SHIPOWNERS' STRUCTURE AND FLEET DISTRIBUTION IN THE LNG SHIPPING MARKET: A COMPARATIVE STUDY WITH CONTAINER AND DRY BULK MARKETS

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ABSTRACT

The LNG (Liquefied natural gas) shipping market has witnessed a rapid development in recent years in line with the rising world LNG trade. The purpose of this paper is to explore unique features of the LNG shipping market compared to two other market segments: container and dry bulk. More in particular, the characteristics of the LNG shipping market are examined by providing a comparative analysis on shipowners' structure and fleet development. Several concentration measures are applied to test the ownership concentration and size distribution of ship owners in the three markets. In addition, the evolution of the LNG fleet and a comparison of the ship size distribution with container and bulk sectors are also studied within this paper.

KEYWORDS

LNG Shipping; Container; Bulk; Market structure; Concentration; Fleet development.

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1. INTRODUCTION

Natural gas is one of the "Big Three" fossil fuels that make up the vast majority of world's energy consumption along with coal and oil. As a cleaner burning fuel than both oil and coal, with less carbon emissions, natural gas has been seen as an increasingly attractive fuel source. According to the latest report from EIA The International Energy Outlook (2010), the total natural gas consumption worldwide is expected to increase by 44%, from 4.9 trillion m^3 in 2007 to 7.2 trillion m^3 in 2035, of which about 30% volume is traded internationally and the rest is absorbed by domestic production. Nowadays, the transportation of natural gas is mainly done by pipeline and by shipment in the form of liquefied natural gas (LNG). The latter one transported around 27% of world trade volume in 2009 and the figure is still growing.

LNG is natural gas stored and transported in liquid form at atmospheric pressure at a temperature of -161°C (-256°F). Liquefied gas occupies a volume corresponding of 1/600 of the gas in the gaseous state which eases the transportation process and allows LNG to be shipped in specialized carriers. Most studies indicate that LNG shipping is more competitive in cases where pipeline transportation is not feasible due to geographic constraints or not economic, particularly for medium and long distances Wang & Notteboom (2011). With the development of the LNG spot trade, LNG shipment also offers diversity and flexibility of gas supply around the world and assists to shape a global gas market.

LNG projects are highly capital intensive and technologically sophisticated. It costs several billion dollars to construct facilities for the LNG supply chain (gas exploration, liquefaction, transportation and regasification). Commitments to such high investment lead to the LNG projects to set a template for the business. Security of supply is paramount: long-term planning and close cooperation between sellers and buyers resulted in long-term, rigid contracts with shipping tied in. Given such industrial pattern, LNG shipping boasts its own characteristics in contrast to the other shipping industries, e.g. the container and bulk sectors.

What are the unique features of the LNG shipping market compared to container and bulk segments? And what are the reasons behind such features? These questions are the motivation for this study. Hence, the aim of this paper is to explore the answers of these questions by a comparative study with container and bulk markets on two dimensions: shipowners' structure characteristics and fleet composition. Several concentration measures are applied for analyzing the numbers and size of ship owners and the distribution of transport capacity among the owners within the three shipping segments. Moreover, the development of the LNG fleet, its size evolution and distribution will also be examined in order to draw some conclusions on its fleet features. The same studies for the container and bulk sectors are also included in this paper.

This paper is organized as follows: Section 2 gives a brief overview of LNG trade dynamics in recent decades, especially underlining the market changes driven by short-term/spot trade. Section 3 contains an analysis of shipowners' structure characteristics by examining the evolution of market structure and by providing a comparative study on shipowners' concentration. Section 4 looks at the growth of the LNG fleet and ship distribution by size in compares these to the other two shipping sectors. Finally Section 5 provides some concluding remarks.

2. DYNAMICS IN WORLD LNG TRADE – AN OVERVIEW

Traditionally, the LNG industry has been a highly structured one, tied to long term contracts of 20 years or more. Due to the massive cost of building the facilities, finance was only available if banks could see long term guarantees of a project's viability in place. The supply chain was characterized by fixed contracts with destination clauses to prevent cargoes being diverted into markets other than those stipulated. In the early of 1990s, the LNG world trade was firmly divided between the Atlantic Basin and Asia Pacific markets. There was minimal trade between these two regions, and consequently little or no market or price interaction Thompson et al (2009). Specific import terminals serviced specific contracts, with the shipping capacity contracted for specific routes, meaning that vessel supply and demand were normally very closely matched, with few vessels spare for short term or spot operations.

However, with debottlenecking and the expansion of liquefaction plants in exporting countries, more surplus volume was offered which either effectively rolled into long-term contracts and sold to the same buyers or flowed into the alternative markets. As a result of the latter a short-term market started to emerge and regionalization of the industry began to break down. Other drivers favoring the short-term market include:

- Flexibility of supply: once the long-term buyers could not absorb the contracted volume, with more flexible contract terms (i.e. no destination restriction clause), the sellers can divert the cargo to alternative buyers in order to arbitrage prices between the markets;
- Quick response to gas demand: once natural events occurred upon buyers (i.e. pipeline supply is curtailed or a sudden increase of seasonal demand), the buyers can search for gas from alternative supplies.

With the growth of the short-term trade (Figure 1), a new global and competitive gas market is in the making. But "the long-term contracts would be still alive and well" Jensen (2004) since no supplier has yet undertaken to build a new facility on a speculative basis without a contracted outlet.

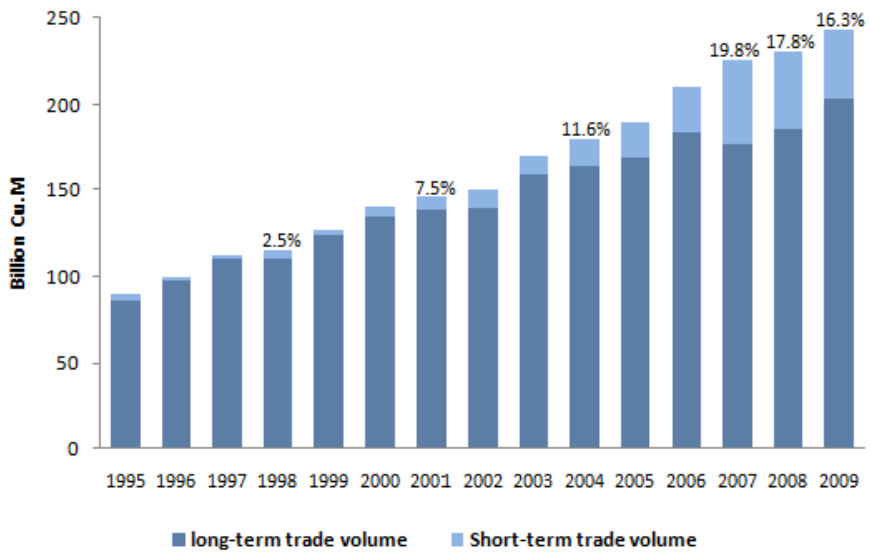


Figure 1: Evolution of LNG short-term trade
Source: Jensen (2009)

Nowadays, the LNG trade is taking place in three main trading bases, one covering the Asia/Pacific and the other the Atlantic (including the Mediterranean), while the Middle East, sitting between these two blocs, benefits from its geographical advantage of being able to trade with both markets.

The Asia/Pacific market is the largest and longer established of the three markets. The region has been dominated for some time by Japan, which imported 36% of all LNG traded in 2009, and 57% of Asia's imports. Second comes South Korea, with Taiwan and India forming a third layer of importers. China is a nascent presence that will soon become a major importer based on the new regasification capacities being built there. Exports in this market remain dominated by Indonesia and Malaysia, but Australia is not far behind having increased its exports significantly in 2009, by 19.4% over 2008. Long-contracts still influence this market especially on the export side, but South Korean and China, two major importers for spot cargo, take some volume from the Atlantic base.

The main consuming nations in the Atlantic market are in Western Europe and North America. Spain, the largest importer in Europe, accounted for 11.3% of all imports in 2009; France and the USA imported 5.3% each and the UK, the fastest growing importer in Europe, accounted for 4.4%. On the export side, Algeria is the largest producer in this market, with Trinidad and Tobago and Nigeria forming a second tier leaving Egypt a step behind. Equatorial Guinea only started operations in 2007 and is already the next largest exporter. In the Middle East, Qatar is by far the largest exporter in the world, exporting commodity to both Asia/Pacific and Atlantic markets accounting for 20.3% of all trade volume in 2009. Besides, Oman and Abu Dhabi are fast growing sellers in that region. It is notable that both Atlantic and the Middle East are more active in the short-term market where 90% of world spot volume flows out to the consuming markets.

3. LNG SHIPPING MARKET: A COMPARATIVE STUDY WITH CONTAINER

AND BULK MARKETS

3.1 The structure of the LNG shipping market

The LNG industry originally developed as a niche business where a relatively small number of sellers and buyers used a traditional approach with ships dedicated to bilateral trades for long-term contracts. Due to the large capital requirements of LNG projects together with the high risks involved, the market participants were limited to the so-called "super majors". Buyers were either government monopolies or franchised utility companies from OECD countries. Sellers were typically either major oil companies or national oil companies of producing countries. Hence, financial creditworthiness for the project was usually not an issue. In order to structure a risk sharing system among the participants, the long-term contract between buyer and seller was central to the project. The risk sharing logic was embodied in the phrase "the buyer takes the volume risk and the seller takes the price risk" Jensen (2004). Hence most contracts featured take-or-pay provisions to assure buyer offtake at some minimum level and a price escalation clause to transfer responsibility for energy price fluctuations to the seller. Although long-term contracts were common, the point of delivery might be either F.O.B or D.E.S, depending on which party assumed the tanker transportation responsibility. Tankers might be owned by either buyer or seller or independent shipowners, but traditionally were dedicated to a specific trade, usually for the life of the contract.

After the 1990s the buyers wanted more flexibility to their supplies because more parties saw the potential of LNG projects. As a result, LNG shipping became under the control of different parties. Therefore, LNG shipping moved away from a position where it is traded on specific routes to more flexible trades (spot trade is growing). Also buyers started to move upstream and participated in upstream activities such as shipping. Sellers also started to move along the chain, becoming minority owners in shipping as occasionally in regasification plants.

By far, as part of the global trend towards privatization of the energy markets, the transformations taking place in the LNG market are heavily influenced by deregulation and liberalization in both the upstream and downstream gas markets. Figure 2 indicates that the ongoing changes have recently resulted in more cooperation agreements and the setting up of creative consortiums between market players. Nowadays, it can be found that some independent shipowners cooperate with upstream gas sellers by investing in liquefaction projects (i.e. in 2004, Golar LNG had a corporation with the BG group). Some other shipping companies invest with downstream buyers in import terminals or even take over the role of refrigeration terminals by converting ships to floating gas production or regasification units Engelen & Dullaert (2010).

One of the most noticeable changes in the market structure (which has both contributed to and benefited from the new short term market place) has been the emergence of companies that invest throughout the LNG supply chain. There are an increasing number of firms who have a portfolio of liquefaction interests which they use to supply product to a portfolio of import terminals using vessels they control specifically for this purpose. Such group mainly includes a number of oil majors like Shell, BP, ExxonMobil, ConocoPhillips; utilities such

as BG, ENI and Osaka Gas; private companies like Mitsui and Statoil; and quasi-government companies like Sonatrach and Qatar Petroleum Clarkson (2010).

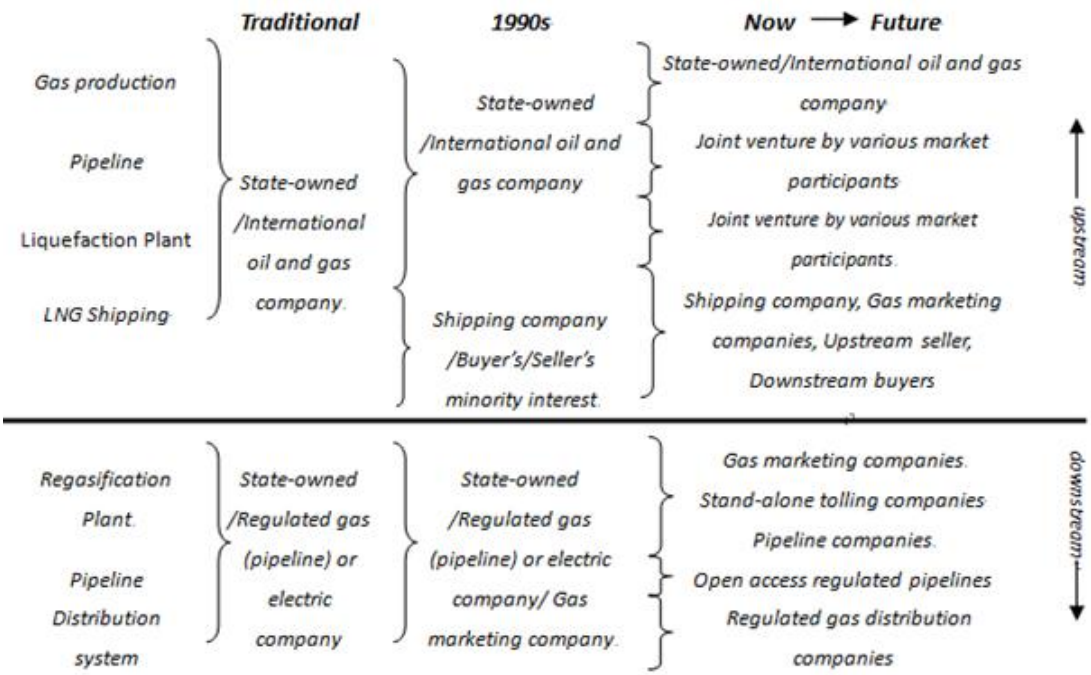


Figure 2: Evolution of the LNG market structure
Source: own representation based on Engelen & Dullaert (2010*)*

The market structure in LNG shipping only recently started to receive attention in academic literature. Jensen (2004) pointed out that, although long-term contracts in LNG have been the vehicle for sharing the large up-front investment risks that characterize LNG projects, the short-term trading is growing fast in recent years. The study also shows that declining costs of delivering LNG, the growing diversity of supply sources and a loosening of the traditional rigid industry structure have created a system which can transmit price signals freely between isolated regional gas systems, therefore arbitrage trade is developed. However, as the author noted, the increase of physical flows between regions does not imply a global market. Since the long term contract still remains a mainstay of international trade, the growth of short-term trade volume and price arbitration are limited accordingly. Thus, a LNG global market may well not live up to its expectations. Dorigoni et al. (2008) conclude that LNG shipping is intrinsically related to LNG sector dynamics, especially since the owners of tankers are companies controlled by gas producers and to a lesser extent by gas importers. This implies that long-term contracts are often used.
Gkonis and Psaraftis (2009) used a game theoretic approach to study competition in LNG shipping. The conclusions contain three key points for strategic decision-making by shipping lines. First, shipping companies must take into account the capacity each company supplies to the market. Second, the greater versatility and adaptability achieved by having smaller vessels in the fleet should be compared to the economies of scale advantages that a portfolio consisting of large scale vessels enjoys. Finally, non-cooperative collusion may exist in the LNG shipping business.

Engelen and Dullaert (2010) examined transformations in gas shipping aimed at understanding the features of the gas shipping market, distinct with other main merchant markets (dry, tanker and container markets). They demonstrate that the LNG shipping market is transforming and evolving to a more competitive setting. The operational efficiency in the LNG market can be increased significantly when sellers take a more thorough stance towards contracting tonnage on the back of product supply. More flexible contracts will be used in a market with more dispersed sellers and buyers.

3.2 Concentration measures

After discussing the evolution in the LNG shipping market in the last decades, the question is how the market structure exactly looks like in the LNG shipping industry and how the number and size of companies in the market is distributed. The number and size distribution of firms is a key element of market structure which reflects to some extent the nature of competition in the market concerned.

Concentration measures are the most widely used indicators of market structure. In this section, we use the most common measures for market concentration and aim to apply these measures to examine the market structure in the LNG shipping market in the next section. In our study we focus on one aspect of market structure, i.e. the concentration level of capacity control by shipowners. We thus look at the vessel supply side of the market, not the distribution of actual ship operators or the competition between these shipping lines. The shipowners' structure does not necessarily reflect the level of competition between shipping lines since various forms of chartering contracts make that shipowners are not necessarily the ship operators (see next section).

N-firm concentration ratio: measures the share of the industry's n largest firms in some measure of total industry size. The formula for the n-firm concentration ratio is as follows:

$$CR_n = \sum_{i=1}^{n} S_i$$

S_i is the share of the i-th largest firm in total industry sales, assets or employment. And n is the number of firms in the industry. There are no set rules for the choice of n, the number of large firms to be included in the calculation of CR_n. The most common concentration ratios are n=4 or 8, which means the four and the eight largest firms. Concentration ratios are usually used to show the extent of market control of the largest firms in the industry and to illustrate the degree to which an industry is oligopolistic.

For most practical purposed, both the choice of n and the choice of size measure may not be too crucial. For example, Bailey and Boyle (1971) find that n-firm concentration ratios for several values of n are highly correlated. In practice, an attractive property of the n-firm concentration ratio is that it requires size data on the top n firm only, together with the corresponding aggregate size measure for the entire industry. In other words, the data requirements are less demanding than for the other concentration measures. However, the use of data for the top n firms only is also a limitation, in the sense that no account is taken of the number and size distribution of firm that are outside the top n. Furthermore, no account is taken of the size distribution within the top n firms. It also does not provide a lot

of detail about competitiveness of the industry Lipczynski, et al (2009). The concentration ratios just provide a sign of the oligopolistic nature of an industry and indicate the degree of competition. The Herfindahl-Hirschamn (HH) index provides a more complete picture of industry concentration than does the concentration ratio.

Herfindahl-Hirschman (HH) index: Hirschman (1945;1950) both suggested a concentration measure based on the sum of the squared market shares of all firms in the industry. The HH index is calculated as follows:

$$HH = \sum_{i=1}^{N} S_i^2$$

S_i is the market share of firm i, and N is the total number of firms in the industry. The maximum value of HH=1 occurs when the size distribution of the N firms is highly skewed. In the most extreme case, one dominant firm has a market share only which means the industry consists of a singly monopoly producer. The minimum values of HH= 1/N occurs when the industry consists of n equal-size firms. In this case, each firm has a market share of S_i= 1/N[1]. A practical difficulty with the HH index is its requirement for individual size data on all of the industry's member firms. The HH index provides a greater degree of discrimination than the concentration ratio. As a result, when the two indicators offer differing signals the former one is likely to be more reliable.

There is also a normalized HH index (HH*) for comparison with different markets. Whereas the HH index ranges from 1/N to one, the normalized HH index ranges from 0 to 1. It is computed as:

$$HH^* = \frac{(HH - \frac{1}{N})}{1 - \frac{1}{N}}$$

Where N is the number of firms in the market, and HH is the usual HH Index, as above.

Lorenz curve and Gini coefficient: A Lorenz curve named after Lorenz (1905) shows a cumulative frequency curve that compares the distribution of a specific variable with the uniform distribution that represents equality. A diagonal line represents this equality distribution. The greater the deviation of the Lorenz curve from this line, the greater the inequality is Notteboom (2006). The Gini coefficient named after Corrado Gini (1912) is usually defined mathematically based on the Lorenz curve. The formula definition for the Gini coefficient is as follows:

$$G = \frac{\sum_{n=1}^{N} \sum_{i=i}^{n} X_i}{0.5\,(N+1) \sum_{i=1}^{N} X_i} \quad (X_i \text{ is the size of firm } i)$$

The Gini coefficient can range from 0 to 1. A low Gini coefficient indicates a more equal distribution, with 0 corresponding to complete equality, while higher Gini coefficient indicates more unequal distribution, with 1 corresponding to complete inequality. The Gini coefficient is the most common statistical measure of diversity or inequality which was initially developed to measure the degree of concentration/inequality in income distribution

[1] The United States Federal anti-trust authorities such as the Department of Justice and the Federal Trade Commission use the HH index as a screening tool to determine whether a proposed merger is likely to raise antitrust concerns. The Antitrust Division of the Department of Justice considers: HH index below 0.0100 indicates a highly competitive index; the index below 0.1000 indicates an unconcentrated index, and if it is between 0.1000 and 0.1800 to be moderately concentrated and above 0.1800 to be concentrated. As the market concentration increases, competition and efficiency decrease and the chances of collusion and monopoly increase.

(Kendall and Stuart 1969; Allison 1978). It is however quite common to use the Gini inequality index in studies on maritime industry especially on port system concentration. Fopr example, Ducruet et al. (2009) identified 34 academic studies on port concentration between 1963 and 2008.

3.3 Shipowners' concentration analysis: empirical results for the three shipping segments

This section uses the three measures above to examine shipowners' concentration and size distribution features in the LNG shipping market, compared with the container and bulk shipping sectors. The size measure we use relates to the ownership of transport capacity of each ship owner in each market. The analysis is based on an extensive database of Clarkson containing the situation for March 2011. There are 56 owners holding 363 tankers with 51.9m m^3 in total in the LNG market. The container market counts 622 owners possessing 4985 ships with a total capacity of 14.2m TEU. The dry bulk sector is crowded with 1608 owners having 8236 bulk carriers with 544.5m dwt. Table 1 provides an overview of the top 10 shipowners in each of the markets.

As discussed above, most of LNG fleet capacity is owned by oil and gas majors (see Table 1), and just a small part falls into independent shipping companies committed to long term contracts by life of the ship. There is nearly no speculative activity in this market. Thus, most of the owners are also operators. For these reasons, the ownership of tanker capacity can also be seen as a good indicator to examine the LNG shipping market concentration and thus the level of competition in the market. This is however not the case in the container and bulk markets where the vessel owner is not necessarily the vessel operator and thus the supplier of vessel services to the customer base. Hence, charter contracts (voyage, time and bareboat) are very common in the dry bulk market. Container shipping lines typically own less than half of the vessels they operate and charter in the remaining part (see Figure 3).

Table 1: Top 10 shipowners in the LNG, container and dry bulk markets (March 2011)

LNG Market			Container Market			Dry bulk Market		
Owner	Capacity (m^3)	%	Owner	Capacity (TEU)	%	Owner	Capacity (dwt)	%
1.QatarGas*	6,063,700	11.68%	1. Maersk#	1,108,171	7.77%	1.COSCO	24,856,543	4.56%
2.MISC(Petronas)*	3,675,877	7.08%	2. MSC#	862,520	6.05%	2.NYK	17,270,244	3.17%
3.NYK	3,252,181	6.26%	3. CMA CGM#	496,617	3.48%	3.MOL	14,983,942	2.75%
4.MOL	2,843,770	5.48%	4.Reederei C.P	484,293	3.40%	4.K-Line	13,260,510	2.44%
5.Teekay	2,362,0	4.55%	5.COSCO#	375,946	2.64%	5.Zodiac	7,312,05	1.34

	33						9	%
6.Shell*	2,094,015	4.03%	6.Evergreen#	342,300	2.40%	6.China shipping	7,029,706	1.29%
7.K-Line	2,027,231	3.91%	7.NSB N.	341,881	2.40%	7.Angelicousis	5,584,306	1.03%
8.BW Ltd*	1,918,287	3.70%	8.NVA N.	334,896	2.35%	8.Enterprises	5,339,800	0.98%
9.BG Group*	1,834,412	3.53%	9.Peter Dohle S.	329,722	2.31%	9 Hanjin shpg.	4,897,163	0.90%
10.Nigeria LNG*	1,743,009	3.36%	10.Hapag-Lloyd#	325,309	2.28%	10.HOSCO	4,756,580	0.87%
Total	27,814,515	53.58%		5,001,655	35.08%		105,290,853	19.3%
Market total	51,910,768	100%		14,257,291	100%		544,567,433	100%

(* indicated as a oil and gas major; # indicated as a shipping line)
Source: own compilation based on Clarkson data

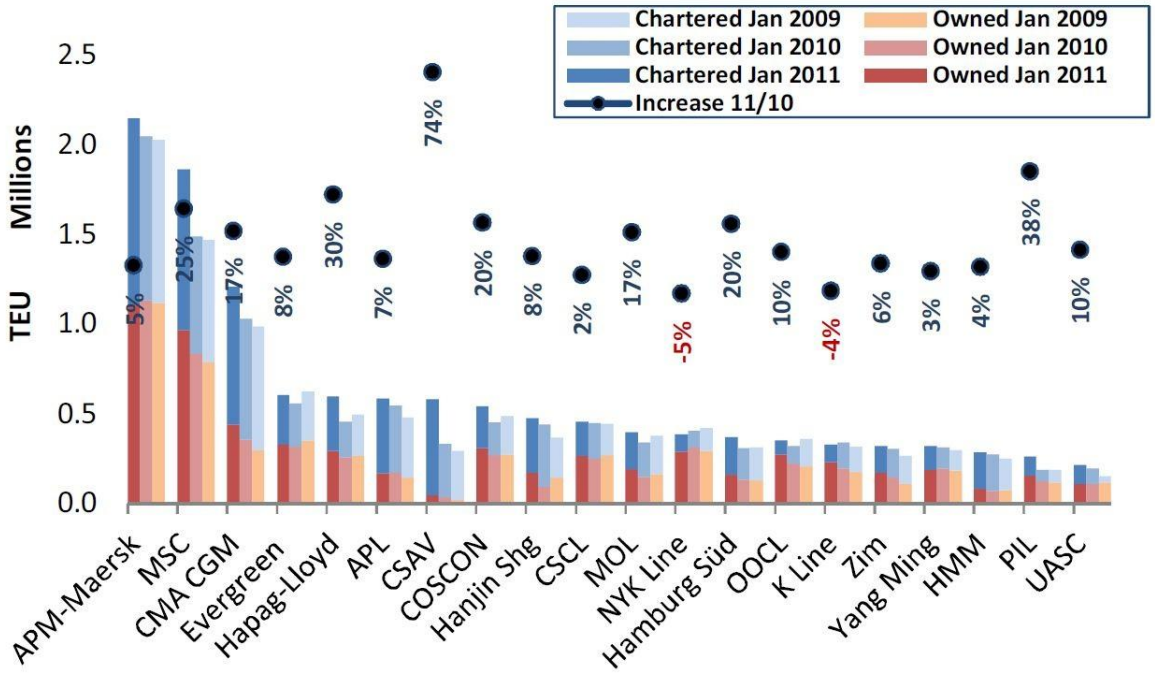


Figure 3: Chartered and owned vessel capacity (in TEU) in container shipping
Source: based on data Alphaliner Weekly Newsletter, 2011, Issue 1

Table 2 lists all the empirical results by applying three concentration measures for three shipping markets. For the n-firm concentration ratio, we take the most widely used n=4 and n=8 to test the cumulative market share of transport capacity owned by the largest four and

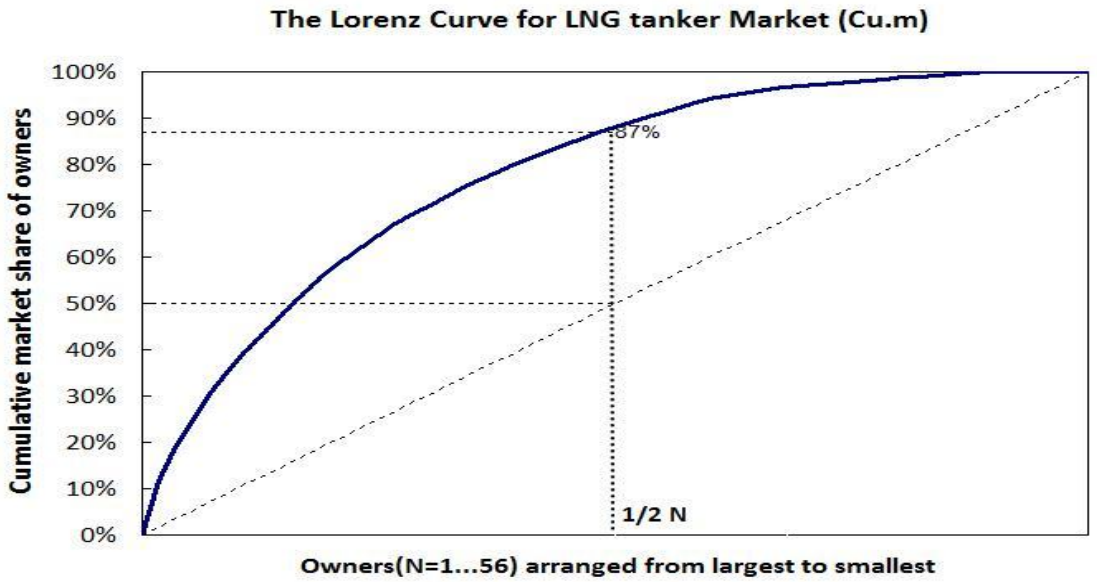
eight shipowners in each market. The unit of transport capacity for each ship is cubic meter (Cu.M or m^3) for LNG tankers, TEU for containerships and deadweight tonnage (DWT) for

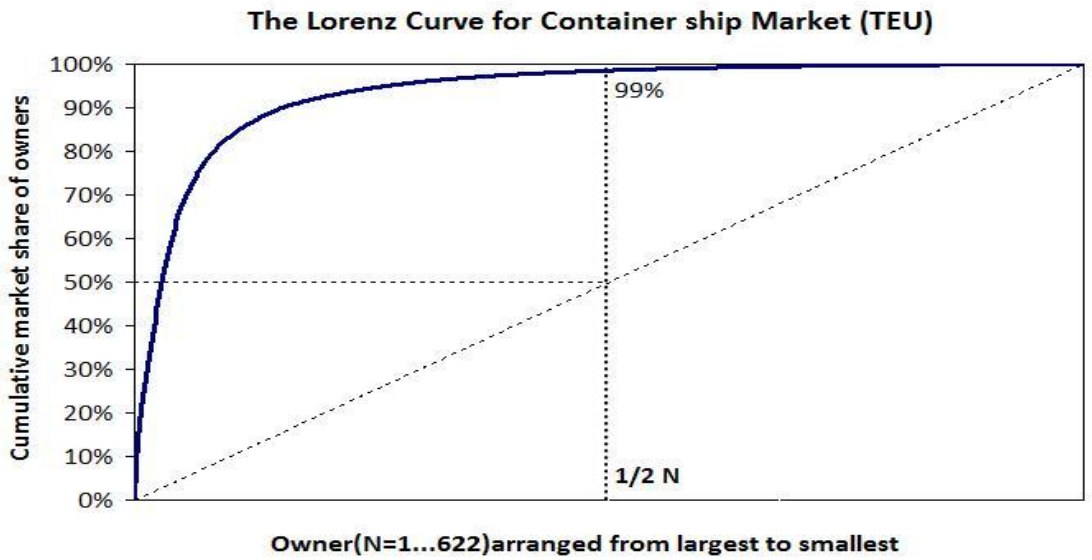
Market segments:	LNG tanker (Cu.M)	Containership (TEU)	Bulker (DWT)
n-firm concentration ratio			
CR_4	0.3051	0.2070	0.1292
CR_8	0.4669	0.3049	0.1756
Herfindahl-Hirschman (HH) Index			
HH	0.0426	0.0220	0.0071
HH*	0.0252	0.0204	0.0065
Gini Coefficient	0.5488	0.8713	0.7361

bulk carriers. Comparing the CR_4 and CR_8 results in the three markets, it can be concluded that the LNG shipping market is more concentrated than the container and bulk segments. However, the concentration ratio cannot take account of the number and size distribution of owners that are outside the top n and also the size distribution within the top n owners. Hence, the concentration ratio cannot provide an accurate picture about the shipowners' structure in the three markets.

Table 2: Empirical concentration results for the three shipping segments (March 2011)
Source: own representation based on Clarkson data

The market size and the number of total shipowners in the three markets are different. To make it comparable, the HH indexes have to be converted into the normalized HH index (HH*) with a range of value from 0 to 1. It is notable that the LNG market is still slightly more concentrated than the container and bulk markets.
As shown by the Gini coefficients, the LNG tanker market is more equal than the bulk and containership markets. The Lorenz curves for these three markets (Figure 4) clearly illustrate the degree of inequality of owner size in the three markets. The greater the deviation of the Lorenz curve from the diagonal line, the greater the inequality is. Thus, the container ship market has the highest degree of inequality followed by bulk market and the LNG tanker market. The scatter plots (Figure 5) show the size distribution of each owner in the three markets by average size and number of vessels. The average capacity of most LNG tanker owners is intensive within the range of 130,000-150,000m^3. In contrast, the size of containership owners is more diversified with large owners having more and bigger size of ships. The bulk market is characterized by many small owners.


The Lorenz Curve for LNG tanker Market (Cu.m)
Cumulative market share of owners
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
87%
1/2 N
Owners(N=1...56) arranged from largest to smallest


The Lorenz Curve for Container ship Market (TEU)
Cumulative market share of owners
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
99%
1/2 N
Owner(N=1...622)arranged from largest to smallest

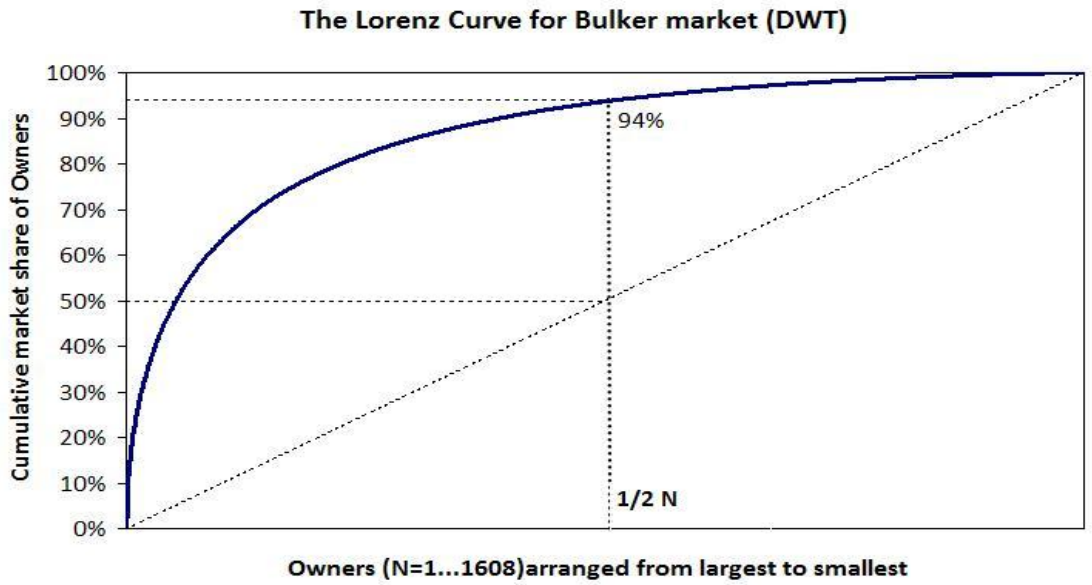
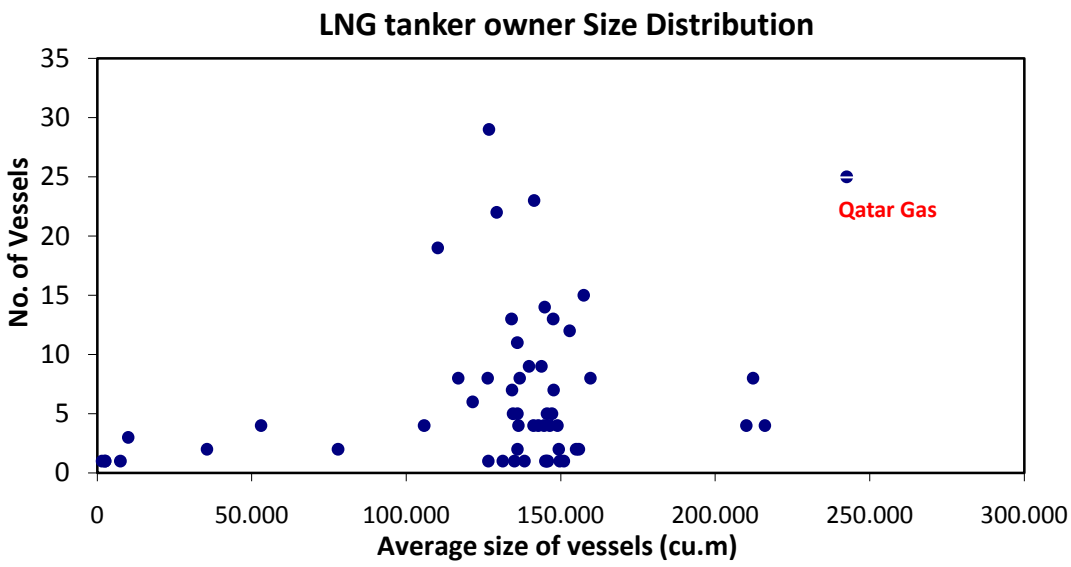
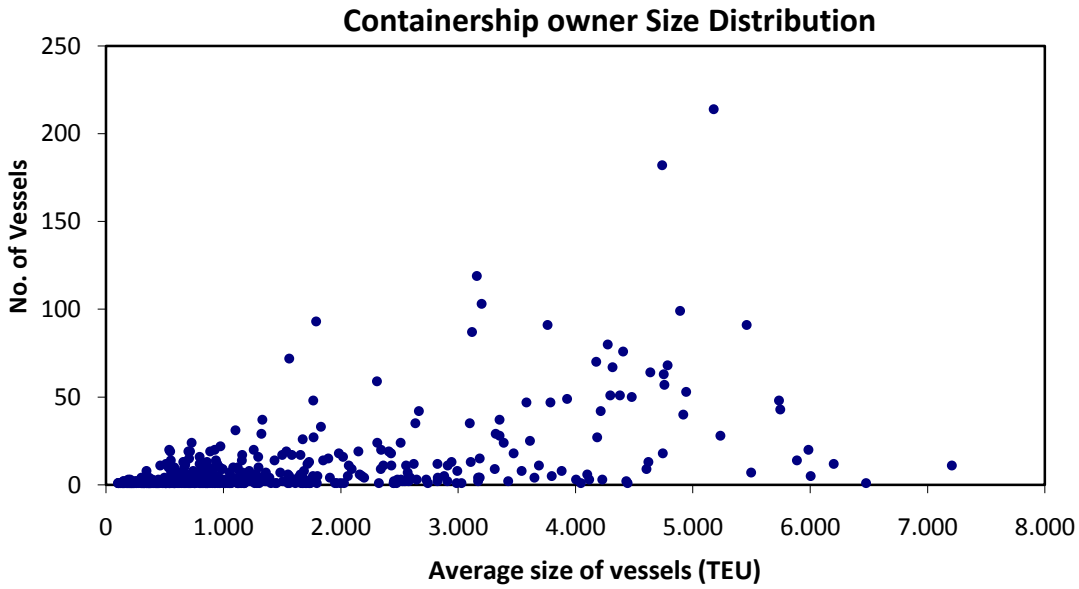

The Lorenz Curve for Bulker market (DWT)
Cumulative market share of Owners
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
94%
1/2 N
Owners (N=1...1608)arranged from largest to smallest

Figure 3: The Lorenz Curve for three markets (based on date for March 2011)
Source: own representation based on Clarkson data


LNG tanker owner Size Distribution
No. of Vessels
35
30
25
20
15
10
5
0
Qatar Gas
0
50.000
100.000
150.000
200.000
250.000
300.000
Average size of vessels (cu.m)


Containership owner Size Distribution
No. of Vessels
250
200
150
100
50
0
0
1.000
2.000
3.000
4.000
5.000
6.000
7.000
8.000
Average size of vessels (TEU)

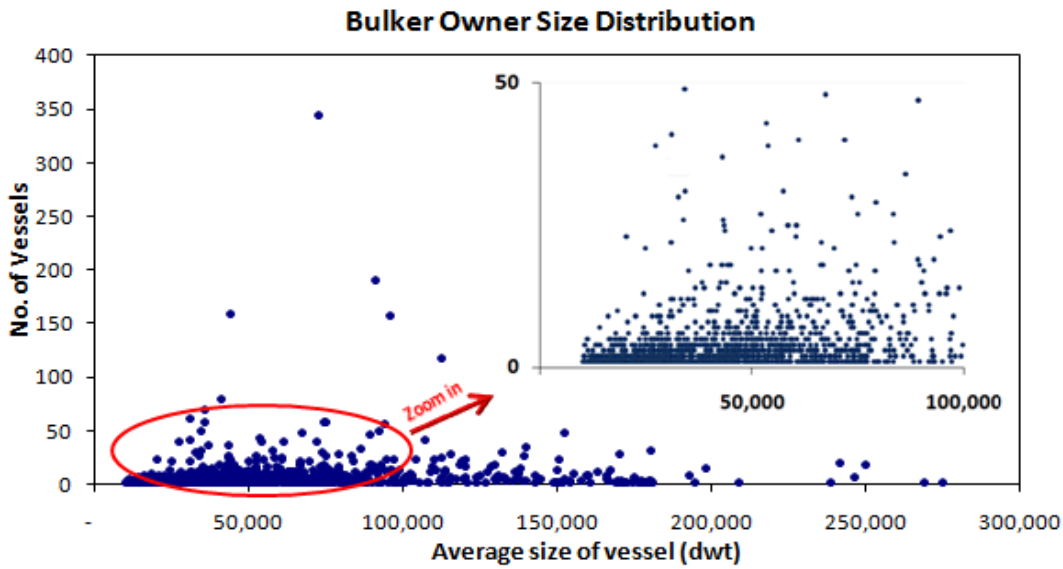

Bulker Owner Size Distribution
No. of Vessels
400
350
300
250
200
150
100
50
0
50
0
50,000
100,000
Zoom in
-
50,000
100,000
150,000
200,000
250,000
300,000
Average size of vessel (dwt)

Figure 4: Owner size distribution in three markets (based on date for March 2011)
Source: own representation based on Clarkson data

Through the analysis of market concentration in the three markets, some notes can be made on the characteristics of the LNG shipping market:

- The LNG shipping market is a rather small market compared to the container and bulk market segments.

- The LNG shipping market is more concentrated than the container and bulk shipping sectors in terms of distribution of transport capacity among the owners. It was noted that in the container market some shipowners chart out vessels to liner service providers who are actual ship operators, and many asset players do speculative activities by selling and purchasing ships in the bulk sector. Thus, the ownership of a vessel as size measure might not be an accurate indicator to examine the shipping market structure in these two segments. Nevertheless it is estimated that the container shipping market is more concentrated if one takes into account alliances, consortia, or discussion agreements where liner shipping companies share vessels and schedules. But for the bulk sector, many small and individual shipping companies offer identical services transporting raw materials over the world. The market is rather competitive.

- The LNG shipping market is less unequally distributed than the container and bulk markets as shown by Lorenz curves. This seems surprising given the higher concentration level in the LNG market as shown by the normalized HH index. The reason for this seeming contradiction between concentration levels and inequality levels can be examined by using Figure 5 that illustrates the distribution among owners by average ship size and number of ships owned. It can be concluded that in the LNG market, the fleet size of the owners is mostly determined by the number of ships not the ship size (most common average ship size is 130,000-150,000m^3), except for Qatar gas who is the only LNG tanker owner possessing the largest tankers at this moment. In contrast, the container market is filled with some large shipowners (many of which also act as shipping lines, see Table 1 earlier) who hold a huge vessel capacity both in number and size of the vessels. At the others side of the market there are a large number of small shipowners who typically own smaller vessels. A similar situation can be found in the bulk market.

4. LNG FLEET DEVELOPMENT

The development of the LNG fleet is in line with the growth of LNG trade. The 1980s were a bleak period for the LNG business, characterized by high energy prices and a collapse in demand for natural gas, when interest in LNG projects including the ships to transport it was minimal. The revival in demand for gas in the 1990s brought a lot of new projects, with accompanying ship orders promoting a second period of steady fleet growth until the early years of the 21st century. The glut of new projects that were approved at that time sent the order book spiraling. In the period 2000-2003 around 20 vessels a year were ordered at a cost of in excess of $12 billion, but 2004 was when things really took off. That year a record

70 ships were ordered with a contract value of $23.0 billion.

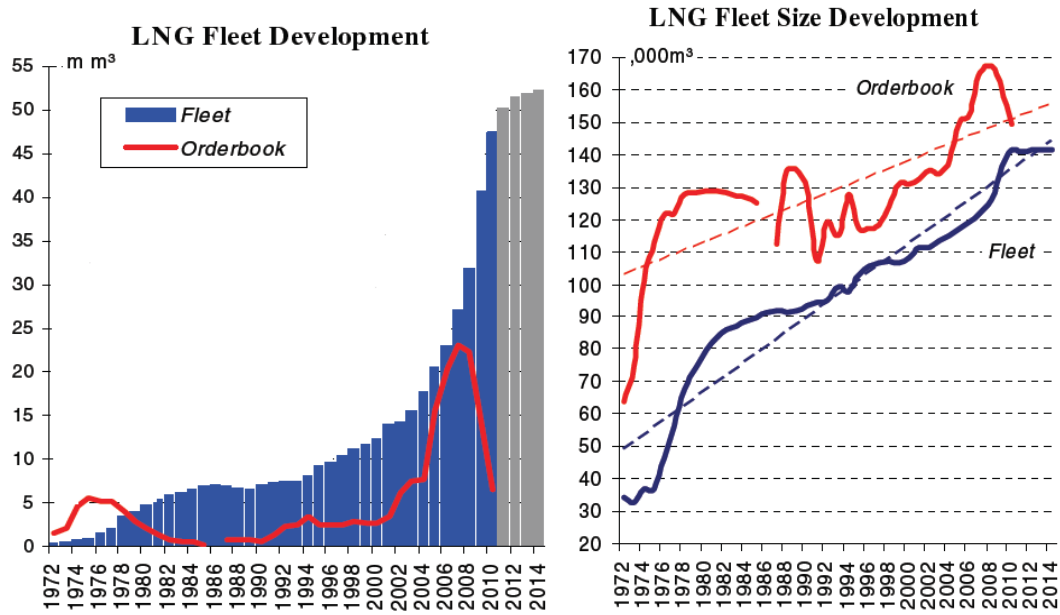


Figure 6: World LNG fleet development and forecast
Source: Clarkson data 2010

However, the LNG fleet appears about to resume a period of unspectacular growth in the wake of the economic crisis in 2009. According to research by Platou, the supply of LNG shipping capacity has outweighed demand during the last three years, resulting in fewer new tankers being ordered with a current order book (now reducing as deliveries outnumber orders) of 33 vessels of 4.7m m^3, just 9.5% of the current fleet by carrying capacity. So far the fleet has increased to 363 vessels of 51.9m m^3. The remaining order book is due to be delivered over the next few years and assuming no scrapping, this will mean a fleet of at least 384 vessels with a capacity of 54.5m m^3 by 2014.

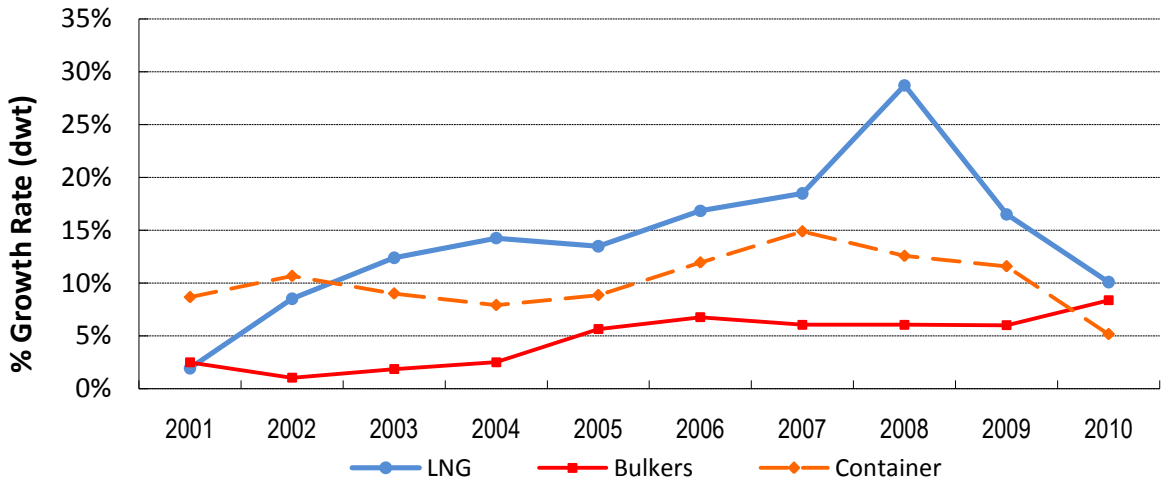
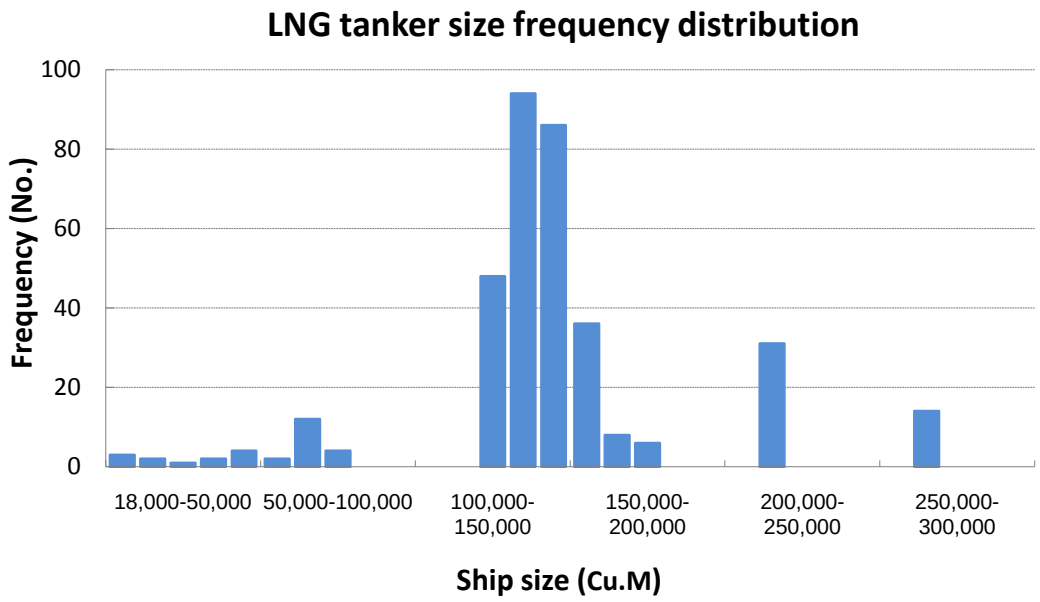
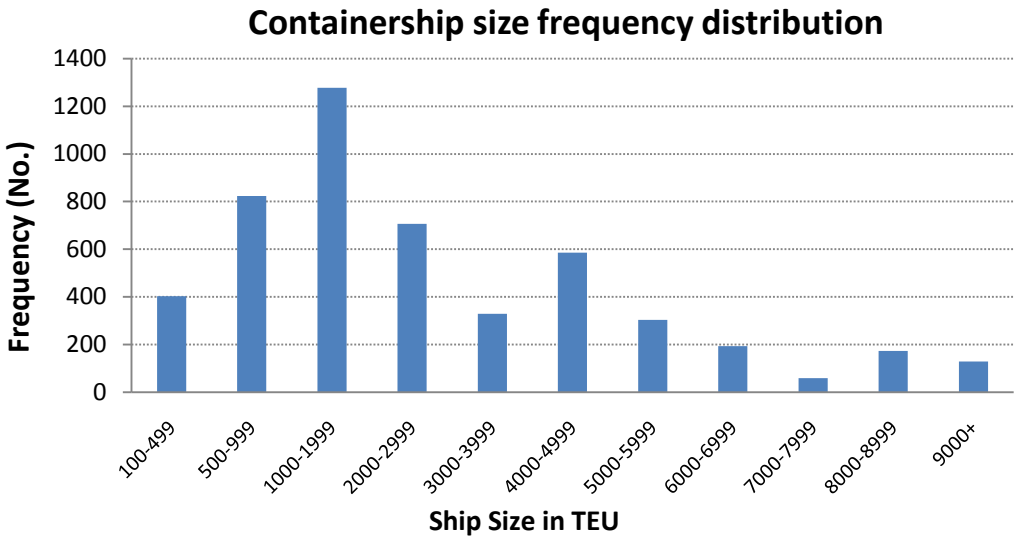


Figure 7: Growth rate of LNG tanker VS. Containership, Bulk carrier
Source: own elaboration based on Clarkson data

The "traditional" LNG vessel, as built between the early 1960s to the start of 2000, could be grouped into one of three size ranges. The first category contains the small carriers of between 25-50,000m^3 which were used for short range trades, especially in the Mediterranean. Vessels between 120-138,000m^3 were in the larger sized class. In 2002 the first 140,000m^3 vessel was delivered in what can be seen as the initial step of the change in the LNG fleet. However it was not until 2006 when a 150,000m^3 vessel entered the fleet. In 2008 vessels of up to 165,000m^3 were delivered. However, the changes to the fleet have not just been a simple up-scaling.

There are now a significant number of so called "Q-Flex" (210-217,000m^3) and "Q-Max" (260-270,000m^3) vessels operating in the fleet. These vessels were initially designed to service new projects in Qatar (owned by Qatar Gas). The first of the "Q-Flex" vessels was delivered in late 2007, and the first "Q-Max" vessel a year later in October 2008. By now there are 13 Q-Max vessels and 31 Q-Flex in the LNG fleet. 2010 has seen the first vessels in the 170-180,000 m^3 range delivered, narrowing the gap between the larger of the more traditional vessels and the new Qatari designs. With delivery of larger tankers, the average size of the LNG fleet has been growing from 112,649 m^3 in 1998 to 136,367 m^3 in 2008 and up to 142,092 m^3 in 2010.





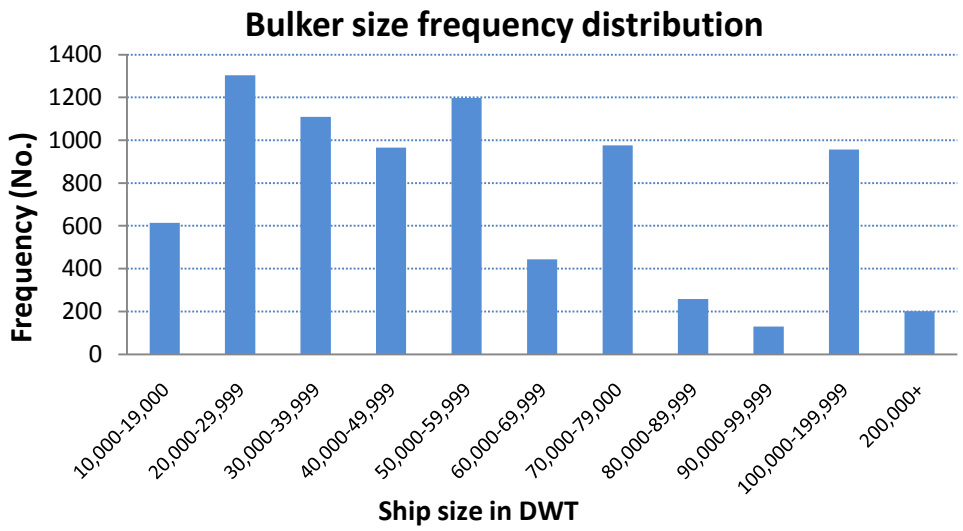


Figure 8: Ship size distribution in the three market segments
Source: own elaboration based on Clarkson data

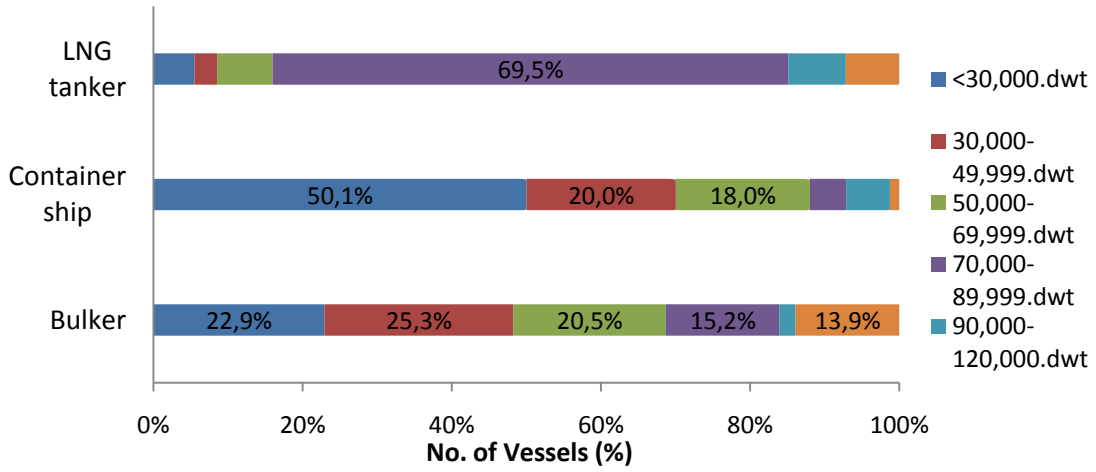


Figure 9: Comparison of ship size distribution in the three markets (in dwt)

Source: own elaboration based on Clarkson data

With respect to ship size distribution in the LNG fleet, we can observe a high concentration within one range of size (130,000-150,000m^3), corresponding to 70,000-89,999 dwt in Figure 9 which accounts for 69.9% of the whole fleet. However, the container and bulk fleet diversify their ship size from different classes catering for different routes and trade flows. In the liner shipping sector, large container vessels are deployed between hub ports and smaller ships are deployed on secondary trades and feeder services. Different parcel sizes in dry bulk also determine the ship sizes in bulk shipping.

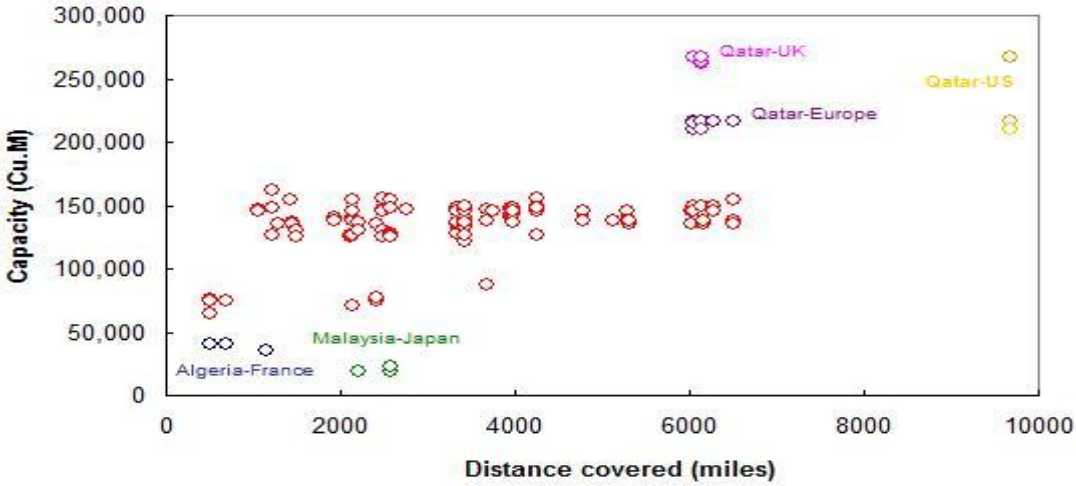


Figure 10: LNG tanker size and distance covered
Source: own elaboration based on data of World LNG Journal (Aug, 2010)

The distribution of ship size by sailing distance of LNG fleet is presented in Figure 10. There are still some small ships operational on regional trades, e.g. Algeria-France (515 miles) and Malaysia-Japan (2208 miles). However, the most common vessel size (130,000-150,000m^3) is deployed on a wide distance range from 1500 miles to 6000 miles, some serving regional and others cross-regional trades (e.g. Qatar to Japan - 12 ships and Korea - 8 ships). The newest classes of large ships, Q-Flex and Q-Max, are deployed on the routes between Qatar and Europe/US. Qatar has become the biggest LNG exporter in the world despite its location far away from the markets: the average distance to Europe amounts to 5,737 miles, Japan is 6,508 miles away and the US 9,680 miles. Qatar Gas uses large ships to reduce unit transport costs and to keep its competitive position.

5. CONCLUSIONS

Natural gas is becoming more important as a clean energy source. LNG shipping can be economically operated on medium and long distances. Cost reductions in all segments of the LNG supply chains and a changing world geography in LNG trade have triggered a lot of new investments in LNG shipping. LNG shipping was initially based on dedicated

long-term contracts and regionally based trade flows. Such limited fluidity leads to an immature market. However the emergence of the short-term/spot trade and the liberalization of the gas market made LNG shipping a most promising area in the shipping industry. The focus in this paper was on the unique features of the LNG shipping market in terms of its vessel ownership structure and fleet development compared to the container and bulk markets. The main conclusions of our analysis are as follows:

- LNG shipping is highly interlinked with LNG projects which normally commit for a long term planning (20 years or more). Tankers are mostly purpose-built for special projects and trades dedicated to the life of the contract. Despite the growth of the short-term trade in recent years, long-term contracts will continue to be dominant as project investors have to secure their return on investment for the capital intensive facilities. The strong link between LNG projects and LNG shipping is unique for this market. In the container and bulk markets, ships are not built to serve cargo flows related to specific projects. Instead, vessels are built and bought/sold following more general market dynamics and influenced by an overall market sentiment.

- The LNG shipping market structure initially was characterized by an oligopoly formed by a few large state-controlled or regulated oil and gas companies and a few independent shipowners. The liberalization trends in both the upstream and downstream gas markets resulted in the emergence of more independent shipping companies who cooperate with upstream gas sellers in liquefaction projects or with downstream buyers in import terminals. Contrary to the container and bulk markets where vessel chartering is widely spread, the shipowners in the LNG market typically also act as ship operator.

- The LNG shipping market is a rather small market compared to the container and bulk market segments where there are a small number of owners with relative small transport capacity. The LNG market is more concentrated in terms of vessel ownership than the container and bulk shipping sectors (examined by concentration ratio, HH index). But, according to the Gini coefficients and Lorenz curves, the LNG shipping market is less unequally distributed than the container and bulk markets. The reason for this rather interesting combination of higher concentration and lower inequality is that the average tanker size is centralized in the range of 130,000-150,000m^3, which cannot make large players heavily weigh their market share. However, the container and bulk markets are filled with some large companies holding huge capacities both in number and vessel size and many smaller companies with smaller vessel sizes.

- The LNG fleet keeps growing in recent years both in numbers and ship size. Especially with the delivery of large tankers from Qatar gas (Q-Flex, Q-Max), the average size is now reaching 142,092m^3. However, the most common vessel size (i.e. the range of 130,000-150,000m^3, which used to be represented as a LNG project standard constitutes 69.5% of the fleet. In the container and bulk sectors, ship sizes are diversified by trading routes, parcel size and trade flow.

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