Development Trends of World Commercial Fleet during 2001-2018

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Abstract. The article analyzes the development of maritime commercial fleet during the period of 2000 - 2018. The four largest segments of the commercial marine fleet, the oil tankers, the bulkers, the container ships, and the general cargo ships have been considered. These segments formed 85% to 90% of the total deadweight of the world commercial fleet in different years. The peculiarities of development of these four segments of commercial fleet were determined. A special period in the development of oil tankers segment in 2012-2013 is highlighted when under the influence of MARPOL 73/78 huge tonnage of the single hull oil tankers was phased out. The correlation analysis between the development of world commercial fleet and world seaborne trade was carried out. Strong correlations between the tonnage of oil tankers and oil and gas trade, tonnage of bulkers and bulk and other dry cargo trade, tonnage of container ships and container transportation were determined.

1. Introduction

The water transportation system consists of naturally existing, that is water surface, and of artificial, that is much less in volume artificial channels, seas, environment for movement. Water transportation system also includes water vehicles and terminals, or ports, providing connection between water and other transportation systems. The water transportation system is often divided in two parts, sea part and river part, or inland water. This article describes the development of the maritime segment of the water transportation system.

The historical moment of origin of water transport is determined inexact because it refers to the first or second stage of development of transportation infrastructure [1]. It is believed that the first paddle water vehicle appeared about 12 thousand years ago and allowed to use natural infrastructure of reservoirs for needs of social development. Since that time, the water transportation system can be considered as formed within the infrastructure of natural and artificial waterways, terminals, and water transportation vehicles. During the time being, the water transportation system saw a number of technological breakthroughs, each of them was important for public attractiveness: a sail for the wind power, a propeller for mechanical traction, heat engines and electric movement later. The design features of water vehicles also changed, and the changes were directed towards increasing the capacity of the vehicle and removing restrictions by features of cargo, by distance and by navigation area.
From ancient times to nowadays water transport has been providing mass cargo transportation. The most important advantage of water transport is that it has a high carrying capacity and virtually unlimited throughput capacity at low cost. Costs for water transportation infrastructure are intended to the construction of terminals, artificial channels to improve the economic efficiency of transportation, while vehicles mostly travel in a natural environment that does not require investment. Three disadvantages of the water transport system include low speed, dependence on weather conditions and low transport accessibility. Delivery of goods by water transport in unimodal mode may be achieved in very rare case.

2. Dynamics of world maritime fleet during 2000 – 2018 years
Being the provider of activity of the maritime segment of the water transportation system, the maritime commercial fleet is represented by a wide variety of vessels. However, about 90% or more of the total world deadweight is provided by only four types of vessels:

- oil tankers, mainly intended for crude oil transportation, with a relatively small share for oil products transportation;
- bulk carriers, specialized to carry mainly four major bulk cargoes - iron ore, coal, grain and bauxite/alumina/phosphate rock;
- container ships, specialized for transportation of standard sea containers;
- general cargo ships, designed to transport general cargoes, including bulk and packaged goods such as metal, timber, and other minor bulks, and usually able to carry containers.

2.1. Dynamics of four main types of ships
Figures 1 and 2 based on [2-20] show the dynamics of the total deadweight of the world fleet on four listed above types of ships, and their share in the world fleet.

![Figure 1. Deadweight of four main types of cargo ships during 2000-2018 yrs.](image-url)
As follows from Figure 1, during the period under review there has been a steady and rather rapid growth in the tonnage of the maritime fleet. In 2000, the total deadweight of the four main types of vessels was about 739 million tons, by 2018 (to end of the year) the total deadweight reached 1749 million tons, having totally increased 2.36 times.

2.2. Development of oil tanker fleet

Significant part of the water transportation system is represented by tankers, among them the largest segment is occupied by crude oil tankers and petroleum product tankers. Seems the economic feasibility assumes that raw materials should be processed into high added value products as close to raw sites as possible. However, crude oil has a peculiarity. Modern technologies of crude oil refinery provide 110% output of petroleum products by adding water. In other words, at least 1.1 tons of commercial oil products can be obtained from one ton of crude oil. Thus, transportation of crude oil is more profitable than that for petroleum products.

For reviewed period the total deadweight of oil tanker fleet has doubled, from 283.95 to 564.784 million ton, but its share in the world fleet has decreased from 35% to 29% with a maximum of 37.25% in 2004 and a minimum of 27.95% in 2015. The reason was the faster growth of bulk and container fleets, as well as significant growth of gas tankers segment. As can be seen in Figure 1, after 2011 the total tonnage of oil tankers has decreased with the recovery of the lost value only by 2015. It was the impact of the 1989 accident of the Exxon Valdeze oil tanker in Prince William Sound, Alaska. The oil tankers of old design usually had a single hull. The single hull of ship was also the wall of the oil tank where the crude oil is stored. Even in a minor accident and minor damage to single hull the oil from the tanker spills into the waters freely. An oil spill from the Exxon Valdeze single hull tanker caused direct damage of USD 287 million in 1989 year costs [21]. As result of Exxon Valdeze oil spill, the U.S. enacted the Oil Pollution Act (1990), under which new tankers intended to be operated in U.S. coastal waters must have a double hull. In double hull construction the oil tanks are structurally separated from the hull, so minor damage to the ship hull does not destroy the tank wall, and does not cause oil spill. In 1992 and 2003, the International Maritime Organization adopted a recommendation (1992 and 2003 amendments to MARPOL 73/78) to prohibit the exploitation of the single hull oil tankers over 25 years old. In 2015, all single hull oil tankers were prohibited, regardless of age, from the day and month of ship building. From that date, single hull tankers could be prohibited from entering any port in the world.
and even from trans-shipment in coastal waters. The result was a mass phase-out of single hull oil tankers between 2010 and 2015.

Figure 3 shows the newbuilding of oil tankers, the oil tanker tonnage for demolition, and the oil tankers deadweight growth as the difference between the built and demolished tonnage.

![Figure 3. Newbuilding and demolition of oil tanker fleet.](image)

The data in Figure 3 require explanation. Until 2008, the tonnage of the world fleet was presented in deadweight tons in UNCTAD documents. From 2009, the methodology has changed from deadweight to register tonnage, i.e. the statistics switched from mass-dimensional data to volume-dimensional data. Thus, the sequence of UNCTAD data is broken into two incompatible parts - to 2008 year and from 2009 year. To eliminate data incompatibilities, the conversion was made from register tonnage to deadweight. It was assumed, that deadweight of crude oil tanker is fairly related to register tonnage due to the cargo characteristics and similar design of oil tankers. From analysis on few randomly selected oil tankers was found that for Suezmax oil tankers deadweight to register tonnage ratio vary from 1.9 to 1.95 with the most expected value of 1.93. Converted UNCTAD's data are presented on the Figure 3 after 2008 year.

The data from [22] were used to verify the conversion. The oil tankers demolition was estimated at 2.5 million tons of deadweight in 2016, and at 11.2 million tons in 2017, that well conform to 2.4 million ton in 2016 and 11.5 million tons in 2017 by conversion (see Figure 3). Difference may be explained from some uncertainty and incompleteness of source.

In fact, the uncertainty and incompleteness of UNCTAD's data are significant. From Figure 3, the negative gain of oil tanker deadweight was observed only in 2001. However from Figure 2, in 2001 the oil tanker deadweight grew, and in 2012 and 2013 the total deadweight of the tanker fleet decreased. The contradiction between the two datasets may be explained most likely by the unrecorded tonnage of phased-out tankers. Figure 4 shows series of deadweight dynamics of oil tanker fleet based on ship register data, and on ship newbuilding/demolition data. Dissemblance line represents the misregistered tonnage.
We may suppose that the main sources of dissemblance are incomplete data on newbuilding and ships demolition, as well as possible double count of ships when ship change the owner. Another important source of dissemblance may be the tonnage of unofficially demoli shed ships. As Figure 4 shows, about 38 million tons of unaccounted deadweight were decommissioned during 2012, and another 19 million tons in 2013, totally amounting to 350 Suezmax class oil tankers. Highly likely these ships were abandoned or sunk.

2.3. Era of bulkers

Another important part of the maritime commercial fleet is bulkers, or large dry cargo ships specialized for transportation of bulk cargo. In modern world trade, four highlighted major bulk cargoes are the iron ore, the coal, the grain, and the bauxite/alumina/phosphate rocks. For a long time in the economic theory the globalized doctrine spread that manufacturing industries gravitate to the sources of raw materials. According to this doctrine, it is economically ineffectively to transport raw materials over long distances. Therefore, manufacturing industry should be moved as close as possible to the source of raw materials, and the finished or semi-finished products with high added value only should be transported to the customer. However, the doctrine showed its inevitability. Certainly, the building of complex manufacturing in developing countries with poor infrastructure, power engineering, and low human capital was less efficient than transportation of raw materials for thousands of miles. There is another reason. The processing of four major cargoes is the object of basic industrial enterprises for the national economy. Thus, steel production is usually concerned as basic for heavy industry. Developed countries prefer to process iron ore on the national territory and to include added value to the gross domestic product. As result, for example Australia, being capable to process large amounts of iron ore, is one of largest exporters of unprocessed iron ore. In 2019 Australia exported an estimated 814 million tons of iron ore for 80.15 billion USD, or over a quarter of Australia's national export in terms of price. It’s why we see the huge growth in the bulkers segment. The total bulkers deadweight ran from 291.6 million ton to 842.5 million ton from 2000 to 2018 (to the end of year), or almost 2.9 times. It is very fast comparing other types of ships (see Figure 1). Share of bulkers in the world commercial fleet grew steadily from 34.8% in 2000 to 42.6% by the end of 2018.

Figure 5 shows the newbuilding of bulkers, the bulker tonnage for demolition, and the bulker deadweight growth as the difference between the built and demolished tonnage.
It must be noted that data on Figure 5 has the same drawback as on Figure 3. To bridge the break in methodology, the data of UNCTAD were converted from gross tonnage to deadweight for the period from 2009 to 2018. Basing on parameters of few large projects like Hudsonmax, Panamax, Supramax, and Kamsarmax it was found that deadweight to register tonnage ratio vary from 1.78 to 1.88 with the most expected value of 1.80. Converted UNCTAD's data are presented on the Figure 5 after 2008 year. The notes from [12] were used to verify the conversion where gross tonnage and deadweight are showed line by line. The bulkers demolition was estimated at 4.953 million ton of deadweight in 2010, and bulkers newbuilding was at 73.424 million ton in same year, that well conform to 5.01 million ton and 72.5 million ton respectively by conversion (see Figure 5). Difference may be explained from some uncertainty and incompleteness of sources.

Uncertainty of UNCTAD's data for bulkers are much less significant comparing to oil tankers. Figure 6 shows series of deadweight dynamics of oil tanker fleet based on ship register data, and on ship newbuilding/demolition data. Dissemblance line represents the misregistered tonnage. As we can see, the significant dissemblance occurred in 2011 only. That year the growth of bulker tonnage was very large, and dissemblance did not exceed 20% of new tonnage. Possible reason is inaccuracy or delays in registration.

2.4. Development of container ship and general cargo ship segments

Containerization of general cargoes is a trend that has been observed in maritime transportation since the 60s of the 20th century. The share of containerized cargo in the total turnover of transport systems is constantly growing, and the tendency to gradually push out of non-containerized general cargoes from the turnover, including by tariff practices, is obvious. In general, there are three ISO container sizes involved in global maritime transportation: 20-feet, 40-feet and, much less frequently, 45-feet containers. National systems also support other sizes. For example, in North America the 53-foot containers are carried in large amounts, and 60-feet containers can be found in transportation too.
Before International Standard Organization defined container sizes, manufacturing and test methods, labelling, coding and registration rules, many older container types were involved in maritime traffic. These containers appeared a variety of dimensions often incompatible and were not adapted for securing well. Carriers generally demonstrated the negative attitude and called these containers "brown plague" because traditionally they were painted in red-brown iron ochre. However, standardization changed the tone of carriers by showing the effectiveness of the wide use of standard containers. The container ship segment showed blowing increase of 3.8 times from 69.6 million ton in 2000 to 265.6 million ton of deadweight in 2018 by end of year (see Figure 1).

The general cargo ships segment is the only major maritime transport segment that decreased during the period under review. Traditionally, general cargo ships were relatively small universal vessels that could carry dry cargoes or containers. As large specialized vessels showed much more efficiency, the small general cargo ships have been phased out from the commercial shipping market. General cargo ships were replaced by bulk carriers for the dry cargoes and by container ships for the container transportation. The segment of general cargo ships decreased from 102.6 million tons in 2000 to 74 million tons in 2018, correspondingly from 12.7% to 3.7% of the world commercial fleet.

Unfortunately, sequential data on newbuilding/demolition of these two segments are available for 2012-2018 years. Data are given in gross tonnage. Conversion is made on the basis of UNCTAD information with deadweight to gross tonnage ratio of 1.11 for container ships and 1.38 for general cargo ships. Dissemblance lines are presented on Figures 7 and 8. Differences between registration data and newbuilding/demolition data for two segments are very distinct. Dissemblance line of container ship segments looks adequate because data on registration and newbuilt/demolished tonnage are very similar in behaviour. Dissemblance line of general cargo ship segments implies that significant part of general cargo fleet was phased out of operation in other way than demolition for scrap. It looks many general cargo ships were abandoned or sunk like it was for oil tankers in 2012-2013 years.

Figure 6. Dissemblance between register data and newbuilding/demolition of bulker fleet.
3. Analysis of relationship between dynamics of world seaborne trade and development of world commercial fleet

Occurrence of correlation between development of world commercial fleet and the current state of world seaborne trade is the next point of interest. Table 1 is based on data of [22] and represents the dynamics of world seaborne trade in few important segments.

| Type of cargo | 2000  | 2005  | 2006  | 2007  | 2008  | 2009  | 2010  |
|---------------|-------|-------|-------|-------|-------|-------|-------|
| Oil and gas   | 2163  | 2422  | 2698  | 2747  | 2742  | 2642  | 2772  |
| Main bulks    | 1295  | 1711  | 1713  | 1840  | 1946  | 2022  | 2259  |
| Containers    | 598   | 1001  | 1092  | 1215  | 1272  | 1134  | 1291  |
| Other dry cargoes | 1928 | 1975  | 2197  | 2232  | 2269  | 2060  | 2087  |

| Type of cargo | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  |
|---------------|-------|-------|-------|-------|-------|-------|-------|
| Oil and gas   | 2794  | 2841  | 2829  | 2825  | 2932  | 3055  | 3146  |
| Main bulks    | 2392  | 2594  | 2761  | 2988  | 2961  | 3041  | 3196  |
| Containers    | 1411  | 1458  | 1532  | 1622  | 1660  | 1734  | 1834  |
| Other dry cargoes | 2188 | 2304  | 2392  | 2408  | 2471  | 2459  | 2526  |

Data of Table 1 and data on ships registration (see Figure 1) may be used for calculation of Pearson correlation coefficient. Table 2 represent the correlation coefficients for the different sets of presumably related variables. The lower two string in Table 2 represents the upper and lower limits correspondingly of Pearson correlation coefficient with 95% confidence level.

As we can see from Table 2, there is strong correlation between registered deadweight of oil tankers and oil and gas trade, bulkers and four major bulks trade, container ships and containers transportation. The positive correlation between deadweight of general cargo ships and other dry cargoes trade except four main bulks is not observed. Segment of general cargo ships is shrinking yet the transportation of all kinds of dry cargoes is growing. The possible reason is phasing out of universal general cargo ships being replaced by bulkers for dry cargoes and container ships for container transportation. The rightest two columns of Table 2 show that there is higher correlation between the segment of bulkers and the total transportation of dry cargoes of all kinds.
Table 2. Correlation between commercial fleet tonnage and seaborne trade.

| First variable: registered tonnage | Oil tankers | Bulkers | Container ships | General cargo ships | Bulkers + General cargo ships |
|-----------------------------------|-------------|---------|----------------|---------------------|-----------------------------|
| Second variable: world seaborne trade | Oil and gas | Main bulks | Containers | Other dry cargoes | Main bulks + other dry cargoes |
| Correlation coefficient (CC)       | 0.935       | 0.992   | 0.979         | -0.789              | 0.981                       |
| CC Fisher transformed              | 1.700       | 2.747   | 2.277         | -1.068              | 2.320                       |
| Standard error (n=14)              | 0.302       | 0.302   | 0.302         | 0.302               | 0.302                       |
| Upper limit transformed at 95%     | 2.291       | 3.338   | 2.868         | -0.477              | 2.911                       |
| Lower limit transformed at 95%     | 1.109       | 2.156   | 1.686         | -1.659              | 1.723                       |
| CC Upper limit at 95%              | 0.980       | 0.997   | 0.994         | -0.444              | 0.994                       |
| CC Lower limit at 95%              | 0.804       | 0.974   | 0.934         | -0.930              | 0.939                       |

4. Conclusion

Basing on analysis presented above we can develop next few conclusions.

1. The world commercial fleet is growing during 2000-2018 years at high and steady rates. Total deadweight of world commercial fleet has increased from 795 million ton in the beginning of 2000 to 1979 million ton by the end of 2018 or in 2.49 times. The four largest segments of the commercial marine fleet, the oil tankers, the bulkers, the container ships, and the general cargo formed 85% to over 90% of the total deadweight of the world commercial fleet in different years.

2. Three main growing segments of commercial fleet are oil tankers, bulkers, and container ships that count 80% to 85% of total world tonnage. These segments have grown in 1.99, 2.9, and 3.8 times correspondingly. The fourth segment, general cargo ships, is going down.

3. Oil tankers segment looks the most vulnerable part of world commercial fleet. The 2008 crisis influenced the growth of segment significantly. But the strongest attack was from 1992 and 2003 Amendments to MARPOL 73/78 brought mass canceling of single hull tankers during 2012 and 2013. Huge tonnage of canceled oil tanker was not counted in demolition data and had disappeared.

4. Universal by nature general cargo ships gave way to bulkers specialized for dry cargo, and to container ships specialized for container transportation. Seems we may see the total liquidation of general cargo ships as type of fleet soon. Supposed reason is obsoletion of idea of universality in ships design.

5. There is strong correlation between deadweight of oil tankers and volume of oil and gas seaborne trade, and the same for bulkers and dry cargoes, and for container ships and container transportation. There is no correlation between development of world bulk and dry cargo seaborne trade and tonnage of general cargo ships. Supposed reason is phasing out of universal general cargo ships.

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