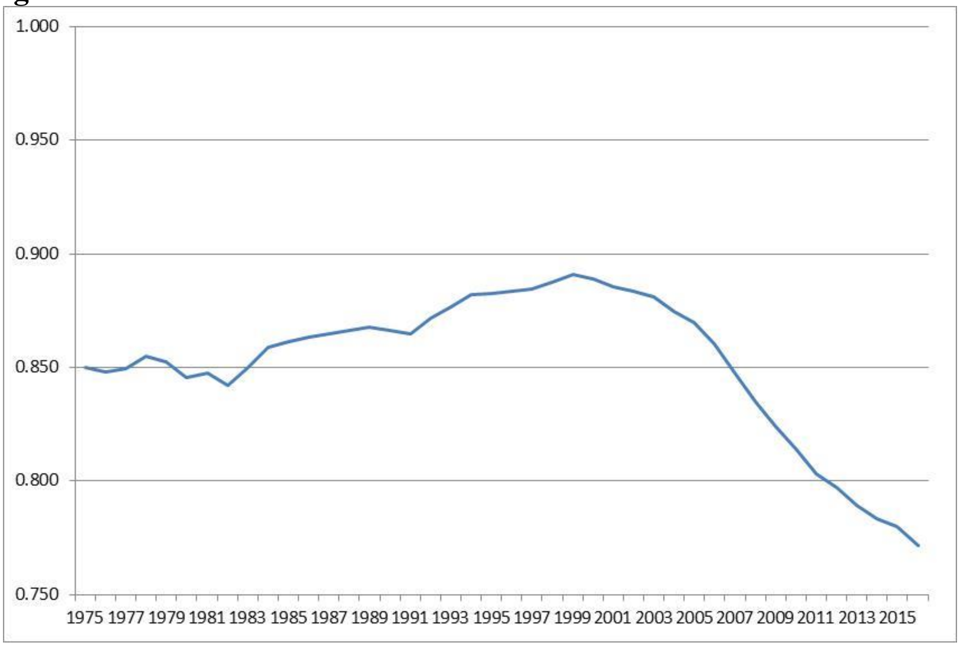
(Data) Based on the data from Table A2 (a).

(b) Gross Domestics Products (GDP)



(Data) Based on the data from Table A2 (b).

Figure 4: The correlation coefficients between GDP and container shares



(Note) This figure is based on the data sets on Tables A1 (a) and (b).

Figure 5: Container port management system

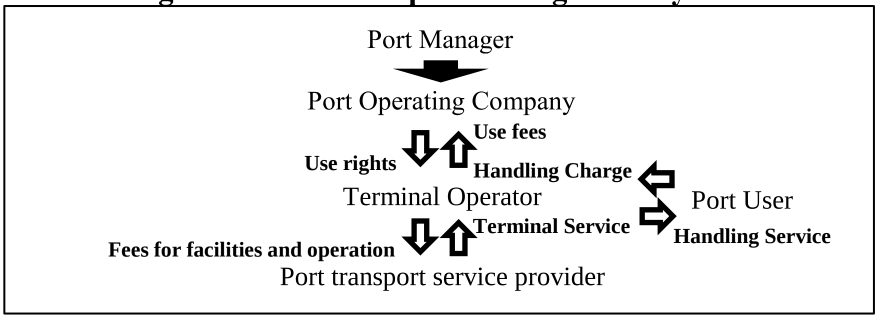


Figure 6: Global maritime container flows in 2016

Source: Ducruet et al. (2018)

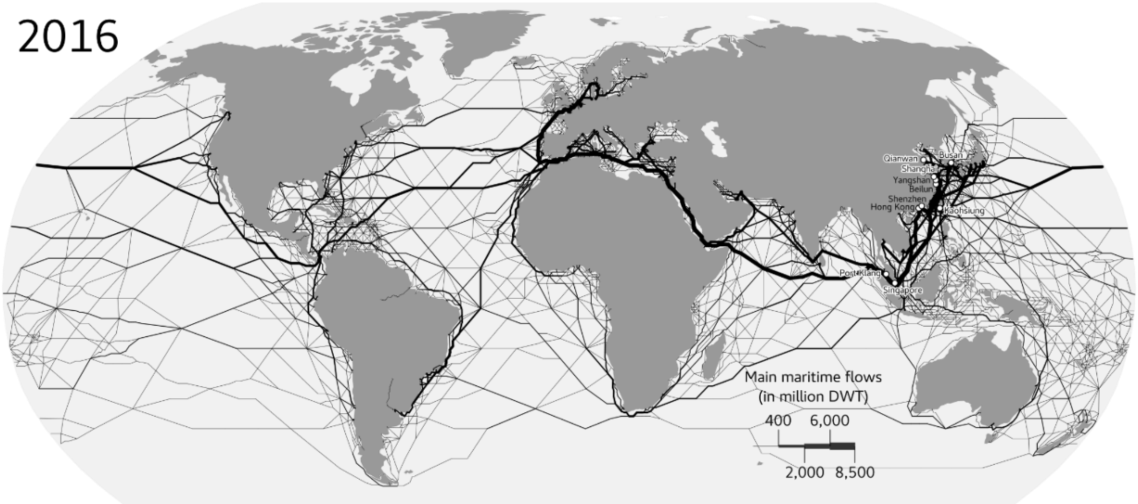


Figure 7: The process of liner service design

Source: Ducruet and Notteboom (2012)

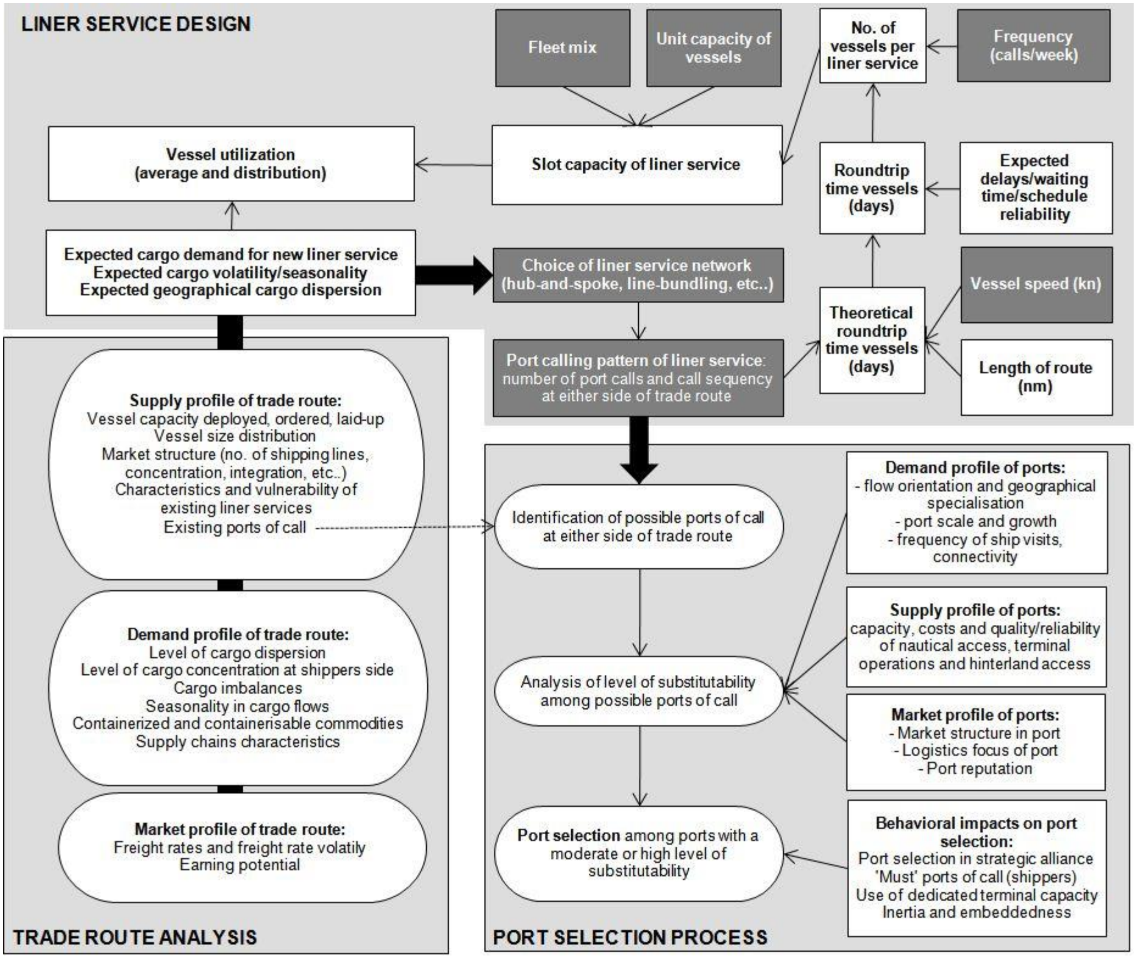


Figure 8: Global container port traffic concentration, 1977-2016

Source: own elaboration based on Lloyd's List Intelligence data

N.B. calculations realized using Wessa software, https://www.wessa.net

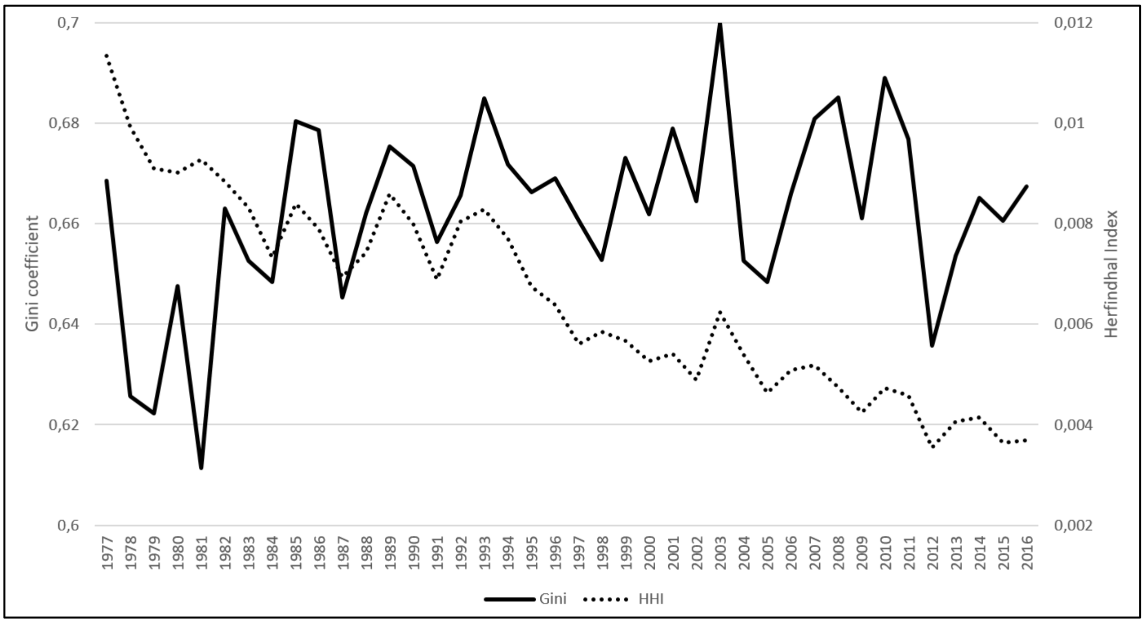
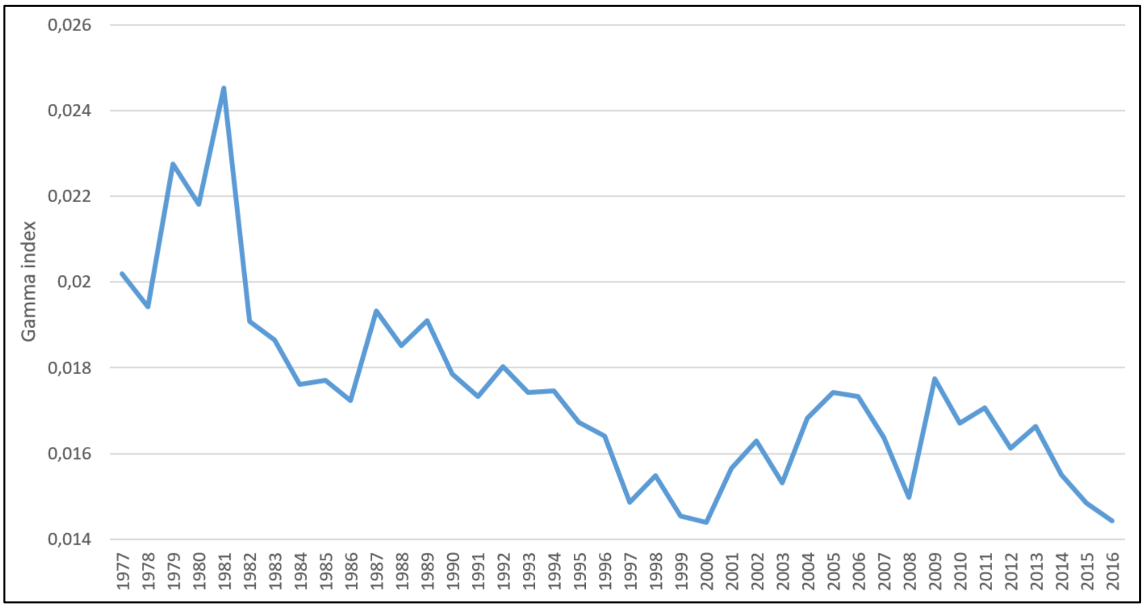


Figure 9: Global container network concentration, 1977-2016

Source: own elaboration based on Lloyd's List Intelligence data



Appendix:

Table A1: Average growth rates by countries/regions

(a) Container handling volumes

	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015
USA	10.5%	6.3%	5.7%	4.6%	7.5%	7.2%	4.6%	1.0%
Canada	12.1%	7.5%	7.2%	3.1%	16.3%	7.4%	3.2%	4.0%
Germany	15.3%	8.8%	7.8%	6.4%	11.8%	12.1%	-0.2%	9.3%
Spain	22.8%	16.7%	5.2%	10.7%	12.9%	9.7%	6.8%	3.0%
Netherlands	12.6%	6.2%	6.5%	5.4%	5.7%	8.3%	4.2%	2.1%
Belgium	13.7%	10.3%	5.3%	8.8%	12.1%	9.4%	7.5%	0.4%
Italy	31.3%	4.8%	3.5%	10.9%	18.6%	7.4%	-0.1%	1.0%
UK	10.5%	5.1%	7.0%	3.2%	6.7%	5.6%	1.8%	5.8%
France	22.4%	7.2%	1.3%	2.4%	11.6%	6.6%	3.1%	4.2%
Sweden	9.4%	8.9%	0.2%	9.7%	3.9%	7.9%	-0.5%	3.4%
Ireland	8.2%	1.9%	7.6%	8.8%	9.4%	6.2%	-3.7%	2.3%
Denmark	39.2%	6.1%	-1.4%	4.4%	4.5%	14.4%	-37.2%	-1.0%
China	65.3%	53.1%	26.8%	93.4%	19.5%	11.1%	16.6%	6.9%
Hong Kong	13.3%	9.4%	17.5%	19.9%	7.7%	4.6%	1.2%	-3.0%
Japan	13.6%	10.3%	7.7%	6.0%	4.6%	5.5%	1.6%	2.3%
Korea	32.8%	13.3%	13.9%	14.1%	15.0%	11.1%	4.5%	6.6%
Taiwan	28.8%	13.8%	12.7%	7.6%	-20.9%	4.1%	0.6%	2.5%
Singapore	33.2%	13.3%	25.3%	17.8%	7.6%	6.6%	5.2%	1.8%
Malaysia	21.2%	18.1%	18.2%	18.6%	17.8%	22.0%	8.5%	5.7%
Indonesia	49.2%	23.6%	33.5%	17.4%	18.4%	7.9%	11.0%	8.4%
Thailand	94.7%	16.3%	22.0%	12.8%	10.4%	10.0%	5.4%	5.1%
Vietnam						16.8%	18.7%	8.7%
Philippines	36.3%	8.8%	17.2%	8.3%	10.4%	3.7%	7.5%	7.3%
India	224.8%	22.9%	12.0%	15.1%	12.6%	15.3%	13.1%	5.6%
Brazil	74.7%	31.6%	3.1%	16.0%	12.8%	19.9%	5.1%	6.4%
Australia	10.4%	3.7%	4.1%	6.9%	9.3%	8.0%	4.9%	3.4%
Turkey		117.7%	15.2%	16.3%	42.1%	16.3%	14.1%	7.4%
UAE	58.7%	16.6%	17.6%	17.9%	27.2%	14.6%	9.7%	7.1%
Saudi Arabia	80.9%	3.8%	-3.4%	7.7%	6.7%	75.1%	7.5%	8.2%

(Note) West Germany and East Germany are integrated as Germany before 1990. And, Hong Kong is excluded in China for constant discussion.

(b) Gross Domestic Products (GDP)

	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015
USA	2.7%	3.7%	3.4%	3.4%	2.6%	4.3%	2.5%	0.8%	2.2%
Canada	4.4%	3.7%	2.7%	2.6%	1.7%	4.0%	2.6%	1.2%	2.2%
Germany	2.4%	3.4%	1.4%	3.3%	2.1%	1.9%	0.6%	1.3%	1.7%
Spain	5.3%	2.0%	1.4%	4.5%	1.5%	4.1%	3.4%	1.1%	-0.2%
Netherlands	3.3%	2.6%	1.1%	3.4%	2.3%	4.3%	1.3%	1.3%	0.8%
Belgium	3.7%	3.2%	0.9%	3.1%	1.6%	2.9%	1.8%	1.4%	1.0%
Italy	3.2%	4.5%	1.7%	3.1%	1.3%	2.0%	0.9%	-0.3%	-0.6%
UK	2.1%	2.3%	2.4%	3.5%	1.6%	3.3%	2.8%	0.4%	2.1%
France	3.9%	3.4%	1.6%	3.4%	1.3%	2.9%	1.7%	0.8%	1.0%
Sweden	2.6%	1.4%	2.0%	2.4%	0.7%	3.6%	2.6%	1.7%	2.1%
Ireland	4.9%	4.6%	2.6%	4.7%	4.7%	9.4%	5.6%	0.8%	7.7%
Denmark	1.7%	2.7%	2.8%	1.5%	2.3%	3.0%	1.3%	0.3%	1.1%
China	5.9%	6.6%	10.7%	8.0%	12.3%	8.6%	9.8%	11.3%	7.9%
Hong Kong	6.6%	11.6%	5.8%	7.8%	5.3%	2.7%	4.3%	4.0%	3.0%
Japan	4.6%	4.4%	4.3%	5.0%	1.6%	1.1%	1.2%	0.2%	1.0%
Korea	10.0%	8.6%	9.4%	10.5%	8.4%	5.7%	4.7%	4.1%	3.0%
Taiwan									
Singapore	9.6%	8.6%	6.9%	8.7%	8.7%	5.7%	4.9%	6.9%	4.1%
Malaysia	7.2%	8.6%	5.2%	6.9%	9.5%	5.0%	4.8%	4.6%	5.3%
Indonesia	7.0%	7.9%	4.8%	6.3%	7.1%	1.0%	4.7%	5.7%	5.5%
Thailand	5.8%	8.0%	5.4%	10.3%	8.2%	0.9%	5.5%	3.8%	2.9%
Vietnam			3.8%	4.8%	8.2%	7.0%	6.9%	6.3%	5.9%
Philippines	5.8%	6.1%	-1.1%	4.7%	2.2%	3.6%	4.6%	5.0%	5.9%
India	2.9%	3.2%	5.2%	6.0%	5.1%	6.1%	6.7%	8.3%	6.8%
Brazil	10.3%	6.7%	1.2%	2.3%	3.1%	2.1%	2.9%	4.5%	1.1%
Australia	3.2%	2.8%	2.9%	4.0%	2.4%	4.2%	3.2%	2.8%	2.7%
Turkey	5.8%	2.5%	4.9%	5.7%	3.3%	4.1%	4.9%	3.4%	7.1%
UAE		16.2%	-1.3%	3.3%	3.8%	5.6%	5.4%	2.5%	4.9%
Saudi Arabia	15.0%	7.5%	-9.9%	7.6%	3.7%	1.7%	4.1%	2.8%	5.2%

(Note) The GDP data of Taiwan is not available on the World Bank Open Data.

Table A2: The relative shares for global total by countries/regions

(a) Container handling volumes

	1975	1980	1985	1990	1995	2000	2005	2010	2015
USA	30.3%	23.1%	20.6%	17.8%	13.9%	11.8%	9.8%	8.3%	7.0%
Canada	2.5%	2.0%	1.9%	1.8%	1.3%	1.3%	1.1%	0.9%	0.8%
Germany	4.2%	4.0%	4.0%	3.8%	3.2%	3.3%	3.5%	2.3%	2.8%
Spain	1.5%	1.9%	2.7%	2.3%	2.3%	2.5%	2.3%	2.3%	2.1%
Netherlands	6.5%	5.5%	5.0%	4.4%	3.6%	2.8%	2.4%	2.1%	1.8%
Belgium	2.8%	2.5%	2.6%	2.2%	2.1%	2.2%	2.0%	2.0%	1.6%
Italy	1.8%	3.3%	2.7%	2.1%	2.2%	3.0%	2.5%	1.8%	1.5%
UK	8.0%	6.1%	5.2%	4.7%	3.4%	2.8%	2.1%	1.5%	1.6%
France	2.3%	2.9%	2.7%	1.8%	1.2%	1.3%	1.0%	0.8%	0.8%
Sweden	1.2%	0.8%	0.8%	0.6%	0.5%	0.4%	0.3%	0.2%	0.2%
Ireland	1.2%	0.6%	0.5%	0.4%	0.4%	0.3%	0.2%	0.1%	0.1%
Denmark	1.2%	0.9%	0.8%	0.4%	0.3%	0.2%	0.2%	0.1%	0.1%
China	0.0%	0.1%	0.8%	1.4%	12.6%	17.7%	17.2%	25.4%	28.3%
Hong Kong	4.6%	3.9%	4.1%	6.0%	9.1%	7.8%	5.8%	4.3%	2.9%
Japan	10.7%	9.2%	9.9%	9.3%	7.7%	5.7%	4.4%	3.3%	2.9%
Korea	1.1%	1.8%	2.2%	2.7%	3.3%	3.9%	3.9%	3.4%	3.7%
Taiwan	2.7%	4.4%	5.5%	6.4%	5.7%	4.5%	3.3%	2.4%	2.1%
Singapore	1.3%	2.5%	3.0%	6.1%	8.6%	7.4%	5.9%	5.3%	4.6%
Malaysia	0.4%	0.5%	0.7%	1.0%	1.5%	2.0%	3.1%	3.3%	3.5%
Indonesia	0.0%	0.2%	0.4%	1.1%	1.5%	1.6%	1.4%	1.5%	1.7%
Thailand	0.1%	0.5%	0.7%	1.3%	1.4%	1.4%	1.3%	1.2%	1.2%
Vietnam	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.6%	1.1%	1.3%
Philippines	0.5%	1.2%	1.1%	1.6%	1.4%	1.3%	0.9%	0.9%	1.0%
India	0.0%	0.4%	0.7%	0.8%	1.0%	1.1%	1.3%	1.7%	1.7%
Brazil	0.3%	0.4%	1.1%	0.8%	1.0%	1.0%	1.4%	1.3%	1.4%
Australia	4.3%	3.2%	2.5%	1.9%	1.7%	1.5%	1.3%	1.2%	1.1%
Turkey	0.0%	0.0%	0.3%	0.4%	0.5%	0.7%	0.8%	1.1%	1.2%
UAE	0.0%	0.9%	1.3%	1.8%	2.6%	2.2%	2.5%	2.8%	3.1%
Saudi Arabia	0.0%	2.2%	1.7%	0.9%	0.8%	0.6%	1.0%	1.0%	1.1%
Others	**10.5%**	**14.9%**	**14.4%**	**14.1%**	**5.1%**	**7.2%**	**16.4%**	**16.6%**	**16.5%**

(Note) West Germany and East Germany are integrated as Germany before 1990. And, Hong Kong is excluded in China for constant discussion.

(b) Gross Domestic Products (GDP)

	1975	1980	1985	1990	1995	2000	2005	2010	2015
USA	23.7%	23.5%	24.3%	23.9%	24.4%	25.4%	24.8%	22.7%	22.0%
Canada	2.8%	2.8%	2.8%	2.7%	2.6%	2.7%	2.6%	2.4%	2.4%
Germany	7.5%	7.3%	6.9%	6.8%	6.7%	6.2%	5.5%	5.2%	4.9%
Spain	2.6%	2.3%	2.2%	2.3%	2.2%	2.3%	2.3%	2.2%	1.9%
Netherlands	1.6%	1.5%	1.4%	1.4%	1.4%	1.5%	1.4%	1.3%	1.2%
Belgium	1.0%	1.0%	0.9%	0.9%	0.8%	0.8%	0.8%	0.7%	0.7%
Italy	4.8%	5.0%	4.7%	4.6%	4.4%	4.1%	3.7%	3.2%	2.7%
UK	4.8%	4.4%	4.4%	4.3%	4.2%	4.2%	4.1%	3.7%	3.6%
France	5.5%	5.4%	5.1%	5.0%	4.8%	4.7%	4.4%	4.0%	3.7%
Sweden	1.1%	0.9%	0.9%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%
Ireland	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%	0.4%	0.3%	0.4%
Denmark	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%
China	1.1%	1.2%	1.8%	2.2%	3.5%	4.5%	6.1%	9.2%	11.8%
Hong Kong	0.1%	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Japan	10.4%	10.7%	11.6%	12.4%	12.0%	10.7%	9.8%	8.6%	7.9%
Korea	0.4%	0.5%	0.7%	1.0%	1.3%	1.4%	1.5%	1.7%	1.7%
Taiwan	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Singapore	0.1%	0.1%	0.1%	0.2%	0.2%	0.3%	0.3%	0.4%	0.4%
Malaysia	0.1%	0.2%	0.2%	0.2%	0.3%	0.3%	0.4%	0.4%	0.4%
Indonesia	0.5%	0.7%	0.7%	0.8%	1.0%	0.9%	1.0%	1.1%	1.3%
Thailand	0.2%	0.2%	0.3%	0.4%	0.5%	0.4%	0.5%	0.5%	0.5%
Vietnam	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%
Philippines	0.3%	0.3%	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.4%
India	1.0%	1.0%	1.1%	1.2%	1.4%	1.6%	1.9%	2.5%	3.0%
Brazil	3.2%	3.6%	3.4%	3.1%	3.3%	3.1%	3.1%	3.3%	3.1%
Australia	1.7%	1.6%	1.6%	1.6%	1.6%	1.7%	1.7%	1.7%	1.7%
Turkey	0.8%	0.8%	0.9%	1.0%	1.0%	1.0%	1.1%	1.2%	1.4%
UAE	0.2%	0.4%	0.3%	0.3%	0.4%	0.4%	0.4%	0.4%	0.5%
Saudi Arabia	1.1%	1.3%	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%
Others	22.3%	22.3%	21.6%	20.6%	18.6%	18.5%	19.3%	20.2%	19.8%

(Note) The GDP data of Taiwan is not available on the World Bank Open Data.

Table 3: The changes of container ship sizes

	1	2	3	4	5	6	7	8	9
Category	**Early**	**Fully Cellular**	**Panamax**	**Panamax Max**	**Post Panamax**	**Post Panamax II**	**New-Panamax**	**VLCS (very large)**	**ULCS (ultra large)**
Year	1956-	1970s	1980	1985-	1988-	2000-	2014-	2006-	2013-
Capacity	500-800	1,000-2,500	3,000-3,400	3,400-4,500	4,000-6,000	6,000-8,500	12,500	11,000-15,000	18,000-21,000
Length(m)	200	215	250	290	300	340	366	397	400
Beam(m)	20	20	32	32	40	43	49	56	59
Draft(m)	9	10	12.5	12.5	13	14.5	15.2	15.5	16
Across	6	10	13	13	15	17	19-20	22	23
High *	4 (4)	5 (4)	6 (5)	8 (6)	9 (5)	9 (6)	10 (6)	10 (8)	10 (8)

(Note) * High is the number of container high on deck, the number in parenthesis is below deck.

(Source) Rodrigue (2017).

Table 4: The classification of port management organization and operational form

			1. Government	**2. Leased home**		**3. Term-leased land**		**4. Ownership**
				With equipment	Without equipment			
development plan and permission			Port manager	Port manager	Port manager	Port manager	Port manager	Operator
Construction	Infra-	Non-profit	Port manager	Port manager	Port manager	Port manager	Port manager	Operator
		Profit				Operator	Operator	
	Super-				Operator			
Ownership	Infra-non-profit		Port manager	Port manager	Port manager	Port manager	Port manager	Operator
	Infra-profit						Operator	
	Super-				Operator	Operator	Operator	
Operating			Port manager	Operator	Operator	Operator	Operator	Operator
Example			Tanjung Priok (Indonesia), Laem Chabang (Thailand), Durban (South Africa), Haifa (Israel)	Kaohsiung, (Taiwan) Busan (Korea), Japanese major ports, Seattle (USA), Chinese ports, Dubai (UAE)	European major ports (Rotterdam, Humbug), Los Angeles, Long Beach, NY/NJ (USA)	Hong Kong	Kaohsiung (Taiwan), Busan (Korea), Leam Chabang (Thailand), Jawaharlal Nehru Port (India)	Singapore, UK, New Zealand

(Source) Kurihara (2014).