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«VALUATION OF SHIPPING COMPANIES LISTED ON STOCK EXCHANGE MARKETS »

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Abstract

The aim of this dissertation is to analyse, examine and provide useful conclusions related to the efficiency of shipping companies with a use Data Envelopment Analysis as well as Liquidity Ratio. In this study fifthy worldwide, leading, different-sized and listed on international stock exchange markets shipping companies were involved.

For this purpose, two models were used in DEA analysis, which examined the relative efficiency in terms of revenues having as inputs the total assets and operating cost and as output the total costs as well as the relative efficiency in terms of profitability having as inputs the vessels value and their operating cost and as output the gross profit. The analysis was conducted between 2011 and 2014. From this analysis, it can be observed that in both models the shipping companies are efficient in general but that there is also space to improve further their efficiency and to reduce costs so that they can become more productive. Also, the results of two models show a considerable convergence and can be reliable.

Regarding Liquidity Ratio, it was divided into current ratio and quick ratio and the variables used were current asset, current liabilities and inventories. Useful conclusions were drawn from this analysis having to do with the types, size and nature of the companies in terms of their efficiency.

Overall, it can be said that from both analyses Data Envelopment Analysis (DEA) and Liquidity Ratio fruitful outcomes were produced which showed that both these methods are very useful and can contribute the most to improve efficiency in shipping companies as well as in other sectors of maritime industry.

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Chapter 1

Introduction

It is undeniable the fact that the world economy has been suffering due to the global recession. Although commercial companies are in decline because of the economic crisis and the tough competition they have to deal with, they have to accept the challenge and try to improve their efficiency and productivity even further.

It is important to mention that with the term efficiency in a company, we do not refer only to its economic profit but to a broader spectrum deriving from it. More analytically, improvement in efficiency also means improvement in the time of producing a good or a service. Furthermore, efficiency is inextricably linked to quality. In other words, every decision that affects the operation of a business also affects the efficiency of the firm. Finally, the increase in the efficiency of a firm has a direct result in the increase of its profits.

More specifically, in the maritime industry in which we are going to focus our interest in this paper, there is even tougher competition than in any other typical industry as it operates worldwide. Furthermore, the maritime industry is one of the first industries that have suffered more intensively from the global crisis. With the word crisis we do not refer only to the economic crisis. Two main examples of crisis that had a severe impact on the maritime industry are firstly, the economic crisis in 2008 and secondly to what extent the oil crisis is related to maritime.

As it was mentioned before, in a broader sense, improvement in efficiency leads to profitability and growth. It is extremely important to underline that the development of a maritime company and the improvement of its efficiency not only brings in income to it but also to other related industries. In a maritime firm, the main factors that influence its efficiency are the fleet and the ports that visit. Thus, it can be easily understood that there is a strong relation between fleet and ports.

Previously, we pointed out the significance of efficiency in a company. However, in order to improve efficiency we should check first how to evaluate it. One widely accepted method of evaluating efficiency is Data Envelopment Analysis (DEA)

DEA has been used in the last decades in a great number of different industries with success. One of these industries is the maritime one. Maritime firms, as they face challenging competition, are forced indirectly to improve their efficiency continuously. By using updated data this paper has as a goal to analyse the efficiency of maritime industry.

The second chapter introduces the term of efficiency in a company generally and more specifically in the maritime industry. The third chapter introduces and analyses the Data Envelopment Analysis method. The fourth chapter show the data that we collected from the fifty leading maritime companies worldwide. The fifth chapter display the results of the DEA method for the fifty biggest maritime companies worldwide. The sixth chapter presents the methodology of Data Envelopment Analysis. In the seventh chapter, liquidity ratio is presented as well as its use in the companies' comparison in terms of their financial status. In the eight chapter conclusions drawn from the use of DEA method an Liquidity Ratio are presented.

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Chapter 2

EXPENSES, INCOME AND EFFICIENCY IN MARITIME

2.1 Introduction

Cost reduction and efficiency improvement are of vital importance for the profitability in the maritime industry not only as a whole but also for every shipping company separately. The need to reduce expenses together with the improvement in efficiency has led shipping companies to the designing of new vessels as well as new transportation systems to meet the modern needs of it and to offer better productivity.

In maritime, there are three main types of transportation a) dry cargo b) wet cargo and c) commercial container cargo. The development in transportation in of solid and liquid cargo is mainly attributed to cost reduction, which is associated with the full loading of the vessel and the exploitation of its financial scale. Similarly, the development in commercial packaging transportation is due to the improvement in efficiency in combined transportation. The operation of freight market affects the operational costs and efficiency both in general terms and every company itself. For instance, the companies transferring solid and liquid cargo operate in the charter market, where there is the perfect competition, while the companies transferring commercial packaging cargo in the liner market, where the operation cartel exists as well as monopoly conditions.

The factors that theoretically affect both the cost and efficiency in maritime are analyzed in this chapter. In the second unit examines the operational cost and income of a maritime company and its fleet and how they are connected with the improvement of its efficiency. In the third unit of this chapter, the types of various freight/cargo markets, their contracts, the main types vessels and all this affects efficiency are analyzed.

2.2 Costs, financing, and operational expenses in maritime

Efficiency in maritime and in particular from the operational viewpoint on behalf of maritime companies is dealt with two main ways: operational efficiency and technical efficiency. The former concerns the maximum possible exploitation of a maritime company's fleet, which can be achieved through an efficient and long-term plan as well as the correct prediction of the needs of maritime markets in future. More specifically, one method to achieve this is the emphasis given on particular vessels like liners, commercial cargo ships or even cargo ships transferring chemicals, vehicles etc.

The emphasis put on a particular type of vessel provides the maritime company the opportunity to focus better on the specific line of maritime so as to manage its fleet in a more efficient way and to achieve reduction in costs and increase in its profits. Besides, a number of companies have started using smaller, more flexible vessels equipped with new technology loading/unloading methods, which can have access to more ports resulting in the increase of their profits.

Finally, effective productivity has to do with the optimal programming of the fleets, where the equivalent freight market and charter agreement allow and which can be achieved though various ways like the decrease in the number of ships voyages, particularly those without cargo as well as securing types of contracts to benefit the scheduled fleets.

Technical efficiency has mainly to do with the mechanical improvement of ships. This can be achieved through the construction of vessels following particular specifications with optimal hydrodynamic features and with engines performing the best consumption as well as with the daily maintenance of ships. The desired goal is vessels to have lower operational costs and the most efficient technological exploitation.

It is apparent that the two aforementioned approaches have as an ultimate objective to maximize the financial performance, in other words, the best exploitation of sources to bring profits. More specifically, because of maritime nature to fluctuate between profitable periods of time and recession, shipping companies have to take advantage of the former so as to be able to operate

smoothly in difficult financial times. Productivity in combination with the company's management, fleet exploitation and capital management are the ultimate goals for every shipping company.

The required financial performance of a company can be achieved through three variables: its operational cost, its income from its fleet freight and its funding.

2.2.1 Shipping companies' revenues

As for a shipping company's revenues, it is something that cannot be clearly estimated as the freight charge is defined by the local markets and as a result, the revenue cannot be controlled by the management department. The only thing that can be checked upon is the efficient programming of a fleet's performance since as it was mentioned before there are different choices of time-charter or voyage-spot charter). What must be secured in this case is the fleet utilization rate (the proportion of the number of days the ships are freighted per year), in other words the fleet should be freighted as many days as possible. Finally, to secure some income so as to face dangerous circumstances in times of insecurity, there are maritime derivatives which help shipping companies to put in practice the so called 'hedging'.

2.2.2 Funding and capital cost of shipping companies.

Regarding the funding of a shipping company, this should be based on various forms mainly on loan or own funds. Depending on the financial conditions both ways could be proved effective for the company. The term capital cost has to do with the repayment either with installments or with other ways of the remaining capital used for a ship's purchase.

Taking into consideration all the above, it can be mentioned that all these factors in combination with an economic crisis can seriously affect the operational costs of a shipping company to a great extent. To conclude, it can be inferred that in order to achieve the maximum required financial outcome as well as the optimal efficiency of a shipping company the key to success is the reduction in operational costs.

2.2.3 Operational costs of shipping companies.

The financial outcome and the efficiency of a shipping company depend to a great extent on the reduction of its operational costs. To be more specific, it must be stated that according to Stopford there are five types of operational costs: Operating costs, having to do with the daily fleet operation e.g. maintenance, wages, spare parts etc. Periodic maintenance costs, referring to maintenance costs while ships' inspection and they could be considerably high for old ships. Voyage costs, these include a voyage costs e.g. fuels, port and channel charges. Capital costs, e.g. installments, interest rates a company has to pay. Cargo handling costs, they have to do with loading-unloading, packaging in the hulls of a ship and sometimes could be considerably high especially in container ships.

It is also worth mentioning as the ship is getting older the proportion of costs changes since on the one hand the initial capital is being repaid but on the other hand there is an increase in maintenance, operation and travelling expenses. Besides, the more the size of a ship increases, the more its total costs per ton DWT decrease.

The operational costs of a ship constitute 25% of its total costs and they consist of the following: Crew's wages and their expenses, which depend on the ship's size, number of crew and the legislation of the country the ship belongs to. Besides, they depend on spare parts, supplies like engine's oil, maintenance cost of machinery and equipment. Insurance cost also constitutes a type of operational cost and it is divided into Hull & Machinery Insurance and Protection & Indemnity Insurance. Finally, ship's management costs and other similar expenses are included in the operational costs.

In periodical maintenance costs are included the costs for regular surveys by the register the ship is registered so that its seaworthiness can be evaluated. There are annual surveys, intermediate surveys and special ones. They include ship's docking every two years, analytical checking of all its machinery and repair. These types of costs depend on ship's age and how good the regular maintenance is.

As for the voyage costs, they constitute almost 50% of the total costs, and their higher proportion has to do with fuels of the main engine and electro motors. Reduction can be achieved through decrease in speed service but also with the use of environmentally –friendly new technologies in a ship's engine. The port charges depend on a ship's size or on the cargo loaded and the channel charges (e.g. Panama or Suez) are also voyage costs.

Cargo handling costs especially for the ships that do not have their own cargo handling means are divided into loading and unloading costs and they can be reduced with the better design of a ship so as to facilitate these procedures.

2.3 Other factors affecting efficiency

It is common knowledge that the efficiency of a shipping company is affected by both internal factors and company's decisions as well as other external factors which function independently. Some of these factors are the type of maritime market under which the fleet operates and the agreement on freight charges the company comes to. As it has been already mentioned both the type and the size of a fleet's ships also affect the operational costs. Consequently, it is important to analyze these various factors so that we can have a clear picture of their impact on a shipping company's efficiency.

2.3.1 Freight Markets

From the financial standpoint, the freight market is divided into two broad categories: freight charter and freight liner. In the former category, ships operate without having to follow a particular scheduled voyage between specific ports but they are consigned after agreeing on equivalent contracts, freight-contracts, agreed between the ship owner and consignor so as they could travel everywhere and whenever they want to. Freight charter functions as a medium of a perfect competition as the transferring ability from ship owners to consignors as well as the equivalent freight charges cannot be affected neither by ship owners nor by charterers, nor can ship owners or charterers be organized so that they can apply

their own policy. Thus, freight charges keep fluctuating and are determined according to the demand and supply of the transferring ability a company offers.

On the contrary, fleets in freight liner operate under regular, scheduled voyages, on specific dates and freight charges. Under these circumstances, there is no pure and free competition among shipping companies in this situation as shipping companies themselves create a regime of monopoly by determining and controlling freight charges. In the freight liner, shipping companies operate with fleets carrying commercial cargo in contrast to other companies carrying solid and liquid cargo which operate mainly in the charter market. Furthermore, freight in the liner market goes straight to the consumer either as a whole or in small units with its final price fixed. Cargo is consisted of different types of products and consigned by different merchants. Unlike, in liner market, cargo is consisted by uniformly loaded amounts of the same product (solid or liquid), of a low special value, and which need further processing before being promoted to the customer.

2.3.2 Types of charters and contracts

The main types of charters are: voyage charter, time charter, bareboat charter and contract of affreightment. Depending on the season and the circumstances one type of a charter might be more profitable than another one and vice-versa.

In a voyage charter, the ship owner undertakes the responsibility for carrying a particular consignment after coming to an agreement with the charterer from port A to port B in the time given. Freight is the amount of loading to be carried calculated in dollar/ per ton of load, the ship owner is in charge of the ship's operational cost except for loading/unloading costs. When the consignment is operated within a short time is called express and the freight is called spot-freight.

In a voyage charter, the charterer leases the ship for a specific period of time. The ship owner continues to have the management of the ship (crew management, maintenance etc.) however, the charterer is responsible for the operational command of the ship as well as the operational costs. The freight charge is calculated in dollar/ ton DWT/ per month.

Bareboat charter is a subcategory of time charter. In this case the ship owner gives the ship 'bare' to the charterer who undertakes all the obligations and responsibilities having to do with the ship operation e.g. crew, maintenance etc. The ship owner deals only with insurance matters. This type of charter has to do with longer periods of time and the freight charge is lower.

In contract of affreighment, the ship owner is obliged to fulfill the charterer needs for carrying particular amounts of goods within a given time to specific ports. The ship owner can use his own fleet or to charter ships of other companies to fulfill his obligations and the calculation of the freight cost is dependent on the carried load.

2.3.3 Types and sizes of ships

The main types of ships used in maritime nowadays are dry bulk carriers, tankers and containerships.

Dry bulk carriers with carrying capacity from 10,000 to 35,000 tones DWT are called 'handysize', those from 35,000 to 50,000 tons DWT are called 'handymax' and the ones from 50,000 to 80,000 tons DWT 'panamax'. What is more, these types of bulk carriers have the maximum –allowed size so that they can go through Panama channel when they are loaded. Finally, ships with carrying capacity of over 80,000 tons are called 'capesize'. The only exception comes from dry bulk carriers with carrying capacity of 82,000 tons DWT and such sizes that allow them to dock Kamsar port. These carriers are called 'Kamsarmax'.

Likewise, tankers are divided into different categories depending on their carrying capacity. The ones from 10,000 to 30,000 tons DWT are called 'handy size', from 30,000 to 60,000 tons DWT are called 'handymax'. Tankers with carrying capacity from 25,000 to 45,000 tons DWT are called 'medium range'. Those from 60,000 to 80,000 tones DWT are called 'panamax' so that while they are fully loaded and their maximum-allowed size to be able to cross Panama channel. The ones from 80,000 to 120,000 tons DWT are called 'aframax', and the ones from 120,000 to 200,000 tons DWT are called 'suezmax' so that they can cross Suez channel while they are fully loaded by having the maximum – allowed size. Tankers with carrying capacity from

200,000 to 320,000 tons DWT are called 'VLCC – very large crude carriers' and the ones from 320,000 to 550,000 tons DWT are called 'ULCC – ultra large crude carriers'. Finally, containerships are also divided into categories according to their carrying capacity which is measured in TEU (Twenty – foot Equivalent Units). Those with capacity of 2,000 TEU are called 'feeder', from 2,000 to 3,000 TEU are called 'sub-panamax', from 3,000 to 4,000 TEU are called 'panamax' , and those from 4,000 to 10,000 TEU are called 'post-panamax'. The bigger containerships with carrying capacity from 10,000 to 12,000 are called 'suezmax' and finally the ones from more than 12,000 TEU are called 'post-suezmax'.

2.4 Conclusions

Taking all the above into consideration, it can be inferred that shipping companies can improve their efficiency together with the increase of their revenues but most importantly together with a decrease in their operational costs. Suitable management techniques combined with flexible strategy and planning are necessary to achieve optimal efficiency while it is of equal importance the funding policy of the shipping company's activities. Finally, factors affecting productivity such as the freight market the company deals with, freight charges and the size of the ships are also strongly correlated with efficiency.

Chapter 3

PRODUCTIVITY AND EFFICIENCY ANALYSIS IN MARITIME-BIBLIOGRAPHY

3.1 Introduction

In this unit, the bibliography overview referring to efficiency analysis in maritime and the application of DEA to maritime transportation are presented.

Up to now, the analysis of efficiency in maritime has been focused on its productivity emphasizing mainly operational costs, better design on a fleet's schedule as well as the optimal production of ships' engines. However, there are other factors determining the relative efficiency of shipping companies and there are studies having to do with the efficiency related to ports, airline companies, and airports as well as in other economy branches.

3.2 Productivity and efficiency measurement in maritime

Previous research has put emphasis on productivity measurement and more specifically in labor productivity. Goss (1982) analyses the term productivity by separating it into 'natural indices' and 'economic indices' of productivity. These indices suggested by Goss can be used in maritime in general, in a shipping company and in a ship's operation. They are very useful to obverse efficiency in general, negotiate wages and to analyze both technical and organizational innovations which improve efficiency.

A natural productivity index of an output factor is defined as:

FP = (output / factor)

A labour productivity index is defined as: FP (L) = (output / labor)

Some other productivity indices are:

1. GRT/NRT per man
2. DWT per man
3. bale cubic capacity per man
4. passengers per man
5. TEU slots per man
6. meters of ro-ro cargo per man

However, these natural measurements do not express exactly productivity nor efficiency. The factor cargo should be mentioned. In other words, a ship with a carrying capacity of 20,000 tons dwt operating with 70% load factor can have lower productivity than a ship with carrying capacity of 17,500 tons dwt operating with 80% load factor, because it is a bigger-sized ship and needs more crew without affecting the income. In this case the relevant productivity measurements are:

1. cargo ton-miles per man
2. passenger ton-miles per man

Nevertheless, financial indices are better than those of natural ones. For instance, the indices below are more accurate as they take into consideration not only cargo volume but also freight charges.

1. gross output per man at current prices or at constant prices
2. net output per man at current or constant prices

However, these financial productivity indices present certain problems. Goss proves that indices used to express productivity and efficiency have to be adapted by taking into account carrying capacity, real cargo, differences in distance, cargo uniformity and crew's constitution. Also, these indices refer only to labor and they ignore to a great extent the importance of invested funds in a shipping company and ship's operation. As a result, the indices referred to the total output factors, like labor and

funds, are more indicative than the other ones referring only to labor productivity. These types of indices are ‘ total productivity index’ in which its denominator is not labor but a complex index of all productivity factors.

North (1968) uses the index of total productivity to examine the sources of productivity increase in ocean shipping between the period 1600-1850), and in particular which was the contribution of the use of productivity’s indices, i.e. labor and capital, and which was the contribution of the introduction of new technology. He divides the time into two periods, 1600- 1800 and 1800-1850. These two periods had different productivity increase sources. In the first period, the main factors were the reduction in labor cost and reduction of the time of ship remaining at a port. In the second period the main source of the rise in productivity was the increase in the ship’s size and the increase in cargo in relation with the carrying capacity.

Frankel (1991) examines technology implications in maritime by citing the index:

Cargo carried in ton miles (or TEU miles) / sum of all costs involved

This index displays productivity in terms of the amount (value) of capital outflow related to the amount (value) of capital inflow.

Besides, productivity or cost per product unit depends on cash inflow values, which change accordingly (e.g. wages, fuels). Thus, both the estimated and real changes of prices and wages should be taken into consideration while analyzing productivity in relation to technology.

Evans (1994) analyses the productivity of fleets carrying dry and wet cargo in both short and long terms as well as the factors affecting it. This paper examines whether a market operates better based on the premise that freight charge equals to marginal cost. In the analysis, various factors are also taken into consideration such as the time spent at the port, voyage cost, highest speed etc. Furthermore, there are other factors affecting productivity and they have to do with the income deriving from freight charges. These are the demand factor, operation of joint ventures, market fragmentation, fluctuation in fuel prices, the ratio between cargo and capacity etc.

Song et al. (2005) examine cost productivity in the global maritime market related to carrying commercial cargo. In this paper a model used representing the global

maritime market in domain so that the operational cost of carrying commercial cargo can be examined.

3.3 The use of DEA in measuring efficiency in maritime

The previous analysis shows that measuring efficiency with either natural or economic indices cannot present satisfactorily efficiency in maritime industry in general, shipping companies nor in a ship operation. Productivity indices (natural indices) present one side of the problem. Similarly, economic indices, despite the fact that are more accurate than the natural ones, they show certain drawbacks, which reduce their use in efficiency analysis or profitability analysis in maritime, particular shipping companies or ships. More specifically, comparisons cannot be made due to differences in technology, operational system of transportation network, methods of combined transportation, use of ports in maritime industry, shipping company or the ship.

To prevent these sorts of problems in measuring efficiency in the other disciplines of economy too, Data Envelopment Analysis (DEA) has been developed by Charnes, Cooper and Rhodes (1978), which has been used in a number of industries to measure efficiency. Initially, this method was used to measure efficiency of non-profitable organizations (hospitals, schools, state organizations etc.), where the traditional measurements did not produce the reliable outcome. Gradually, this method has gained a broader recognition as it has become apparent that it provides useful data about the operation of profitable organizations which are characterized mainly by their use of their high level of inflow and outflow. This method has a wide application in health industry, education, justice (courts efficiency), airport services, social provision services, pharmacies, banking etc.

In maritime, it has been used to analyse efficiency in transportation systems, ports and terminals (Cullinane 2002, Barros 2003) , (Tongzon 2001, Rios, 2006). However, in maritime efficiency in the transportation system is not affected only by ports and terminals efficiency but also by the efficiency of shipping companies. Nevertheless,

recent applications of this method (DEA) have been made in measuring efficiency in shipping companies. (Lin, Liu and Chu, 2005, Panayides et al, 2011). An overview of a number of selected measurements is presented later in this paper.

3.3.1 The application of DEA in measuring efficiency in transportation

DEA has been used in analyzing efficiency in transportations and as it has been supported the subject of submitting transportation systems is one of the most widely analyzed issue that we cannot solve it unless we measure it first. (Moynihan, 1978)

Such analysis of efficiency in urban transportations is the one published in an article of Barnum et al (2006). In this article a submission index used of various urban transportation sub-units in Chicago and its application in the 'Park-and-Ride' system. This article presents accurately how this efficiency index displays objectively and precisely efficiency of every sub-unit of urban transportation, suggesting at the same time methods of efficiency improvement of the sub-units which were inferior in efficiency in comparison with the other ones.

Karlaftis(2004) uses DEA method in one of his articles to examine two essential issues in transportation systems 1) the correlation between two basic efficiency dimensions ; efficiency and effectiveness of transportation systems and 2) the correlation between efficiency and economic scale. In this article, a range of indices measuring efficiency in urban transportation systems, productivity and quality of service are presented which take into consideration the different objectives on various administrative levels.

Oum et al(1999) examine the comparison of different methods in terms of efficiency and effectiveness in railway transportation. An overview and comparisons of all methods used for measuring efficiency and productivity in railways are presented as well as their applications in the research results of empirical applications.

Fethi(2000) presents another application of DEA in air transporation systems and uses this method to measure the efficiency of airline companies. On a second level,

Tobit method is used to examine the variables affecting the differences in efficiency in airline companies. This type of analysis uses panel data for 17 European airline companies from 1991 to 1995.

Other applications concern airports and in particular the comparison of efficiency between airports. The efficiency measurement of airports serves a considerable number of objectives either for improving their operation, something which airport management is concerned about, or their productivity which interests mainly the state policy and its cooperative organizations. However, measurement and in particular comparison in efficiency between airports, like in all transportation infrastructure , is difficult because of their ownership structure, political restrictions that might be imposed and the economic environment of the region where the airport is.

Tovar and Martin-Cejas(2009) examine the factors affecting the efficiency of various Spanish airports. In their research, parametric (econometric) method is used to analyse factors determining the efficiency of Spanish airports.

3.3.2 The use of DEA in measuring efficiency in ports

Like in airports, efficiency measurement in ports and comparison between efficiency and productivity in various ports interests both ports management so as to improve their operation and the state sectors so that they can improve their efficiency and productivity.

Roll and Hayuth (1993) made one of the first application of DEA to examine efficiency in ports as they consider that DEA is the most appropriate method to measure efficiency in ports.

Panayides et al(2009) provide an extensive overview of bibliography and critical analysis of DEA applications to ports. There is a great number of studies that have been made to analyze efficiency in ports all over the world, to define the variables (inflow-outflow) as well as the sample and the type of DEA used in these cases. What is more, conclusions concerning the advantages and disadvantages of DEA application are drawn and even methodological predictions are provided which have not been used in ports yet.

One of the first DEA applications regarding ports comes from Martinez-Budria et al (1999). In their study, the efficiency of all Spanish ports(26) is examined during the period between 1993 and 1997 and they use DEA by dividing the sample according to their complexity. One of the most interesting parts of their study is the fact that for every port they use five observations having to do with the way this allows efficiency comparisons between ports in every group as well as efficiency development at that period. The findings reveal that there are differences in efficiency development in groups of ports. Especially, ports having more complexity present higher efficiency which means moving closer to the efficiency limit during the time under examination. Exactly the opposite occurs to ports with smaller complexities which present a negative development as a group, while the efficiency of mid-complexity ports shows somehow an in-between development as a group.

Baros(2003) examines the efficiency of Portuguese port with DEA method. In his study, he analyses the technical efficiency and technological development in Portuguese ports and compares their efficiency. Based on his findings, he draws conclusions having to do with the ports administration and makes comparisons between state and private ports.

Another DEA port application was published by Barros and Athanasiou(2004), which examines the efficiency between two Greek and four Portuguese ports. Their study presents the lack of efficiency in Greek ports and in particular the one of Thessaloniki's. Also, it offers useful recommendations about efficiency improvement based on European Union policy for ports operation. Similarly, Barros(2006) presents an efficiency analysis for 24 Italian ports between 2002 and 2003 by combining operational and financial variables and estimates how the operation of these ports comes closer to desired efficiency indices.

3.3.3 DEA Application to measuring efficiency in container ports

A special case concerning measuring efficiency in ports is the one having to do with the efficiency in containers terminals. A general overview of analyzing efficiency methods and productivity is provided by Cullinane(2002).

Tongzon(2001) presented one of the first DEA application in container terminals. In his study, he examines the efficiency between four container ports in Australia and twelve international ones as well as comparing it by using DEA method. He follows the approach of Roll and Hayuth(1993) with the use of DEA in analyzing efficiency between container and commercial ports.

Cullinane and Wang (2006), and Wang and Cullinane (2006) compare efficiency with DEA method in 106 European container ports more than 10,000 TEU in 29 European countries in 2003. Their study examines and compares efficiency and the financial scale of the aforementioned ports. The study concludes that there is a considerable lack of efficiency in a great number of ports and especially in those of the ex-soviet Union as well as in many Scandinavian ports while British ports show the highest efficiency.

Rios (2006) analyses the relative efficiency of container ports in Latin America ports (MERCOSUR) with DEA method between 2002 and 2004. In this sample, 15 Brazilian , 6 Argentinean and 2 Uruguayan ports are included. In his study, natural indicators are used for inflow-outflow indices and more specifically five inflows (number of cranes, number of piers, number of employees, terminal surface, size of equipment) and two outflows (TEU number and average container cargo per hour per ship). The analysis concludes that 60% of the ports are efficient during that time. Also, some ports act as benchmarking for other less productive ones.

Conclusions drawn from measuring efficiency in container ports can be very useful in analyzing other more general issues like privatization and private port management. Cullinane, Ping and Wang(2005) analyse the relationship between port privatization and their relative efficiency as one of the most fundamental objectives in privatization is the increase in efficiency. Their study presents both the advantages and disadvantages of the container ports privatization and they use DEA to analyse in an empirical way how privatization affects efficiency in container ports. The sample includes 30 of the biggest ports all over the world in 2001, emphasizing mainly Chinese ports between 1993 and 1999. The study concludes that privatization either in property or in management of ports does not result in increase in efficiency. However, another study comes to a totally different conclusion after using a different measuring method.

3.4 Efficiency Measurement in shipping companies

Measurement of efficiency in shipping companies carrying solid or liquid cargo as well as commercial container cargo contributes to the efficiency of the whole transportation system and as a result in the development in both maritime industry and economy. Also, having a good insight of shipping companies' efficiency is fundamental in a highly competitive environment like that one of maritime as it allows companies to compare their productivity with that of their rivals and to improve it even further.

Lin et al (2005) applied first DEA to measure efficiency in shipping companies. This study examines the efficiency of 14 shipping companies in Taiwan with the help of financial indicators representing inflows/outflows. It analyses companies' efficiency from a financial perspective which is useful for both administration and the companies' shareholders. This type of analysis is conducted with the help of financial indicators as it provides a simple but a comprehensive presentation of a company's development in relation to previous times or to other companies. DEA is used rather than indicators to determine the relative efficiency in shipping companies in Taiwan. The study includes 14 ocean shipping companies of Taiwan in 2003. It uses two inflows and two outflows and evaluates efficiency as well as the definition of the most productive companies.

In one of their studies, Panayides, Lambertides and Savva (2011) use DEA with financial data of shipping companies to evaluate both the operational and commercial efficiency of shipping companies in the three most important maritime branches; solid cargo, liquid cargo and commercial container cargo. They use DEA together with Stochastic Frontier Analysis (SFA) and compare the results. Their sample includes 26 worldwide leading shipping companies and the data was provided by Datastream and it referred to 2008. The study uses variables like the company's market capitalization, profitability, investments and includes a wide range of both big and small companies. The smallest company has fixed costs 0,251 million dollars and employs 130 employees while the biggest has fixed costs 61,5 million dollars and employs 117,319 employees. The sample includes 15 commercial

cargo container companies, 6 companies carrying solid cargo and 5 with liquid cargo. Out of these, 15 companies are listed on New York's Stock Market (NYSE) and NASDAQ, 4 are listed on European Stock Markets, 3 in Tokyo's, 3 in Taiwan's, 2 in Shanghai's and the rest are listed on other Stock Markets. The results coming from both models (DEA and SFA) are similar.

It can be said that the results from this study are useful for two main reasons. Firstly, by using DEA enables you not only to interpret in a better way the financial conditions and results coming from the companies but also to evaluate better the other maritime branches e.g. solid cargo, liquid cargo and commercial container cargo. In doing so, investors and company's shareholders get better informed about the company's development, their efficiency and productivity in comparison with the other rival companies. Secondly, simultaneous analysis of a company's operational and market efficiency and productivity helps to improve to a great extend the comprehension of a company's profitability and its potential to compete with other shipping companies.

3.5 The aim of this study

In order for the comparison between companies in terms of efficiency to be more effective it should be based on indicators (indices) or comparable measurements thus, a number of factors play an important role in this aspect. Consequently, the calculation of the relative efficiency is more important and difficult than the simple calculation of both natural and physical productivity indicators.

Moreover, the way shipping companies are funded and in particular the capital extraction through stock market, as it has been presented in chapter 2, affects the operational costs of companies and as a result their efficiency. Also, since 2004, competition in maritime industry has increased dramatically as a result from market conditions but also from restrictions imposed both from clients and authorities responsible for shipping networking operation.

Thus, competition makes it urgent for companies to improve their efficiency in their sectors; solid cargo, liquid cargo and commercial container cargo. Even in times when freight charges are low, improvement in efficiency is vital for the survival of shipping companies. Even so the attempt to improve efficiency is common for the aforementioned three sectors; this type of improvement is neither steady nor continuous. For this reason, it is imperative for ship owners but also for the investors to continually compare the relative efficiency of their companies and fleets with other companies or with fleets of a similar transportation sector or between different sectors of shipping industry. Although knowledge of relative efficiency is crucial for shipping companies, there are very few studies refer to it. More specifically, it can be said that there is a considerable mismatch between studies referring to relative efficiency in other maritime sectors such as ports infrastructure and container ports/terminals. Moreover, there are no studies referring to companies' relative efficiency so that they can be compared and certain factors affecting their productivity to be analyzed. The result of such inadequacy existing in studies relating to shipping companies' efficiency has led to the fact that certain variables and measurements have not been developed, which could have been used to analyze the relative efficiency.

Data Envelopment Analysis is the method which has been designed to fill this gap in research. It can be used to examine shipping companies' efficiency as well as efficiency in ports infrastructure and container ports. A theoretical presentation of the basis of DEA methodology, together with the various forms of its application is provided in the next chapter.

The evaluation of efficiency is based on the choice of variables having to do with inflows-outflows. This choice is dependent on institutional environment the company operates in so that the variables can reflect in an accurate way how companies organize in general their operation so as to transform inflows to outflows. Finally, both inflows and outflows are displayed accurately by the financial variables of the fundamental companies' analysis or by the whole maritime industry.

Chapter 4
THE SAMPLE OF SHIPPING COMPANIES TAKING PART IN THE ANALYSIS

4.1 Introduction

In this chapter, the information and the statistics taken from fifty leading companies, which are publicly traded, are mentioned in order to value their efficiency and to compare them.

4.2 Information for each company

Algoma Central Corportation was incorporated in 1899 in Sault Site. Algoma is listed on the Toronto Stock Exchange. It is the largest company that operates in the domestic market and transfers cargo within the Great Lakes, St. Lawrence River and Canadian East coast regions. Nowadays, it comprises four operating segments, domestic dry-bulk, product tankers, ocean shipping and real estate. The three major commodities carried are coal for power generation, crushed aggregates for construction, gypsum for wallboard manufacturing and salt.

Algoma Central Corporation fleet includes: 18 hopper-hold vessels for domestic use, 7 gearless bulk carriers, 7 product tankers, 5 ocean self-unloaders and 1 tanker. The 38 ships that Algoma manage have capacity 1250595 DWT.

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AP Moller-Maersk A/S was incorporated in 1904 in Copenhagen. Even today the main office of the company is in Copenhagen. Maersk is listed on the Denmark Stock

Exchange. Maersk not only owns one of the world's largest shipping companies but also it is involved in a wide range of activities in the shipping, logistics, oil and gas industries. Maersk is the world's largest container shipping company. It owns more than 600 containers with capacity approximately 2,3 million TEU.

Baltic Trading Ltd. is a shipping company specializing on the dry bulk industry spot market. The company is listed for trading on the New York Stock Exchange.

Baltic Trading Ltd. owns a fleet of 14 vessels. The company also operates chartered in vessels.

Capital Product Partners L.P is an international, diversified company. Since 2007 is listed on NASDAQ New York with code name (CPLP). The main offices are in Athens, because it is managed mainly from Greek people. The average age of the Capital Product Partners L.P fleet is 6.8 years old. **ΔΕΝ ΕΧΩ ΒΡΕΙ ΑΡΙΘΜΟ ΠΛΟΙΩΝ**

Concordia Maritime AB is an international tanker shipping company. It is listed in NASDAQ Stockholm since 1984. The company focus on cost-effective freight and safe transportation of refined petroleum products and vegetable oils. The main office of

the company is in Gothenburg, Sweden. The company owns 13 tankers with total capacity of 907000 DWT.

Cosco Shipping Co. Ltd. was incorporated in 1961 in China. It is one of the world's largest groups specializing in global shipping, modern logistics, ship building and repairing. Its fleet size ranks the second worldwide and first in China.

The fleet that the company owns and manage is over 800 vessels with total capacity 56 million DWTs. It has the largest dry bulk fleet worldwide and the fifth container fleet size worldwide. The company focuses more on the container fleet. The container fleet is consisted of 160 vessels with total capacity of over 750000 TEU. Cosco in 1993 was listed on Singapore Stock Exchange.

China Shipping Development Company Ltd. was incorporated in 1994 and the main office is in Shangai. The company focuses on coastal and ocean shipping of crude oil and refined oil, coastal and ocean shipping of coal and iron ore. It is listed for trading in the Hong Kong Limited Stock Exchange anf the Shanghai Stock Exchange.

China Shipping Development Company Ltd. owns an oil tanker fleet of more than 80 vessels with total capacity of more than 8 million DWT. The fleet is consisted of VLCCs, Aframax oil tanker, Panamax oil tankers, Handymax and Handysize oil tankers.

D' Amico International Shipping S.A. operates a fleet of double-hulled tankers, which mainly transport refined petroleum products. The origins of this company start from 1936 in Rome, where the D' Amico family bought the first vessel. In 2001 the company was listed on Milan's Stock Exchange.

The company owns 45 vessels with total capacity of 2,3 millions DWT. The company also has 9 new buildings with total capacity of 406000 DWT.

Danaos Corp. was incorporated in 1972 and the main office is in Athens. In 2006 Danaos was listed on New York's Stock Exchange. Danaos generaly operates only container ships.

The fleet that Danaos owns is consisted of 56 container vessels with total capacity of 334239 TEU. The company is managed mainly by Greek people.

Diana Shipping Inc. specializes in the ownership of dry bulk carriers. In 2005, Dianna Shipping Inc was listed in the New York's Stock Exchange. The company owns 40 bulk carriers with total capacity of 4,6 million DWT with average age of 7 years old. The company has also three new buildings. Diana Shipping Inc. also owns the

26,1% of Diana Containership Inc. The Diana Containership ,also, is listed on New York's Stock Exchange and operates eleven container vessels. The seven of them are panamax vessels and the four of them are post-panamax. It has also two new buildings that they are panamax type. Diana Containership Inc has total capacity of 62205 TEU. Finally, Diana Shipping Inc is managed mainly by Greek people.

Dryships Inc. specializes mainly in the ownership of dry bulk carriers. In 2005, Dryships was listed on the NASDAQ of New York's Stock Exchange. Dryships Inc is managed by Greek people and the office is in Athens.

Dryships Inc. owns a fleet of 39 dry bulk carrier, which are more spesifically 13 capesize, 24 panamax and 2 supramax with total capacity of 4,3 millions DWT. Furthermore, the company also owns 10 tankers, comprising 4 suezmax and 6 aframax with total capacity of over 1,3 milions DWT and 9 ultra deepwater drilling units, comprising of 2 ultra deepwater semisubmersible drilling rings and 7 ultra deepwater drillships. Also, the company has 4 deepwater drillships new buildings scheduled to be delivered until 2017.

Dampskisselskabet Norden A/S. was incorporated in 1871, making it one of the Denmark's oldest internationally operating shipping companies. The company operates in dry cargo and product tankers worldwide. The main office is in Hellerup. The company is listed for trading on the NASDAQ Copenhagen.

Dampskisselskabet Norden A/S. owns a fleet of 263 vessels. Norden is one of the largest operators of Supramax and Panamax dry cargo vessels. Its fleet can be devided in two categories: dry cargo vessels and tanker vessels. The dry cargo fleet is consisted of Handysize, Panamax, Supramax, Post-Panamax and Capesize. The tanker fleet is consisted of Handysize and MR product vessels. the company has a newbuilding program with 27 vessels on order (24 dry cargo, 3 tanker).

Eagle Bulk Shipping Inc specializes in handymax dry bulk vessels. It is the largest US owner of this type of vessels. The company is listed on the NASDAQ of New Yorks Stock Exchange from 2005. The main office of the company is in New York and its fleet consists mainly of supramax class vessels.

Eagle Bulk Shipping Inc owns 45 vessels with total capacity of over 2,4 million DWT. The company has a strategy to charter their vessels medium or long term.

Euroseas Ltd. was incorporated in 2005 and the main office is in Athens. In 2007 the company was listed on the NASDAQ of New York's Stock Exchange. The company is managed by Greek people.

Euroseas Ltd. owns a fleet of 5 dry bulk carriers (4 panamax and 1 handymax) with total capacity of 338,540 DWT and 10 containerships (3 intermediate, 5 handysize and 2 feeder) with total capacity of 17,587 TEU. The company has a new building schedule of 2 ultramax dry bulk vessels with capacity of 63500 DWT each and 2 kamsamax dry bulk vessels with capacity 82000 DWT each. Furthermore, Euroseas

Ltd owns the 14, 28% of Euromar. Euromar is a shipping company owning 11 vessels (1 postpanamax, 8 intermediate and 2 handysize) with total capacity of 394283 DWT or 29879 TEU. The average age of the Euromar's fleet is 11, 4 years.

Evergreen Marine Corp. Taiwan Ltd. was incorporated in 1968 and its central office is in Taiwan. The company specializes in containership and it has the fourth largest container fleet worldwide. Evergreen is listed on London's Stock Exchange and on Taiwan's Stock Exchange.

Evergreen Marine Corp. Taiwan Ltd. owns more than 150 vessels with total capacity approximately of 560000 TEUs.

Freeseas Inc. was incorporated in 2004 with a different name. The first name of the company was Adventure Holdings S.A. In 2005 the company changed its name to Freeseas Inc., which is the current name of the company. The main office of Freeseas is in Athens. In 2005, the company was listed on NASDAQ of New York's Stock Exchange. In 2007 Freeseas underwent a series of transformative events that led to becoming an even larger company , from owning 3 vessels with average age of 23,3 years and total capacity of 91408 DWT to owning 7 vessels with average age of 13,7 years and total capacity of 193926 DWT. Today, Freeseas owns 6 handy size dry bulk

vessels and 1 handymax dry bulk vessel with total capacity of 197200 DWT and average age of 15 years.

Frontline Ltd. has its origins in Frontline AB, which was incorporated in 1985. The company is listed on Oslo's and New York's Stock Exchange. The company is the world's largest tanker company.

Frontline owns 39 vessels (15 suezmax and 24 vlcc tankers) with total capacity of 9,8 millions DWT.

Genco Shipping and Trading Ltd. specializes in dry bulk vessels. In 2004, the company was listed on New York's Stock Exchange and its main office is in New York. The company owns a large fleet of dry bulk vessels of different sizes (panamax, handymax, handysize, supramax and capesize). Besides, the company owns a fleet consisting of 13 handy size vessels with total capacity of 406964 DWT, 6 handymax with total capacity 282855 DWT, 17 supramax with total capacity of 958075 DWT, 8 panamax with total capacity 593841 DWT and 9 capesize with total capacity of 1564539 DWT. The total capacity of the company's fleet is 3812000 DWT.

General Maritime Co. was incorporated in 1997 and the main office is in New York. Since 2001, it has been listed on New York's Stock Exchange. The company owns one of the world's largest fleet of tankers.

General Maritime Co operates a fleet consisting of 7 VLCC, 11 suezmax, 4 aframax , 2 LR1 and 1 MR2 with total capacity of 4,5 millions DWT. The company has a 7 newbuilding scheduled of eco-VLCC units. The first one will be delivered in mid 2015.

GLOBUS MARITIME LIMITED

Globus Maritime Ltd. specializes in dry bulk carriers. Since 2006, it has been listed on NASDAQ of New York's Stock Exchange. The main office of the company is in Athens.

The company owns a fleet of 7 bulk carriers consisting of 1 kamsarmax, two panamax and 4 supramax. The average age of the vessels is 7,8 years and the total capacity of 452.866 DWT.

Golden Ocean Group Ltd. was incorporated in 1996 and the main office is in Oslo. Since 2004, it has been listed for trading in the Oslo's Stock Exchange and since 2010 it has been listed for trading in Singapore's Stock Exchange. However, in 2015, the company will be delisted from Singapore Stock Exchange and will be listed for trading on Oslo's Stock Exchange and on the NASDAQ Global Select Market.

The company operates a fleet of 48 dry bulk carriers consisting of 26 capesize, 8 kamsarmax, 10 panamax and 4 supramax with total capacity of 5,7 million DWT.

Goldenport Holdings Inc. operates a diversified fleet and provides worldwide shipping service. From 2006 the company is listed for trading on London Stock Exchange. The main offices are in Athens, as it is manages mainly by Greek people.

Goldenport Holdings Inc. owns a fleet of containers and bulk carriers. The container fleet is consisted of one gearless vessel and six geared vessels with total capacity of 15685 TEU. The bulk carriers' fleet is consisted of nine vessels with total capacity of 535770 DWT.

Gulf Navigation Holding PJSC

Gulf Navigation Holding Pisc specializes in chemical tankers. The company was incorporated in 2001 in Oman. The main office is in Dubai from 2003. From 2007 the company is listed for trading on Dubai Stock Exchange.

Gulf Navigation Holding Pisc owns a fleet of chemical tankers and crew boats. The fleet is consisted of 8 chemical tankers with total capacity of 350.350 DWT and 4 crew boats.

HELLENIC CARRIERS

Hellenic Carriers Ltd. was incorporated in 2007 in Jersey. From 2007 the company is listed for trading on London Stock Exchange. The company specializes in dry bulk carriers.

Hellenic Carriers Ltd. owns a fleet of medium-sized bulk carrier vessels. The fleet is consisted of two supramax, one panamax and two kamsarmax vessels with total capacity of 340.055 DWT. The fleet that the company manages has the advantage that provides great flexibility in cargoes and trading routes.

Hyundai Merchant Marine Co. Ltd. was incorporated in 1976 in Seoul. The main office of the company is in Seoul. It is listed for trading on Korea Stock Exchange. Hyundai is one of the largest companies worldwide that provides multiple service such as logistics. The company provides a global service network with more than 60 sea routes and over 100 ports. Hyundai is currently one of the top five Trans-Pacific carriers and one of the top ten in global shipping industry.

Hyundai Merchant Marine Co. Ltd. owns a fleet of 66 vessels. Its fleet is consisted of container and bulk carriers vessels with total capacity of 401.575 TEU or 4.721.796 DWT.

Malaysian Bulk Carriers Berhad owns the largest fleet of dry bulk carrier vessels in Malaysia. The company is listed for trading in Kuala Labour Stock Exchange. The company main office is in Kuala Labour.

Malaysian Bulk Carriers Berhad specializes in dry bulk carriers and product tankers. The bulk carrier fleet is consisted of 5 Post-Panamax with double hull with total capacity of 435.260 DWT, 9 Supramax grab fitted with total capacity of 643.614 DWT and 7 handysize with total capacity of 228.942 DWT. The product tanker fleet is consisted of 3 vessels with total capacity of 142.129 DWT.

Mitsui OSK Lines Ltd. was incorporated in 1964 by a merger of six companies that they had been incorporated until 1878. The main office of the company is in Tokyo. It is listed for trading on Tokyo Stock Exchange from 1942. The company offers a great number of services such as logistics and offshore business.

Mitsui OSK Lines Ltd. owns the world's largest fleet. The fleet is consisted of bulk carriers, tankers, LNG carriers, containerships, car carriers and cruise ships. The company owns a fleet of 894 vessels with total capacity of 62.920.000 DWT.

Navios Maritime Holding Inc. was incorporated in 1954. The main office is in Athens, as it is managed mainly by Greek people. It is listed for trading on New York's Stock Exchange. The company has a reputation for innovation in dry bulk cargo transportation, maritime finance, mergers and acquisitions, and risk management. Navios specializes in dry bulk carrier vessels.

Navios Maritime Holding Inc. owns a fleet of dry bulk carriers with different sizes. The fleet is consisted of one handysize with total capacity of 34.690 DWT, 14 ultra handymax with total capacity of 750.669 DWT, 10 panamax with total capcity of 694.605 DWT and 12 capesize with total capacity of 1.956.663 DWT. Navios also waits two vessels to be delivered by the end of 2015, one panamax and one capesize with total capacity of 264.600 DWT. The company also operates a long-term

chartered-in fleet, which is consisted of 18 vessels with total capacity of 1.770.389 DWT. So the company manages a fleet with total capacity of 5.207.016 DWT.

Nepture Orient Lines Ltd. Singapore was incorporated in 1968 and the main office is in Singapore. It is listed for trading on Singapore Stock Exchange from 1981. It is one of largest shipping companies owning dry bulk carrier vessels. Nepture Orient Lines also owns another shipping company named American President Lines.

Nepture Orient Lines Ltd. Singapore owns a fleet of more than 150 vessels, which transports a volume of over 3 million forty-foot equivalent units (FEU) worldwide.

Newlead Holdings Ltd. was incorporated in 1948 and the main office is in Athens as it is managed mainly by Greek people. The company's intention is to become an integrated commodity, logistics and shipping company. It is listed for trading on NASDAQ New York's Stock Exchange.

Newlead Holdings Ltd. specializes in dry bulk carrier and tanker vessels. The company owns a fleet of ten vessels, which is consisted of 5 dry bulk carriers with total capacity of 248.059 DWT and 5 chemical tankers with total capacity of 18918 DWT. Newlead has also a program to increase the fleet that owns from 10 vessels to 30 vessels.

Nippon Yusen KK was incorporated in 1870 and the main office is in Tokyo. It is listed for trading on New York's Stock Exchange. It is one of the largest shipping companies worldwide. The company provides several services in the shipping field but it specializes in the dry bulk carrier vessels.

Nippon Yusen KK owns a large fleet of dry bulk carriers. The dry bulk carriers' fleet is consisted of 89 vessels with total capacity of 404.301 TEU.

Nordic American Tankers Limited was incorporated in 1995 in Bermuda. The main office is in Norway. It is listed for trading in New York's Stock Exchange from 1999.

Nordic American Tankers Limited specializes in operating a fleet of tanker vessels. The fleet is consisted of 22 suezmax type tankers with total capacity of 3.753.741 DWT. The company has two new buildings scheduled to be delivered by the end of 2017.

Overseas Shipping Group Inc. was incorporated in 1948 and the main office is in New York. The company is listed for trading on New York Stock Exchange from 1973. The company specializes in operating a fleet of tankers. It is the second world's largest shipping company on the Stock Exchange that owns tanker vessels. Furthermore, it is a leading provider of global energy transportation service.

Overseas Shippinh Group Inc owns a fleet of 78 vessels registered internationally and in the United States. The fleet has approximately total capacity of 8,7 million DWT.

Paragon Shipping Inc. was formed in 2006. The main office is in Athens as the company is managed mainly by Greek people. The company is listed for trading on the NASDAQ Global Market from 2010. Paragon specialize in transporting drybulk cargoes.

Paragon Shipping Inc. owns modern and cost efficient drybulk vessels. The company owns 16 drybulk carriers, which can be divided to the next categories: 8 panamax, 2 ultramax, 2 supramax and 4 handysize. The fleet has total capacity of 980.380 DWT. The company also waits for 5 newbuildings to be delivered by the end of 2015 and the new total capacity will be 1.352.780 DWT.

Precious Shipping Pcl. was incorporated in 1989 and the main office is in Bangkok. The company is listed for trading on Thailand Stock Exchange from 1993. It specializes in drybulk carriers and operates the small handysize, supramax and ultramax sectors of the tramp freight market.

Precious Shipping Pcl. owns a fleet of 45 vessels. The fleet is consisted of 30 handysize vessels with total capacity of 833.300 DWT, 9 supramax with total capacity of 501.361 DWT, 2 ultramax with total capacity of 126.984 DWT and 4 cement carrier vessels with total capacity of 84.558 DWT. The fleet that the company owns has total capacity of 1.546.203 DWT. The company also has a newbuilding program for 24 vessels to be delivered by the end of 2016 with total capacity of 1.485.000 DWT.

Qatar Gas Transport Co. Ltd. was incorporated in 2004 as joint stock company (owned 50 per cent by its founding shareholders and per cent by the public). Nakilat provides the critical transportation link in the State of Qatar's liquefied natural gas (LNG) supply chain. The company owns the largest LNG shipping fleet in the world. Nakilat is listed for trading on Qatars Stock Exchange.

Qatar Gas Transport Co. Ltd. owns a fleet of 54 LNG vessels and 4 LPG vessels with combined total carrying capacity of over 8.5 million cubic meters, which means that

the company carries the 15% of the world capacity. Nakilat owns the world's newest and largest gas fleet.

Regional Container Lines Pcl. was incorporated in 1979 in Bangkok. It is listed for trading on Thailand Stock Exchange from 1988. The fleet that the company owns covers more than 60 destinations in Asia, Australasia and the Middle East.

Regional Container Lines Pcl owns a fleet of 40 vessels. The fleet size ranges from 500 TEUs to 2.732 TEUs.

Safebulkers Inc. specializes in drybulk carrier vessels. It is listed for trading on New York Stock Exchange. The main office is in Athens as it is mainly managed by Greek people.

Safebulkers Inc. owns a fleet of 33 drybulk carrier vessels. The fleet is consisted of 12 panamax vessels with total capacity of 915.400 dwt, 7 kamsarmax with total capacity of 575.400 DWT, 11 post-panamax with total capacity of 993.400 DWT and 3 capsized with total capacity 535.500 DWT. The fleet that the company owns has total capacity of 3.019.700 DWT. Safebulkers also has a newbuilding program for 11 vessels to be delivered by the end of 2018.

Scorpio Tankers Inc. operates a fleet of modern product tankers. The company is listed for trading on New York Stock Exchange. The main office is in Monaco.

Scorpio Tankers Inc. owns a fleet of 67 vessels. The total capacity of the fleet that the company owns is 3.805.670 DWT. The company also has a newbuilding program for 12 vessels with total capacity of 919.994 DWT. Scorpio also operates vessels that they are time chartered-in, which are 21 with total capacity of 1.425.368 DWT. The total capacity of the fleet that the company owns and operates is 6.151.032 DWT.

Seacor Holdings Inc. was incorporated in 1989. Its is listed for trading on New York Stock Exchange. Seacor Holdings operate in the shipping area throught the affiliate company named Seacor Marine.

Seacor Holdings Inc. owns a fleet of different types of vessels. The fleet is consisted of anchor handling towing supply vessels, platform supply vessels, mini-supply vessels, crew-fast supply vessels, standby safety vessels, towing supply vessels and speciality vessels.

Star Bulk Carriers Corp. was incorporated in 2006 in the Marshall Islands. The main office is in Athens. The company provides worldwide seaborne transportation services in the dry bulk sector.

Star Bulk Carriers Corp. owns a fleet of 98 vessels with approximately total capacity of 11.5 million DWT. The fleet is consisted of Newcastlemax, Capesize, Kamsarmax, Panamax, Post-Panamax, Ultramax, Supramax and Handymax vessels with carrying capacities between 45.588 DWT and 209.000 DWT.

StealthGas Inc. is a provider of international seaborne transportation services to LPG producers and users. It is listed for trading on NASDAQ Stock Market and the main office is in Athens, as it is mainly managed by Greek people.

StealthGas Inc. owns and operates the world's largest independently owned Handy sized LPG carrier fleet in the 3.000 to 8.000 cubic meter range. The company owns 47 handysized LPG carriers, 3 medium range product carriers and 1 aframax tanker. The company has a new building program of 17 new buildings to be delivered by the end of 2017.

Pan Ocean Co. Ltd. was incorporated in 1966 and it is one of the largest shipping companies in South Korea. In 2013 the company changed its name from STX Pan Ocean to Pan Ocean. The company is listed for trading on Korea Stock Exchange and on Singapore Stock Exchange.

Pan Ocean Co. Ltd. owns a fleet of 288 vessels. It is consisted of break bulk liner vessels, tramper vessels, large bulker vessels, container vessels and specialized vessels.

TBS International Plc. provides worldwide shipping services such as ocean transportation, projects, operations, port services and strategic planning. The company is listed for trading on NASDAQ Stock Market from 1997. The main office of the company is in New York. The company operates mainly its vessels on trade routes around South America and between Latin America and Japan, South Korea and China, as well as ports in North America, the Caribbean, Africa, India and the Middle East.

TBS International Plc. owns a fleet of 14 vessels, consisted of multipurpose tweendeckers and handysize / handymax bulk carriers. The total capacity of the fleet is 626.969 DWT.

Teekay Corporation was incorporated in 1973 and the main office is in Vancouver of Canada. It is listed for trading on New York Stock Exchange from 1995. Teekay owns three affiliate companies that they are also listed for trading on New York's Stock Exchange. The three affiliate companies are: 1) Teekay LNG Partners, Teekay Offshore Partners and Teekay Tankers Ltd.

Teekay corporation operates one of the world's largest conventional tanker fleets including aframax, long range (LR), medium range (MR), suezmax and very large crude carrier (VLCC) vessels. The company owns 160 vessels and operates 19 chartered-in vessels. Teekay has also a newbuilding program for 37 vessels to be delivered by the end of 2016.

Top Ships Inc. was incorporated in 2000 and the main office is in London. The company is listed for trading on NASDAQ Stock Market from 2004. Top ships owns tanker vessels focusing on the transportation of petroleum products and bulk liquid chemicals. The company mainly is managed by greek people.

Top Ships Inc. owns currently one tanker with capacity of 49.737 DWT. The company has a newbuilding program of five vessels to be delivered by the end of 2016 with total capacity of 227.760 DWT.

Torm was incorporated in 1889 and the main office is in Copenhagen. It is listed for trading on NASDAQ OMX in Copenhagen. The company owns a large and modern fleet. Torm is one of the world's leading carriers of refined oil products such as gasoline, jet fuel, naphtha and diesel oil.

Torm owns a fleet of 72 tankers. The total capacity of the fleet is 3.852.507 DWT. The fleet is consisted of Handysize, LR1, LR2 and MR vessels.

Tsakos Energy Navigation Ltd. is incorporated in Bermuda but the main office is in Athens. It is one of the largest shipping companies worldwide that provides seaborne petroleum product and crude oil transportation services. The company is listed for trading on the New York Stock Exchange from 2002. In the past the company was listed also for trading on the Oslo Stock Exchange from 1993 until 2005.

Tsakos Energy Navigation Ltd. owns a fleet of 48 vessels. The fleet is consisted of 45 modern petroleum product tankers and crude oil carriers, 1 Liquified Natural Gas (LNG) and 2 DP2 shuttle suezmax tankers. The company has also a newbuilding program for 1 LNG carrier with expected delivery in 2016. The resulting fleet would comprise 49 vessels with approximately capacity of 4.9 million DWT.

Wilson ASA. was incorporated in 1923 and the main office is in Oslo. The company is listed for trading on the Oslo Stock Exchange from 2005. The company owns a fleet of small and middle size vessels.

Wilson ASA. operates a fleet of 110 vessels, whereof 83 are owned by the Wilson Group. The fleet is consisted of bulkers, general cargo, self dischargers and container vessels. The total capacity of the fleet is approximately 460.000 DWT.

4.3 Statistical data of DEA analysis

As it has already been mentioned before, the statistical sample consists of some of the leading, listed shipping companies all over the world. The data that will be presented are variables of the sample analysis (inputs-outputs) concerning the financial figures of the companies and are presented in millions USD. The results of the analysis are for the years 2011, 2012, 2013 and 2014 so as throughout that period an all-time analysis of the companies' efficiency can be achieved.

As it has already been presented, the sample constitutes of shipping companies focusing on different maritime disciplines: dry, wet, multiple and container cargo. Table 7.1 shows certain statistical data for the analysis input. It can be noticed that the sample is consisted of companies of different financial sizes, something that can be depicted by each company's fleet size.

The definitions of six variables representing each company's data in the analysis are followed. These variables have been described analytically in chapter two.

Table 4.1: Statistics of The Variables

Variable	Lowest Value	Highest Value	Average	Median
2011				
Total Asset	134.980	70.444.000	4.738.047	1.364.928
Vessels Value	1.708	42.393.330	2.788.959	1.034.756
Op. Cost	16.302	36.098.000	2.322.089	290.382
Vessels Op. Cost	13.328	19.507.462	1.519.006	142.866
Revenue	29.538	60.230.000	2.925.940	352.823
Gross Profit	-142.188	72.512.000	2.153.610	53.791
2012				
Total Asset	61.799	875.752.000	22.968.318	1.715.512
Vessels Value	37.503	50.249.000	2.973.913	962.203
Op. Cost	27.307	39.965.000	2.564.390	394.996
Vessels Op. Cost	12.272	20.210.642	1.341.303	167.860
Revenue	8.928	59.036.000	2.919.307	343.074
Gross Profit	-379.233	20.349.500	580.573	43.257
2013				
Total Asset	87.632	932.354.000	24.704.472	1.646.676
Vessels Value	35.067	14.740.617	1.982.986	911.429
Op. Cost	20.084	36.261.000	2.371.677	349.073
Vessels Op. Cost	9.498	17.045.910	1.554.422	208.019
Revenue	6.074	18.971.010	1.589.713	293.384
Gross Profit	-367.198	18.974.000	572.179	44.151
2014				
Total Asset	152.069	974.055.000	28.376.400	1.750.715
Vessels Value	1.321	13.938.059	2.132.246	1.005.244
Op. Cost	23.383	35.633.000	2.372.508	403.870
Vessels Op. Cost	15.857	19.345.548	1.670.529	263.568
Revenue	12.609	21.737.656	1.766.406	379.350
Gross Profit	-213.589	19.252.000	1.158.212	92.465

Total Assets: it refers to the total amount of assets owned by a person or entity. Assets are items of economic value, which are expended over time to yield a benefit for the owner. If the owner is a business, these assets are usually recorded in the accounting records and appear in the balance sheet of the business.

Operating cost: it refers to the total operating expenses of a shipping company and includes both the operating vessel cost and other types of costs such as the administrative ones.

Revenue: it refers to the total income of a shipping company including both freight charges and other types of income.

Vessels Value: it refers to the value of the vessels that is subtracted from the total assets.

Operating Cost: it refers to the cost needed for a vessels operation and it constitutes a part of the total operating cost.

Gross Profit: it refers to the total income of a company coming for the vessels operation minus the operating cost of vessels.

Table 4.2: Data for Each Company for 2011

Company	Total Asset	Vessels Value	Op. Cost	Vessels Op. Cost	Revenue	Gross Profit
Algoma Central Corp.	867.466	493.809	446.570	399.495	547.760	119.080
AP Moller-Maersk A/S	70444	42393.330	36098.0	6303.801	60230.000	18804.200
Baltic Trading Ltd.	384.955	290.640	39.44	16.065	43.490	27.427
Capital Product Partners	1073.98	1073.98	95.02	57.804	130.310	72512.000
Concordia Maritime AB	3758.2	329.11	452.00	162.600	559.600	397.000
Cosco Shipping Co. Ltd.	2871.863	1223.504	780.790	723.876	779.089	55.213
China Shipping Dev. Co.	8279.57	3870.923	1701.87	1635.712	1945.210	309.498
D' Amico Int. Shipping S.A.	670.237	728.779	267.210	141.832	291.721	149.889
Danaos Corp.	3988.104	3241.951	262898	119.127	468.101	348.974
Diana Shipping Inc.	1604.471	1046.719	146.373	55.375	256.786	201.411
Dryships Inc.	8621.689	1956.270	791.223	111.862	1077.662	266.151
DS Norden	2350.255	1387.189	2086.400	2038.816	2272.819	186.419
Eagle Bulk Shipping	1867.257	1235.111	281.764	129.396	313.432	31.668
Euroseas Ltd.	296.148	237.063	57.318	33.160	64.129	30.969
Evergreen Marine Corp.	4145.830	1440.709	507.356	438.932	460.837	21.905
Freeseas Inc.	134.980	81.419	84.109	20.104	29.538	9.434
Frontline Ltd.	1840.569	1347.513	849.476	430.152	723.495	293.343
Genco Ship & Trad. Ltd.	3119.277	2794.860	279.575	143.899	392.214	248.315
General Maritime Co.	-	-	-	-	-	-
Globus Maritime Ltd.	256.059	242.507	26.119	13.328	35.559	22.231
Golden Ocean Group Ltd.	521.219	436.273	24.457	13.378	55.497	42.119
Goldenport Holdings Inc.	564.498	508.807	100.064	57.767	107.329	49.562
Gulf Navigation Hold. Pisc.	677.776	421.117	280.211	61.042	69.217	8.175
Hellenic Carriers Ltd.	188.419	105.014	16.302	15.024	33.186	18.162
Hyundai Merchant Marine	8432.299	4124.445	7032.708	6854.772	7420.767	565.995
Malaysian Bulk Carriers	536.683	1.708	75.570	29.059	98.263	69.204
Mitsui O.S.K. Lines	22474.336	15534.396	17080.698	15982.682	18654.775	2582.093
Navios Maritime Holding	2913.824	1767.946	545.311	439.549	621.235	181.686
Nepture Orient Lines	4136.553	2929.999	8847.574	7754.890	9210.704	1255.814
Newlead Holdings Ltd.	396.752	269.519	50.301	108.625	57.926	-50.625

Nippon Yusen KK	25578.026	8512.562	21729.681	19507.462	23201.079	3693.617
Nordic American Tankers	1125.385	1022.793	150.885	85.174	94.787	9613
Overseas Shipping Group	3993.545	3292.946	1191.719	1011.998	1049.531	-142.188
Paragon Shipping Inc.	432.073	268.608	95.025	54.208	86.907	32.699
Precious Shipping Pcl.	686.797	283.365	81.569	39.998	103.005	52.368
Qatar Gas Transport Co.	7746.784	7262.495	704.521	544.789	811.375	266.586
Regional Container Lines	810.800	528.000	510.700	467.500	498.200	-20.400
Safebulkers Inc.	877.271	655.356	60.179	34.079	168.908	108.936
Scorpio Tankers Inc.	448.230	322.458	157.709	105.210	82.110	-23.100
Seacore Holding Inc.	3928.134	1321.178	2052.558	1895.734	2141.942	246.208
Star Bulk Carriers Corp.	717.928	638.532	171.444	125.247	107.065	-18.182
StealthGas Inc.	695.710	313.098	98.454	28.885	118.280	89.395
Pan Ocean Co. Ltd.	4500.380	3800.200	713.456	680.000	690.500	10.500
TBS International Plc.	920.560	757.850	299.000	260.540	304.790	44.250
Teekay Corp.	11137.677	7890.761	1845.370	1710.500	1953.782	243.282
Top Ships Inc.	675.678	678.432	108.876	76.020	93.000	16.980
Torm	2779.000	2258.550	1398.301	1309.501	1305.000	4.501
Tsakos Energy Navigation	2535.337	2194.360	484.112	412.790	395.162	-17.628
Wilson ASA	419.679	353.899	300.004	270.530	289.050	18.520

Table 4.3: Data for Each Company for 2012

Company	Total Asset	Vessels Value	Op. Cost	Vessels Op. Cost	Revenue	Gross Profit
Algoma Central Corp.	875.752	519.965	437.760	389.510	527.870	109.180
AP Moller-Maersk A/S	72396.000	50249.000	39965.000	6767.440	59036.000	20349.500
Baltic Trading Ltd.	364.370	280.600	40.27	17.8720	27.300	9.430
Capital Product Partners	959.550	959.550	150.700	51.430	153.950	102.520
Concordia Maritime AB	3480.700	306.450	465.900	139.70	543.400	403.700
Cosco Shipping Co. Ltd.	3065.565	1210.070	891.550	882.594	948.241	62.647
China Shipping Dev. Co.	9257.680	4020.050	1800.360	1515.510	1768.580	253.070
D' Amico Int. Shipping S.A.	676.895	770.796	308.565	141.832	325.253	183.421
Danaos Corp.	4212.045	3986.138	436.876	123.356	589.009	465.653
Diana Shipping Inc.	1742.802	1211.138	161.490	66.293	223.232	156.939
Dryships Inc.	8878.491	2059.570	1161.127	116.151	1210.139	152.085
DS Norden	2033.392	967.219	1983.500	1940.213	2131.439	147.939
Eagle Bulk Shipping	1789.144	1160.038	228.030	116.663	190.811	-37.219
Euroseas Ltd.	278.312	206.934	54.050	31.681	54.921	23.240
Evergreen Marine Corp.	4655.991	1736.852	4456.105	4105.920	4230.791	
Freeseas Inc.	114.359	75.690	28.036	18.146	14.260	-3.886
Frontline Ltd.	1688.221	1202.948	594.212	422.132	578.361	156.229
Genco Ship & Trad. Ltd.	2843.371	2662.403	295.798	157.000	226.453	69.453
General Maritime Co.	-	-	-	-	-	-
Globus Maritime Ltd.	165.722	140.860	112.379	16.719	32.197	15.478
Golden Ocean Group Ltd.	397.420	273.826	27.307	16.190	37.315	21.125
Goldenport Holdings Inc.	422.699	387.762	138.012	53.247	78.271	25.024
Gulf Navigation Hold. Pisc.	594.126	405.022	269.762	48.604	54.276	5.672
Hellenic Carriers Ltd.	159.781	77.028	31.454	12.272	13.168	0.896
Hyundai Merchant Marine	7908.884	4279.190	7900.880	7654.550	8046.896	393.346
Malaysian Bulk Carriers	514.845	130.484	72.879	28.315	70.811	42.496
Mitsui O.S.K. Lines	23678.817	16477.856	17759.837	1654.033	17462.234	808.201
Navios Maritime Holding	2929.335	1746.493	535.674	440.890	633.714	192.824
Nepture Orient Lines	5972.361	3637.161	9913.724	7899.354	9511.631	1412.277
Newlead Holdings Ltd.	61.799	37.503	104.628	25.398	8.928	-16.470

Nippon Yusen KK	21222.340	9361.260	22289.138	20210.642	21995.617	1784.974
Nordic American Tankers	1085.624	964.855	203.874	129.365	130.682	1.317
Overseas Shipping Group	4043.535	2911.706	1516.367	1315.083	1137.134	-379.233
Paragon Shipping Inc.	419.974	298.376	68.895	32.658	50.300	17.642
Precious Shipping Pcl.	720.890	486.377	110.412	61.369	114.840	43.257
Qatar Gas Transport Co.	8341.068	6801.855	712.905	561.563	811.584	250.215
Regional Container Lines	670.300	488.500	502.500	429.300	449.000	7.300
Safebulkers Inc.	1082.214	810.001	84.022	49.552	184.296	111.951
Scorpio Tankers Inc.	573.280	395.412	132.556	110.537	115.381	4.844
Seacore Holding Inc.	3700.794	1474.580	1275.879	1144.212	1308.297	164.085
Star Bulk Carriers Corp.	354.706	291.207	393.132	356.312	86.162	-270.150
StealthGas Inc.	713.039	342.033	79.921	52.514	119.213	66.699
Pan Ocean Co. Ltd.	4750.430	3905.789	708.543	670.200	710.351	40.151
TBS International Plc.	940.800	760.450	396.860	322.700	360.894	38.194
Teekay Corp.	11002.025	7321.058	2106.628	1960.680	1956.235	-4.445
Top Ships Inc.	632.670	590.543	102.890	77.100	90.530	13.430
Torm	2355.000	1948.348	1367.900	1291.125	1121.000	-170.125
Tsakos Energy Navigation	2450.884	2088.358	443.045	388.050	393.989	5.939
Wilson ASA	425.032	328.540	269.400	205.707	261.800	56.093

Table 4.4: Data for Each Company for 2013

Company	Total Asset	Vessels Value	Op. Cost	Vessels Op. Cost	Revenue	Gross Profit
Algoma Central Corp.	932.354	529.734	396.604	352.212	491.499	110.959
AP Moller-Maersk A/S	73509.000	4094.979	36261.000	7812.000	47386	18974.000
Baltic Trading Ltd.	557.367	456.290	42.882	18.741	35.97	17.232
Capital Product Partners	1176.81	1328.040	130.171	61.413	171.49	110.081
Concordia Maritime AB	3406.5	291.560	467.400	132.100	467.80	335.700
Cosco Shipping Co. Ltd.	2803.455	1264.850	1115.235	1069.426	1111.520	42.094
China Shipping Dev. Co.	9414.79	4432.790	1843.970	1520.830	1815.064	294.234
D' Amico Int. Shipping S.A.	615.906	770.796	263.279	102.175	293.384	191.209
Danaos Corp.	4066.552	3842.617	315.651	122.074	588.117	466.043
Diana Shipping Inc.	1701.981	1320.375	173.795	77.211	164.452	87.241
Dryships Inc.	10123.692	2249.087	1255.070	208.019	1492.014	103.745
DS Norden	2061.242	1077.953	2129.674	2077.359	2145.899	16.225
Eagle Bulk Shipping	1765.235	1100.539	212.340	119.320	180.655	61.335
Euroseas Ltd.	156.616	105.463	139.102	34.086	40.850	6.764
Evergreen Marine Corp.	5230.573	2285.072	4674.854	4164.829	4176.491	11.662
Freeseas Inc.	87.632	71.834	47.968	17.438	6.074	-11.364
Frontline Ltd.	1367.605	999.280	641.182	441.241	517.190	75.949
Genco Ship & Trad. Ltd.	-	-	-	-	-	-
General Maritime Co.	-	-	-	-	-	-
Globus Maritime Ltd.	155.662	133.577	22.952	15384	29.434	14.050
Golden Ocean Group Ltd.	409.858	262.747	30.722	19.643	37.546	17.903
Goldenport Holdings Inc.	360.957	319.064	60.495	37.501	59.790	22.289
Gulf Navigation Hold. Pisc.	384.600	193.693	275.219	39.993	36.901	-3.092
Hellenic Carriers Ltd.	161.116	124.701	20.084	9.498	10.923	1.425
Hyundai Merchant Marine	6854.879	4354.281	6670.440	6120.090	7068.685	948.595
Malaysian Bulk Carriers	546.977	139.054	70.845	22.886	69.008	46.122
Mitsui O.S.K. Lines	23015.534	14740.617	16214.354	15226.093	16046.720	820.627
Navios Maritime Holding	3158.267	1808.855	520.452	435.763	512.279	76.516
Nepture Orient Lines	6544.045	4674.400	8837.755	8051.320	8831.193	779.873
Newlead Holdings Ltd.	151.331	35.067	152.021	90.512	7.343	-83.169

Nippon Yusen KK	24301.380	8744.239	18796.660	17045.910	18971.010	1925.350
Nordic American Tankers	1136.437	911.429	349.073	257.889	243.657	-14.232
Overseas Shipping Group	3644.494	2416.600	1383.194	1206.918	1015.996	-367.198
Paragon Shipping Inc.	419.545	306.135	76.270	45.762	56.256	10.494
Precious Shipping Pcl.	765.292	560.086	129.735	71.577	144.858	44.151
Qatar Gas Transport Co.	8287.878	7338.761	719.667	367.155	923.718	556.563
Regional Container Lines	598.300	444.900	487.300	417.600	432.000	8.900
Safebulkers Inc.	1112.216	855.200	100.925	60.550	186.721	92.846
Scorpio Tankers Inc.	1646.676	530.270	189.788	163.789	207.850	44.061
Seacore Holding Inc.	3116.233	1332.853	1184.737	1050.219	1247.272	197.053
Star Bulk Carriers Corp.	468.088	326.674	61.551	48.065	69.894	21.829
StealthGas Inc.	850.984	472.594	92.371	60.125	121.481	61.356
Pan Ocean Co. Ltd.	4396.513	3705.779	640.200	590.500	630.120	39.620
TBS International Plc.	1053.520	845.600	406.650	345.800	380.970	35.170
Teekay Corp.	11555.701	6554.820	1769.334	1162.974	1830.085	667.111
Top Ships Inc.	680.100	630.530	130.345	100.210	120.430	20.220
Torm	2008.000	1697.423	1230.500	1067.674	992.000	-75.675
Tsakos Energy Navigation	2483.899	2173.068	456.949	385.900	418.379	32.479
Wilson ASA	442.760	346.070	278.060	210.069	268.153	58.084

Table 4.5: Data for Each Company for 2014

Company	Total Asset	Vessels Value	Op. Cost	Vessels Op. Cost	Revenue	Gross Profit
Algoma Central Corp.	974.055	530.726	401.440	356.892	503.68	116.550
AP Moller-Maersk A/S	68844.000	4682.000	35633.000	7222.000	49569	19078.000
Baltic Trading Ltd.	568.218	486.990	59.857	26.268	45.52	19252.000
Capital Product Partners	1186.710	1320,980	132.066	68.274	192.78	124.500
Concordia Maritime AB	3715.800	312.970	474.800	137.000	531.20	394.200
Cosco Shipping Co. Ltd.	2810.090	1282.585	1146.970	1087.530	1153.903	66.373
China Shipping Dev. Co.	10625.500	4985.010	1980.800	1620.330	1945.950	325.620
D' Amico Int. Shipping S.A.	804.518	573.152	289.854	102.827	315.304	212.477
Danaos Corp.	-	-	-	-	-	-
Diana Shipping Inc.	1787.122	1373.133	194.836	123.805	175.576	51.771
Dryships Inc.	10371.603	2141.617	1604.903	233.593	2185.524	134.854
DS Norden	1778.016	1050.064	2307.511	2251.696	2038.107	-213.589
Eagle Bulk Shipping	1723.414	1639.555	166.489	105.250	123.150	17.900
Euroseas Ltd.	190.578	111.150	55.262	34.731	42.586	7.855
Evergreen Marine Corp.	-	-	-	-	-	-
Freeseas Inc.	-	-	-	-	-	-
Frontline Ltd.	962.179	622.438	632.908	416.828	559.688	142.860
Genco Ship & Trad. Ltd.	-	-	-	-	-	-
General Maritime Co.	-	-	-	-	-	-
Globus Maritime Ltd.	152.069	141.736	23.383	15.857	26.378	10.521
Golden Ocean Group Ltd.	1260.740	852.665	77.229	57.668	96.715	39.047
Goldenport Holdings Inc.	316.445	283.130	58.668	38.817	46.572	7.755
Gulf Navigation Hold. Pisc.	276.363	185.369	33.511	24.325	34.479	10.154
Hellenic Carriers Ltd.	-	-	-	-	-	-
Hyundai Merchant Marine	6476.768	4255.050	6352.630	6070.908	6778.608	707.700
Malaysian Bulk Carriers	-	-	-	-	-	-
Mitsui O.S.K. Lines	22976.049	13938.059	16404.586	15428.508	16803.848	1375.340
Navios Maritime Holding	3158.267	1934.368	510.310	420.240	569.016	148.776
Nepture Orient Lines	5506.695	5890.535	924.891	8000.423	8616.782	616.359
Newlead Holdings Ltd.	190.323	121.255	127.084	50.070	12.609	

Nippon Yusen KK	24788.543	8974.184	21300.456	19345.548	21737.656	2392.107
Nordic American Tankers	1169.024	909.992	365.357	276.793	351.049	74.256
Overseas Shipping Group	3436.491	2275.630	862.332	710.316	957.434	95.102
Paragon Shipping Inc.	460.965	369.032	106.593	54.576	54.763	0.187
Precious Shipping Pcl.	837.255	662.127	142.416	81.708	139.848	55.542
Qatar Gas Transport Co.	8388.638	7392.867	727.459	391.230	969.109	577.879
Regional Container Lines	559.100	412.900	406.300	367.300	420.200	42.400
Safebulkers Inc.	1182.329	960.423	130.981	79.025	154.094	26.716
Scorpio Tankers Inc.	2804.643	1971.878	271.800	250.342	342.807	92.465
Seacore Holding Inc.	3245.033	1184.673	1206.129	1074.310	1319.394	245.084
Star Bulk Carriers Corp.	2062.084	1441.851	148.819	133.523	147.387	13.864
StealthGas Inc.	945.879	711.352	108.942	68.957	131.972	63.015
Pan Ocean Co. Ltd.	4038.785	3160.081	600.482	560.253	670.431	110.178
TBS International Plc.	1080.450	890.430	423.657	380.790	407.650	26.860
Teekay Corp.	11864.212	6399.747	1582.791	1145.302	1993.920	848.618
Top Ships Inc.	705.250	670.420	120.200	85.148	140.864	55.716
Torm	1384.000	1217.809	790.340	666.691	624.000	-42.691
Tsakos Energy Navigation	2669.097	2199.154	467.295	371.521	501.013	129.492
Wilson ASA	450.540	354.900	290.000	225.060	277.919	52.859

Chapter 5

METHODOLOGY: DATA ENVELOPMENT ANALYSIS

5.1 Introduction

The method used in this dissertation to analyse the efficiency of the listed shipping companies is Data Envelopment Analysis (DEA).This method is based on the study of Charnes, Cooper and Rhodes (1978) 'Measuring the Efficiency of Decision Making Units'. Initially, it was developed with an intention of evaluating the relative efficiency of individual units- organizations such as bank branches, hospitals and schools. However, this method has developed continuously up to now both in terms of its theoretical aspects and in terms of its practical applications.

In this chapter, the theoretical aspect of this method is presented as well as its application based on realistic examples so that its rationale to be fully comprehended and to display its advantages over other methods. At the beginning, the term efficiency of a production unit is presented. Next, the method of efficiency measurement is presented together with its advantages over traditional methods like productivity indicators and numerical indices of accountancy. After that, DEA method is presented and its mathematical type. The presentation is done under the premise that the companies operate with stable economic scale.

5.2 The term efficiency

5.2.1 Basic terms

Efficiency measurement is important in a productive procedure since it allows conclusions to be drawn after comparing efficiency from different units. This sort of comparison allows various units to know how to compare themselves with other similar and usually competitive units and to use this knowledge as a tool to improve their performance and consequently their productivity. Performance of homogeneous productive or business units can be measured with DEA method

based upon the terms of efficiency and productivity. The main concept of DEA is its determination to how productive one business unit is into converting inputs into outputs in comparison with another group of similar business units which have the same productive process. In other words, DEA is a method allowing the measurement of the relative efficiency of group of similar productive or business units.

The measurement unit of DEA method is the productive or business unit (Decision Making Unit –DMU) which aims at profit and uses inputs in producing outputs in a productive process. This type of unit determines both the technical and economic ratio between inputs and outputs in seeking profit and the profit gets higher as the cost per product production unit is lower, while the input productivity and efficiency is higher.

The core point which allows comparison between units of a sample is the assumption that all productive or business units of the sample use the same productivity function. In other words, we assume inputs and outputs of the same kind for every unit.

Efficiency calculated for every unit reflect in reality the possibility of input reduction or output increase for stable inputs and outputs respectively, and they are called 'relative' as they are calculated based on the other units of the sample since in practice, there isn't usually the required data to calculate the absolute efficiency.

Efficiency for an input and an output is calculated in the following way:

$$\text{Efficiency} = \frac{Ouputs}{Inputs}$$

While for more than one input and output, the above ratio changes to:

$$\text{Efficiency} = \frac{Output \cdot u_1 + Output \cdot u_2 + \cdots}{Input \cdot v_1 + Input \cdot v_2 + \cdots}$$

The determining factors for every input (u) and output (v) are not available. If they were known, there wouldn't be any problem in defining efficiency.

5.2.2 Technical Efficiency and Price Efficiency

Farrell, in his study 'The measurement of productive efficiency' (1957) supported that efficiency consists of two parts: a) technical efficiency which means the company's ability to produce the maximum product from a given amount of inputs and price or allocative efficiency which depicts the company's ability to use the right ratio of inputs in correlation with the output prices. Both the aforementioned efficiency measurements consist the total economic efficiency.

For a number of samples related to companies using one or more inputs to produce one or more products efficiency according to Pareto is defined as follows:

1. When one company puts emphasis on outputs, it can be productive according to Pareto if it cannot increase its productivity of one of its products without decreasing the productivity of one of the others or without increasing the use of one of its inputs.
2. Placing emphasis on inputs, a company is productive if it is not possible to reduce the use of an input without reducing the production of one of its products. In a mathematical way, these relationships can be defined as follows: If y_{rj} (r= 1…s) are the produced outputs and x_{rj} the inputs (i= 1,….,m) that the company uses then:
3. According to Pareto, with an emphasis on outputs, a company j_o is productive if there is not another company, j, where $j \neq j_{0,}$ and for which $y_{r'j} > y_{r'y0}$ and for some r' and $y_{rj} \geq y_{ry0}$ $\forall$ $r \neq r'$ while $x_{ij} \leq x_{ij0}$ $\forall$ i.

4. According to Pareto, with an emphasis on inputs, a company $j_{0,}$ is productive if there is not another company , j, όπου $j \neq j_{0,}$ and for which $x_{i'j} < x_{i'y0}$ for some i' and $x_{ij} \leq x_{iy0}$ $\forall$ $i \neq i'$, while $y_{rj} \geq y_{rj0}$ $\forall$ r.

   As a result, technical efficiency of a company can be presented in a mathematical way as follows:

   With emphasis on outputs, if L(x) = {y: y output of input x} and assume that L(x) is a closed and curved set, then the technical efficiency of a company (y, x) is $1/\theta^*$ where $\theta^* = \max \{\theta: (\theta\, y) \in L(x) , \theta>0\}$.

In a form of a diagram, this relationship for variables in economic scale can be depicted in the diagram 5.1

Diagram 5.1: Technical efficiency using economic scale variables

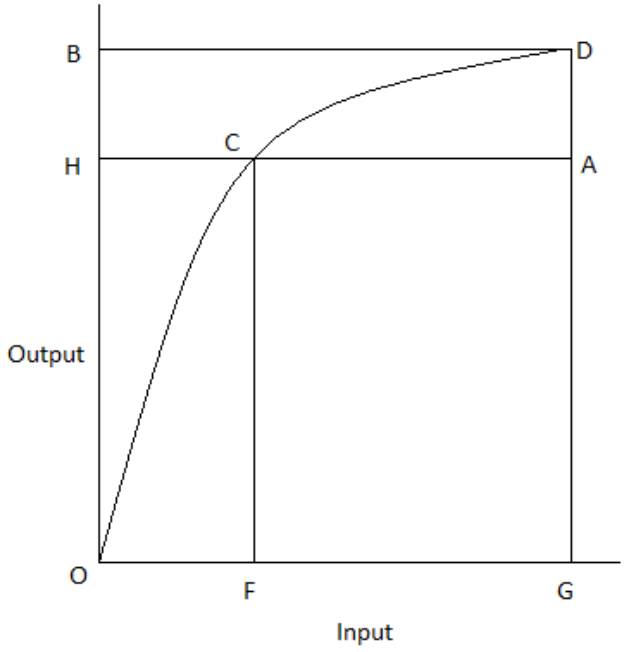
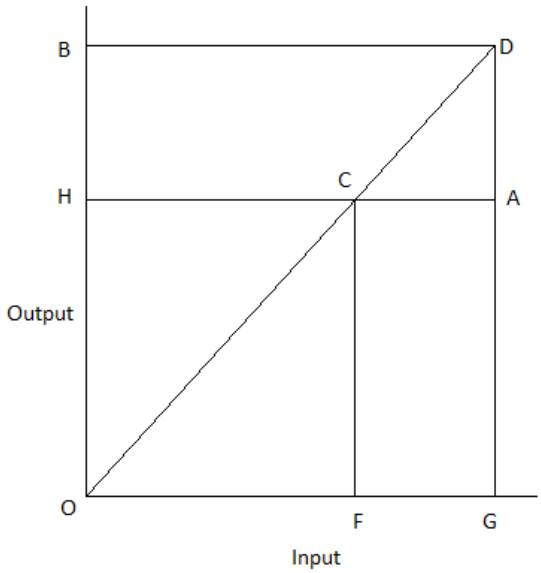


Diagram 5.2: Technical Efficiency using fixed variables of economic scales



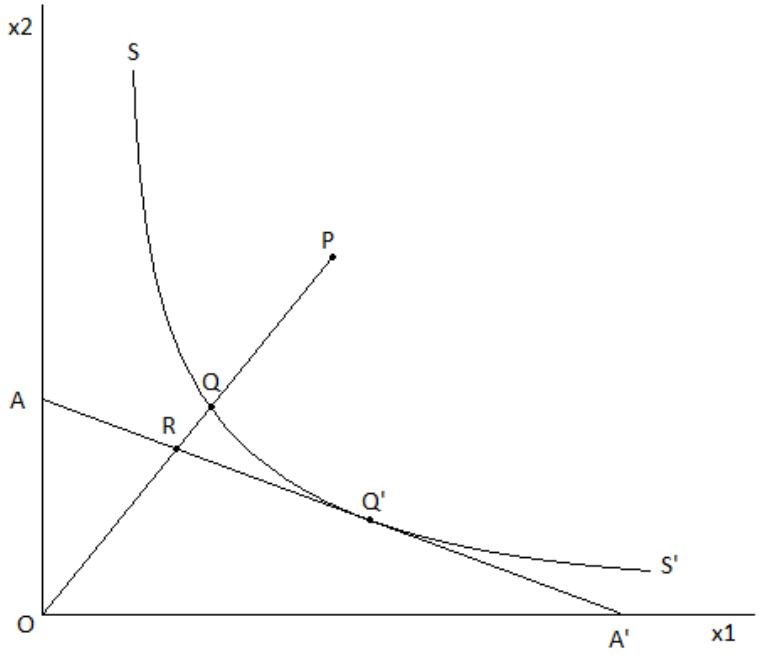
The curve OD shows the development of the maximum product which is achieved for the amount of input given, so OD is the 'productivity limit' of a company and the total of productive processes is the OCDGO surface. One company can operate either above OD curve, for example at D or lower at A. If the company operates at A, it is obvious that it could also operate at D having a bigger product for the same level of input. As a result, a company operating at A is not productive according to Pareto, as it could have achieved either a bigger product for the same level of input or the same product with lower level of input. In the diagram 5.2, we have the same for fixed variables in economic scale.

As it was defined above, technical efficiency of an A company is the proportion of the produced product to the maximum product that can be produced with the same input amount , in other words, OH/OB. Similarly, the technical efficiency of an A company is OF/OG, in which OF is the lowest input amount with which the A company can produce the product it produces, OG.

Apparently, the measurement of the technical efficiency of A company can differ accordingly whether the emphasis is on inputs or outputs (technical efficiency concerning inputs or outputs) and as a result to have a different company ranking related to their technical efficiency. This generally happens except when company A operates with fixed economic scales variables. In this case, the two technical efficiency measurements are equal. Also, it is apparent that when a company is productive according to Pareto, it will be placed above the productivety limit and conseqently both technical efficiency measurements are equal to a unit.

However, as technical efficiency is not mentioned in the values of products and inputs, it does not take into consideration the prices of products and inputs and it can give a false calculation of a company's efficiency. For example, a company can be technically productive according to Pareto, but it is possible not to use the least expensive inputs. Consequently, to measure efficiency, outputs costs should be taken into consideration, in other words, the prices of both products and inputs. In the case of two inputs (x1, x2) and one product and putting emphasis on inputs together with the assumption of fixed variables in economic scale , we will have the following diagram 5.3

Diagram 5.3: Efficiency with emphasis on inputs



The SS' curve is the already known curve of an equal product and in particular one unit of a product. As a result, SS' curve is the domain of all productive, according to Pareto inputs, with the meaning that a possible reduction in the use of one input, it would require the increase in the use of another input so as to remain at the same productivity level (a production unit). On the top right corner above SS' curve, there are all the inputs combinations that can produce a product unit but by using bigger amounts of inputs. The line AA', which is defined as the line of equal cost, presents the inputs combinations of the same costs. The cost line adjoins SS' line at point Q'. At this point, the combination of inputs that manage to produce one product unit has the lowest possible cost. Thus, point Q' which is productive according to Pareto, is higher not only than the other combinations which are less technically productive but also than all the other combinations which are technically productive.

When the prices of inputs are known, then the calculation of the price efficiency or the spread input value is feasible. Price efficiency displays the 'distance' of the input combination used by the particular productive unit and the best combination that

could be used so as to reduce the cost in the given input values. As a result, for the particular productivity unit operating at point P in the above diagram, the price efficiency will be OR/ OQ while the technical efficiency is OQ/OP. The least total of the two, which the total input cost at point A can reach, is OR/OP, which is defined as the total input efficiency.

To conclude, we define as Total Efficiency regarding inputs = (input technical efficiency) x (input price efficiency) i.e.

$$\frac{OR}{OP} = \frac{OQ}{OP} \cdot \frac{OR}{OQ}$$

In general terms, the price value in terms of the inputs of a productive unit can be defined as Cmin/Cte, which for some given input prices, Cmin is the lowest cost which a productive unit can produce outputs and Cte is the cost of the technically efficient input combination. The total productivity of a productive unit can be defined as Cmin/Cob, in which Cob is the inputs cost used in the productive unit. Mathematically, this can be expressed as follows:

For a set of efficient productive units according to Pareto, the vector Yrj (r= 1,..,s) defines the input levels produced by a productive unit j, Xij are the amounts of inputs (i = 1,…,m) used by the same productivity unit and input prices are Wki (i= 1,…m). Then the total efficiency of a productive unit in terms of input (Input Oriented Efficiency – IOE) is:

$IOE_k = C_k (y_k, w_k)/w_k x_k$, where $w_k = (w_{ki}, i=1,...,m)$, $x_k = (x_{ik}, i=1,...,m)^T$.

As a result, the product Wk Xk is the total cost of the productive unit k inputs. Furthermore, Ck (Yk, Wk) is the lower cost in which a productive unit k can produce outputs produced by Ck (Yk, Wk) = Min xi { Swki : x E L (yk)}, where L(yk) has been defined previously. Then, Input Oriented Allocative Efficiency - IAE the k productive unit is:

$IAE_k = IOE_k/TIE_k$, where TIEk (Total Input Efficiency – TIE) is the input technical efficiency of k productive unit.

In the case that emphasis is on outputs, price output efficiency can be defined as similar to the input one, but wit reference to the curved line of the same income instead of the curved line of the same cost.

In conclusion, two points have to be mentioned. First of all, a productive unit cannot be totally efficient without being technically efficient; however, the opposite does not count. In practice, it is essential for a productivity unit to be totally efficient rather than technically efficient. Nevertheless, it is not feasible to measure price efficiency and consequently the total efficiency without mentioning the correct input prices. Besides, efficiency measurement was defined higher with a reference to radial efficiency, which goes through of the axes beginning and as a result the proportion between input and output to remain steady. The major advantage of this definition is that it does not depend on the measurement unit and efficiency measurement does not change unless the measurement unit changes.

5. 3 Efficiency Measurement

A presentation of methods used to evaluate efficiency follows in the next chapters by citing both the advantages and disadvantages emerging during their application and their analysis interpretation.

5.3.1 Decision Making Unit

Every measurement and efficiency evaluation starts with the definition of Decision Making Unit (DMU). It is about a productive entity whose performance we want to evaluate by comparing it with other similar units. DMU can be a company in any business sector, for instance a shipping company, a bank, an industry and then the comparison is made between the companies of the same nature.

In addition, Decision Making Unit can also be one productive unit of a company, like the banking system of a bank, a ship of shipping company's fleet or a factory of an industry. In this case, comparison is made between the branches of the same bank, ships belonging to the same shipping company and factories belonging to the same

industry. Also, this method has been applied extensively in the banking sector to compare efficiency and productivity between branches, in the industrial sector to compare efficiency between factories producing electricity, in schools, hospitals etc.

It is fundamental to define Decision Making Unit and also to define inputs and outputs in order to have a successful evaluation and comparison of the units. If the above are not properly defined then the measurement results will be partial and they will not depict reality. The criterion used for comparison between Decision Making Units reflects the potential of the Unit either to reduce its production with lower cost or to produce a bigger product with the same cost(input)

However, the application of such seemingly simple rule is not easy at all in practice. There are difficulties both in defining Decision Units and defining inputs –outputs. Furthermore, the situation can be even be more complicated when there are different sized economic scales and Decision Units are of a different size too. For this reason, the simplistic methods measurements of indicators which will be presented later are not the best approach to compare efficiency between various units.

5.3.2 Efficiency indicators

The usual method to measure technical efficiency or simply the productivity of a company in terms of inputs-outputs it uses is the observation of the development of various indicators such as: labor productivity indicator, which associates the product with labor, capital productivity indicator, which associates the product with the capital and multi-factor indicator, which associates the produced product with capital, labor etc.

Such an efficiency indicator provides satisfactory information when sizes are adequate, accurate, available and quantitative measureable. This means measurement of both inputs and outputs of a Decision Unit in a particular time period. If inputs and outputs are known, then for instance, various productivity indicators can be drawn in the following form:

1. Quantity of produced products / Labor time needed (Labor Efficiency)

2. Quantity of produced products / Quantity of desired products to be produced (defined or maximum)
3. Quantity of produced products / Maximum quantity of products

Analyzing the first labor efficiency indicator, the numerator (production) apart from production in natural units, it can be expressed in other ways too. For instance, like the total production value in fixed prices, sales value in fixed prices, additional value (gross production value minus the value of intermediary products). Similarly, for the better approach of labor input in the denominator, apart from the labor time, the average number of employees can also be used. The reasons leading to the use of more than one of productivity indicators are the problem of evaluation, lack of proper data and reservations existing while the various quantities are expressed.

According to the traditional method, companies and listed companies used different accounting sizes to certify the profitability potential of every productivity unit. More specifically, they use the accounting figures of profits. Next, to compare like- natured companies (although there is also data between productivity units or other sectors within the same company) the general indicators are calculated as follows:

1. Capital used efficiency, which is depicted as: Profits/ Used Capitals
2. 'Active Capital' efficiency, which is depicted as : Profits/ Total of active capital and
3. Investment efficiency , which is displayed as: Profits/ Investments

Also, some other simple indicators are calculated like profits per employee, profits per ship, profits per transportation unit, profits per account, profits per total expenses, profits per employees' expenses, profits per operational expenses etc.)

These indicators provide data related to financial operation of a company's functions and enable someone to make all-time comparisons, like comparison with other companies. However, like any other solution, this method is subject to restrictions, and as a result is used reliably only under certain circumstances such as:

1. These indicators are static and they do not take into consideration the company's activities and investment decisions, which will have a future impact on the results.
2. These indicators are general because they group all the dimensions of a company's operation into one and they cannot properly depict their interdependence.
3. When these indicators are used as analyzing tools, there is not a proper reference to the composition of the company's activities.
4. To have an accounting evaluation of the profit in financial units, the total production cost is taken into account without having the ability to fully comprehend the source leading to increase in cost e.g. quantity, price.

This leads to the conclusion that:

1. A low-profitability company cannot be less productive than other high-profitability companies, which means that the correlation between profitability with profits shown in the indicators methods is inadequate.
2. It is not only enough for a company to reach high productivity levels having as ctiterion certain objectives (e.g profit increase , quantity increase etc.), but it also has to use in a productive way the means it has at its disposal so as to materialize them.
3. Finally, one of the major administrative objectives should be the localization of dysfunction of certain units, in other words, the creation of analyzing tools which could cover the weaknesses of the indicators as they were mentioned before.

5.4 DEA Method

5.4.1 Overview

The basic point of Data Envelopment Analysis (DEA) is the evaluation of the relative evaluation of individual companies or productive units (Decision Making Unit –DMU) of one sample.

Farrel's study is considered as a starting point of the whole attempt as he introduced techniques of linear programming to define efficiency and analyzed it in separated chunks. After him, Charnes, Cooper and Rhodes (1978) established the already widespread DEA method by introducing a new technique to help evaluate efficiency. This technique is non-parametric method based on linear programming , which achieves to evaluate in quantitative way the maximum value of the relative efficiency of production units. DEA assumes the existence of a set of productivity units and Decision Making Units – DMUs, which operate in a united frame, are comparable, homogeneous, consume the same quantities of inputs and also consume the same amount of multi -numbered inputs and outputs. For one input and one output, efficiency is defined as follows:

$$\text{Efficiency} = \frac{Output}{Input}$$

While for more inputs and outputs the above type changes to:

$$\text{Efficiency} = \frac{Output_1 + Output_2 + \cdots}{Input_1 + Input_2 + \cdots}$$

However, inputs as well as outputs do not carry the same weight and balancing factors are used :

$$\text{Efficiency} = \frac{Output_1 \cdot u_1 + Output_2 \cdot u_2 + \cdots}{Input_1 \cdot v_1 + Input_2 \cdot v_2 + \cdots}$$

The weight factors for every input (v) and output (u) are not available. If they were known, then there wouldn't be any problem in defining efficiency. DEA takes these factors into account.

The weakness of the traditional methods of Decision Making Unit analysis of efficiency with indicators also applies to the case in which multi- inputs are used to produce multi –outputs. With an intention of overcoming the endogenous weaknesses which co-exist in the application of traditional analysis methods of the companies, which also affect other company's activities with multi-inputs to produce multi-outputs (products or services), DEA was developed, which a technique having to do with linear programming. For the application of such a method to measuring efficiency in shipping companies some data is needed like data measuring each one of the products and every input used to be produced, time reference e.g. year, month etc. The products should be included are the ones that the management department believes are the basic ones to fulfill the company's objectives. As for the inputs, the ones that should be included are those which are essential for the products production. As a result, both outputs and inputs will have to be measured with natural units. Nevertheless, financial units are usually the only available measurement units of inputs- outputs.

DEA uses linear programming to create, with the help of data, an effective frontier and later to calculate DMU efficiency in relation to this frontier. DEA contribution is the determination of weighing factors u and v. Overall, after having applied this method to a sample, the degree of the relative efficiency of every DMU is evaluated in comparison to other sample units. This can be achieved by maximizing the ratio of the total balanced input related to balanced total of outputs for every DMU.

The use of DEA solves, to a great extent, the problems indicators show as based on this method a point estimation is achieved, displayed on a number showing the effective use of all inputs for the production of a desired input. When DMU are compared based on indicators, there is no such a measure showing with accuracy their efficiency. Usually, units with values of the corresponding indicator either

higher or lower than the average total indicator are characterized as effective or ineffective. Besides, the analysis includes multiple inputs and outputs (products-services), not necessary measurable from the same measurement units (e.g. a transportation project, invested capital, expenses etc.). Furthermore, inputs which are 'categorial' variables are adapted like markets classifications which are served by companies. Finally, inputs having a qualitative dimension can be included.

The core analysis point of DEA is the comparison of the relative efficiency of MDU units of a sample. Initially, this method was used for the efficiency analysis of non-profitable organizations (Hospitals, schools, state organizations etc.), where the traditional accountancy techniques couldn't provide reliable measurements. Gradually, this method gained a broader acceptance, as it has become obvious that it also provides useful information about the operation of profitable organization which are characterized basically from the use of multiple inputs so as to produce multiple outputs.

This method has been applied with success to evaluate efficiency to bank branches, hospitals, courts, airport services, pharmacies, electricity board services as well as to a number of scientific domains. The meaning of MDU has expanded its application and has a different interpretation depending on the domain used. In a number of applications of this method, units are considered the administrative departments of a company, public organizations, school and university faculties, bank branches, even offered services, employees, business plans, insurance contracts, credit cards etc.

A special issue of Annals of Operations Research (Vol.73, 1997), which has a special publication devoted to DEA method, presents some of the most depictive applications of this method.

5.4.2 The mathematical form of the basic model

This sample evaluates the degree of the relative efficiency of every DMU in terms of the other units of the sample. This can be achieved with maximizing the ratio of the weighed total of outputs in terms of weighed total of inputs for every DMU as follows:

$$\underset{v_i, u_r}{\mathbf{Max}} \; h_o = \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}} \quad [1]$$

$$s.t. \; \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \; \forall \, j = 1, \ldots, n$$

Ur, Vi ≥ e

$$i = 1, \ldots, m \quad r = 1, l, s$$

In which:

h_o is the relative efficiency of unit o

o is the unit evaluated from the set of j = 1,…,n units

j is the number of units j = 1,...,η

r is the number of outputs r = 1,…,s

i is the number of inputs I = 1,..,m

y_{rj} is the amount of output r of unit j (r = 1,2,...,s)

x_{ij} is the amount of input i of unit j (I = 1,...,m)

e is a small positive number (e.g.. e = 10^{-6})

v_i,u_r are the factors for input i and output r respectively, which maximize the partial total of every unit used.

This model is known as CCR (Charnes, Cooper, Rhodes) model. The model in (1) is a non-linear problem of improvement that can also be depicted in a linear form. The most important point concerns the logical explanation of the mechanism leading to the problem solution in terms of efficiency measurement.

A decision unit jo 'selects' the set of weighed factors (vi, ur) for inputs and outputs in order to maximize its relative efficiency. The same weighing factors are then used

in the other units to calculate their efficiency. If another unit with hifger degree of efficiency cannot be found with the use of weighing factors of the fist unit jo, then this unit is evaluated as relatively productive otherwise is considered unproductive. The above 'non-linear' model can be converted, by placing more emphasis outputs, easily into a linear model (Charnes et. Al, 1978, Banker et. al. 1984), as follows:

$$\underset{v_i, u_r}{\mathbf{Max}}\ h_o = \sum_{r=1}^{s} u_r y_{ro} \quad [2]$$

$$s.t. \sum_{i=1}^{m} v_i x_{io} = 1$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leqslant 0 \ \forall\, j = 1, \dots, n$$

Ur, Vi ≥ e

The above type is explains as follows: There are units in the model one of which produces different products by using m different inputs and our aim is to find the relative efficiency ho of every unit in relation to other units of the model.

The relative efficiency ho is the ratio of fixed outputs (real outputs) in relation to fixed inputs (real inputs) of every unit. The model reaches the highest possible value of ho by comparing the inputs and outputs of all model's units so that no branch has an indicator higher than 1. This means that for every unit by determining the values of u_r and v_i , as well as h_o. It has to be mentioned that h_o value has to be lower or equal to a unit, as the efficiency under observation includes the restrictions of model 2.

DEA method shows how efficient a unit is by using real inputs x_{io} to produce real outputs y_{ro} without knowing beforehand either the ratio between inputs-outputs or the ratio of production. So the input data is x_{ij} and y_{rj} while the variables are u_r and v_i.

The solution of the model includes the solution of similar to this programmes as they were presented in terms of model 2 by presenting different weighing factors pairs

(u_{rj} , v_{ij}) . In every program, the restrictions remain the same while their relation changes, as it has to maximize in numbers.

In conclusion, the model is applied once for every MUD of a sample and seeks the value combination of (u_r, v_i) that provides the unit which evaluates the highest degree of efficiency h_o, without resulting in a ratio between inputs-outputs more than 1 (100%) when it is applied to other units of the model.

For every unit, the degree of the relative efficiency is calculated, $h_o = 1$, which shows that a relatively productive unit, or $h_o < 1$, which shows a relatively unproductive unit. The efficiency degree is absolutely dependent on the model of study. If, for example, the estimation of the efficiency degree of a unit is $h_o = 1$, then this unit is the unit of 'the best practice', which means that it isn't necessarily productive but there aren't other units in the model which can be characterised as more productive. As a result, the main duty of DEA is to localise the relatively 'unproductive' units of the model ($h_o > 1$), the ones which could produce the same level and combination of outputs, which already produce, with a lower cost or with the same cost to produce more products.

Besides, this type of analysis provides to the ones who are responsible for decision making with the following information: For every unit labelled as relatively 'unproductive', DEA finds its subset in the report, in other words the set of units with which it had been compared with during the calculation of the efficiency degree so as not to be labelled as such a unit. This happens because the units in comparison present a similar 'profile' of inputs-outputs. This facilitates the determination of efficiency through the comparison between the unproductive unit and the subset of the productive ones as they were presented in the model. In this way, the need to compare 'unproductive' units with the whole set is avoided so that the reasons for such classification can be explained.

Research and actions of the responsible of Decision Making are oriented only towards sectors in which efficiency can be improved. The combination of inputs outputs of the reported subset, which is used for comparison with the values of the unproductive unit, is achieved with the help of a linear combination of the individual values of the unit. Information is given concerning the specific aims which the 'unproductive' units should set so as to improve their operation. Thus, reductions in

certain inputs are recommended, which these units could achieve without decreasing their productivity or in turn, increase in outputs, which they should seek in order to keep the same level of inputs. DEA provides information so that there are alternatives to convert an 'unproductive' unit to a 'productive' one.

As a result, based on these choices, the ones being responsible for Decision Making are able to apply the most viable and financial rights to realise their goals. More specifically, the degree of productivity of one branch is defined in relation to other similar ones and can be referred either to the increase in outputs or the decrease in inputs.

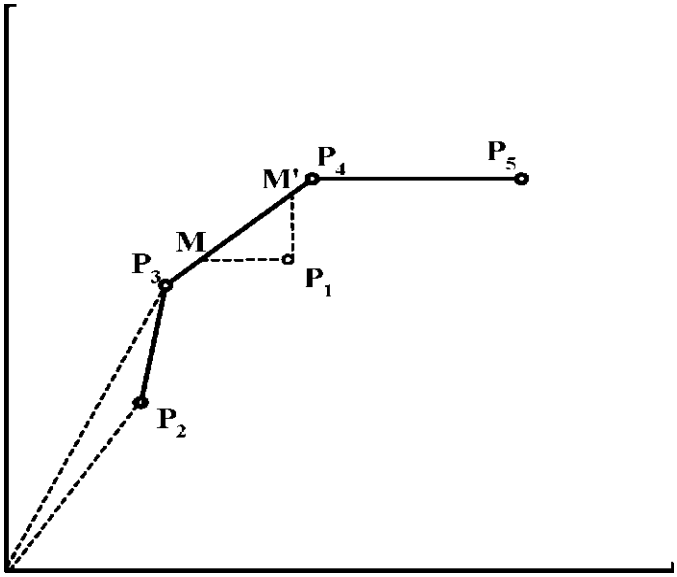
For example, by putting emphasis on input reduction, a unit is considered unproductive, when under the same setting, there are other units or a combination of other units which produce the same quantity for every input, use smaller quantity for at least one input and no bigger quantity for the rest of inputs. Similarly, by putting emphasis in increasing outputs, a unit is regarded as unproductive when under the same setting circumstances, there are other units or a combination of other units which while they use the same or smaller quantity for every input, they produce at least the same quantities for all outputs and a bigger quantity for at least one output.

According to the above, it is apparent that DEA is used for the evaluation of a ratio of outcome under the condition that there is a number of Decision Making Units. The outcome ratio is produced with a linear combination of inputs and outputs which provide the highest level of outputs for a given input quantity or the lowest input level concerning a particular output quantity. After that every Decision Making Unit is compared with the highest possible production frontier of the production ratio by evaluating a factor which depicts the degree of relative production. More analytically, the under-analysis DMU is enveloped from above when the sample meets other Decision Making Units in which outputs are either equal or bigger than that for the same input profile. Likewise, a Decision Unit is enveloped from below when the sample meets a combination of other smaller or the same number inputs as that one for the same output profile. If the unit under analysis cannot be enveloped simultaneously by a combination of other units, then this unit is relatively or more productive.

5.4.3 Diagram of the method

It is useful to present how this method can be displayed on a diagram with the help of a simple problem concerning the evaluation of units having one input and one output referring to diagram 5.4. In this diagram units P1, P2, P3, P4 and P5 are displayed. In the comparison problem of evaluating units, this method meets a 'frontier' of productive units which is called productive limit. In diagram 6.4 this frontier is defined by the broken line which goes through P2, P3, P4 and P5. The units consisting the meeting points of the limit as well as every other unit which is located above the aligned parts connecting the meeting points between them are technically called productive.

Diagram 5.4: Graphic Depiction of DEA



The term 'technical efficiency' has the meaning of weakness of reduction in input without reduction of output or vice versa; weakness of reduction in output without increasing the input. If we design the parallel of the axes straight parts which start from P1 and end up in the section of the productive limit defined by P3 and P4, then

we can define at these points two hypothetical units M and M1, which constitute the linear compositions of P3 and P4. It has to be said that the linear default is the fundamental point of DEA, as we analysed in the previous unit. It can be clearly seen that P1 has a disadvantage in relation to M, as M produces the same output as P1 consuming less input. Furthermore, M1 produces higher output than P1 while consuming the same input. For these reasons P1 Unit is evaluated by DEA as technically unproductive.

5.5 DEA Model with returns to scale – economic variables

The DEA evaluation in the previous models was based on the assumption of a fixed economic scale. However, if there is an assumption of the existence of variables in economic scale, then the model can examine whether the units of the sample present scale performance concerning the used inputs and outputs. The major advantage of this method lies in the fact that it can localise some units with upward ,others with downward and others with steady scale performances, if of course all these three cases appear.

In this case for every Decision Unit the following model known as BCC (Banker, Charnes, Cooper , 1984) is applied:

$$s.t. \sum_{i=1}^{m} v_i x_{io} = 1$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} - \omega_o \leq 0 \ , j = 1, \dots, n$$

Ur, vi ≥ e .....r, i, ωo

The parameter ωo is defined by the writers as the efficiency indicator of the DMUo scale. More analytically, if ω < O , then DMUo presents upward scale

trends . If ω > O then DMUo presents downward scale trends. Finally, if ω = O then DMUo presents steady scale performance.

It has to be mentioned that the overall productivity given from CCR model (1) is divided into two other efficiency categories: technical efficiency and price or allocative efficiency. A unit can have the maximum degree of efficiency when both technical efficiency and price efficiency reach their highest values. Technical efficiency is related to the conversion of inputs into outputs. A unit can be technically efficient when there isn't a possibility to produce more products with the same amount of inputs or to produce the same products with fewer inputs.

If there is available data regarding the cost per unit of the productive factor used, then the evaluation of the relative productivity of the units can be achieved with the calculation of the minimal cost needed so as to produce predefined output quantities. This type of efficiency is known as price or allocative efficiency as it defines the real and effective allocation of cost in the productive factors.

5.6 Conclusion

In this unit, the theoretical foundations of DEA method as well as its application were presented. Initially, the term of efficiency concerning a productive unit or a whole company were presented and then the way to measure efficiency. In this presentation the advantages of DEA over the other traditional methods were displayed as well as productivity indicators and accountancy indices of relevant situations. After that, there was a short presentation of DEA and its mathematical type, under the assumption that all companies operate with fixed economic scale and next under the assumption that companies operate with variable economic scale.

Efficiency indicators constitute useful tools to analyse efficiency of the productive means of a unit. These indicators allow all-time comparisons and the drawing of useful conclusions. However, one indicator is usually restricted to only one input and one output and it cannot include situations having to do with a number of inputs and outputs functioning at the same time. The efficiency of a productive unit can be

dependent on the indicator used. As a result, one unit can be evaluated as productive in terms of one indicator and unproductive in terms of another one, while the opposite can occur in another unit. In this case, factors of relative importance are needed for every indicator and many times are difficult to be evaluated.

Taking all the above into consideration, it can be inferred that it is difficult to evaluate, with a use of indicators, the efficiency of a whole unit displayed in one number. The inadequacies shown by the indicators are covered with DEA, which is considered not only complementary of previous methods but it consists a useful tool to take decisions, to develop strategy and benchmarking.

Chapter 6

DEA STATISTICAL ANALYSIS-RESULTS

6.1 Introduction

In this chapter, the method used for analyzing and applying DEA method is presented. Two models are presented, which were used for this purpose, their results are evaluated and useful conclusions are drawn for both the method used and the companies. Also, according to the data known for each company, companies are classified into categories and conclusions are drawn. Finally, results are compared and evaluated accordingly.

During the use of DEA, an input orientated model was used, which focuses on the fact that for the unproductive units to what extent they can decrease inputs for steady outputs. This is justified by the fact that shipping companies under observation for this study control more their inputs e.g. various costs and they aim at reducing or minimizing them.

Besides, it was assumed that there are economy scales and the equivalent model for this scale was used (BCC or variable returns to scale). This model presents the total efficiency as the ratio of technical efficiency together with the scale efficiency. In shipping companies, both profits and costs depend on the size of the company, as a result it is important to examine the existence of economy scales whether they show an upward or downward trend.

6.2 Models used in Analysis

6.2.1 Model 1 - Revenue efficiency

In model 1 used to analyze the efficiency of shipping companies based on DEA, Total Assets and Operating Cost were used as inputs while Revenue was used as output. This model examines the efficiency of shipping companies in terms of having

revenues. The figures used to describe inputs and outputs are the total figures for every company and in some cases they include revenues and costs deriving from other activities apart from chartering their fleet.

6.2.2 Vessels Profit Efficiency

In model 2 used for the analysis of shipping companies efficiency based on DEA, Vessels Value and Vessels Operating Cost were used as inputs, while Gross Profit coming from vessels operation was used. This model examines the efficiency of shipping companies in terms of making profit from the vessels' operation and in particular from model 1, as both inputs and outputs is partly the ones used in model 1 and they apply to all vessels of every shipping company. As in DEA the variables cannot have negative values, for 2009 when for some companies the gross profit was minus, for the efficiency calculation of shipping companies in their gross profit the highest value was added so that all values to be positive. This method has been proved that does not affect the final results.

6.3 Model Results

6.3.1 Model 1 Results - Revenues Efficiency

In this sub-unit, the results of model 1 – 'Revenues Efficiency' are presented. The variables used as inputs were Total Assets and Operating Cost while as an output Revenue was used. Efficiency of every shipping company in comparison with the other ones was calculated based on DEA for variable returns to scale and input orientated for the years 2011, 2012, 2013 and 2014.

The total results per company, per year are displayed on table 6.1. Every company is mentioned by writing the first four letters of its commercial name. We notice that only one company NEP is productive for the four years of the analysis. The rest of the companies are not as productive. It is important to mention that the majority of

the companies have an average percentage lower tha 50%. In table 6.1 all the numbers are reffered to %.

Table 6.1: Total Efficiency Results per Company per Year

	2011	2012	2013	2014	AV.
ALG	58,76	0,10	0,09	0,04	***14,75***
APM	79,69	87,75	0,08	0,04	***41,89***
BAL	14,45	11,27	10,44	5,41	***10,39***
CAP	15,71	23,16	22,85	10,91	***18,16***
CON	18,74	23,00	21,03	9,46	***18,06***
COS	30,07	40,02	49,40	21,77	***35,31***
CHI	27,47	26,71	28,08	11,52	***23,45***
DAM	43,87	55,12	58,12	21,50	***44,65***
DAN	15,52	21,16	23,38	-	***20,02***
DIA	20,67	19,58	15,27	6,61	***15,53***
DRY	16,14	20,13	22,84	13,62	***18,18***
DSN	72,22	88,62	89,18	37,24	***71,81***
EAG	20,56	15,80	15,91	4,86	***14,28***
EUR	25,58	27,60	24,06	12,93	***22,54***
EVE	13,96	77,55	73,44	-	***54,98***
FRE	19,01	16,73	7,80	-	***14,51***
FRO	37,91	42,32	44,84	26,19	***37,82***
GEN	16,27	12,05		-	***14,16***
GLO	17,76	19,34	28,70	11,22	***19,26***
GOL	14,34	14,67	14,84	5,40	***12,31***
GOH	22,77	23,31	24,71	9,27	***20,01***
GUL	10,19	10,49	9,74	8,31	***9,68***
HEL	22,85	11,50	10,50	-	***14,95***
HYU	67,64	85,01	91,03	39,44	***70,78***
MAL	22,62	20,12	19,45	-	***20,73***
MIT	66,48	70,38	71,25	31,85	***59,99***
NAV	25,32	30,55	24,25	11,58	***22,92***
NEP	100,00	100,00	100,00	100,00	***100,00***
NEW	18,27	8,96	4,22	2,97	***8,60***
NIP	69,13	84,43	76,67	35,20	***66,36***
NOR	10,47	16,93	28,57	17,08	***18,26***
OVE	28,53	34,16	35,20	16,62	***28,63***
PAR	23,24	17,18	19,76	7,20	***16,85***
PRE	18,90	23,07	28,19	10,65	***20,20***
QAT	13,53	14,97	17,86	7,93	***13,58***
REG	53,14	63,94	69,31	32,49	***54,72***
SAF	25,40	26,39	26,81	8,76	***21,84***
SCO	19,10	27,30	19,71	8,32	***18,61***
SEA	50,49	43,91	50,51	22,12	***41,76***
STA	16,97	19,24	22,99	4,98	***16,04***
STE	21,00	25,11	22,43	9,34	***19,47***

PAN	18,67	21,73	21,79	10,79	***18,24***
TBS	35,23	45,06	45,44	20,23	***36,49***
TEE	21,21	24,92	23,92	11,07	***20,28***
TOP	16,71	20,56	25,88	12,74	***18,97***
TOR	44,04	50,29	53,35	21,42	***42,28***
TSA	18,45	22,74	24,78	11,92	***19,47***
WIL	56,62	62,97	64,80	28,01	***53,10***
AV.	***31,16***	***34,33***	***33,69***	***16,64***	

Table 6.2 shows the distinctive measurements in percentages of efficiency results deriving from table 5.1. It can be observed that the minimum efficiency degree fluctuates from 0,04% in 2014 to 10,19% in 2011. The maximum efficiency degree does not fluctuates and it has in all years 100% efficiency. The average efficiency degree fluctuates from 16,64% in 2014 to 34,33% in 2012. The median efficiency degree fluctuates from 11,37% in 2014 to 24,25% in 2012.

Table 6.2: Special Efficiency Measures

	2011	**2012**	**2013**	**2014**
Minimum	10,19	0,10	0,08	0,04
Maximum	100,00	100,00	100,00	100,00
Average	31,16	34,33	33,69	16,64
Median	21,92	23,24	24,25	11,37

Table 6.3 displays the allocation of efficiency rates and it depicts clearly all the above mentioned, while all this data is also illustrated in table 6.1. It can be noticed that there is a reduction in productive companies in the last year (2014), when most of the companies are around 0-20%.

Table 6.3: Allocation Efficiency Rates

	2011	**2012**	**2013**	**2014**
0-10%	0	2	6	23
10-20%	20	13	9	13
20-30%	13	16	18	6
30-40%	3	2	1	5
40-50%	2	4	3	0

50-60%	4	2	3	0
60-70%	3	2	2	0
70-80%	2	2	3	0
80-90%	0	4	1	0
90-100%	1	1	2	1

Diagram 6.1: Allocation Efficiency Rates

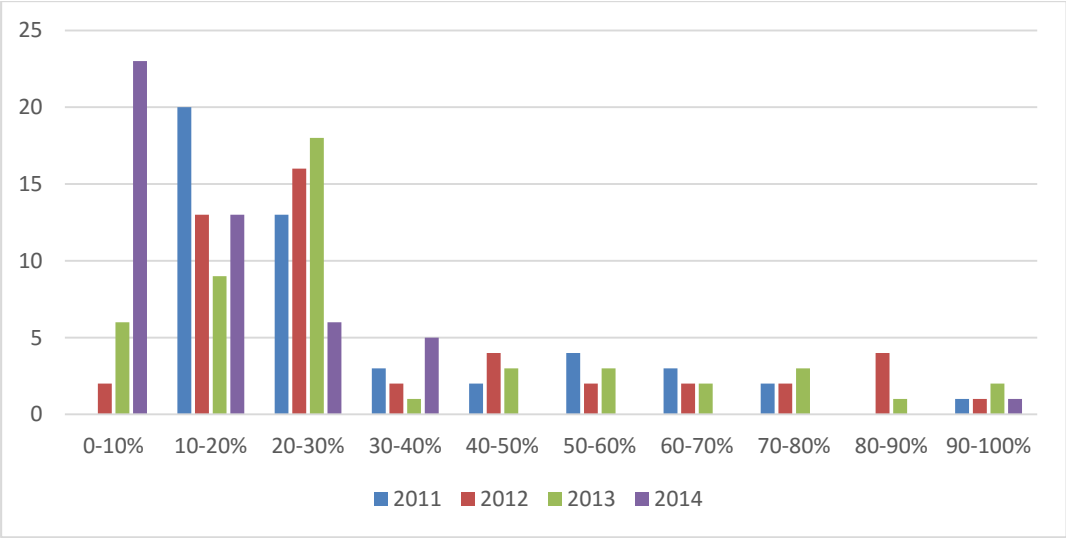


Table 6.4 presents the position of every company in comparison with the other ones of the same sample per year according to its efficiency. The classification is in decreasing order: the most effective company is no 1 position and the least effective in the lowest position (48). It can be noticed that some companies like ALG, DAN, EVE and TSA show a great fluctuation in their classification per year. On the contrary, some other companies like DSN, DAM, FRO, HYU, TOR and WIL are classified in a close position every year. It is also worth mentioning the fact that for the productive companies, their classification was carried out based on the fact to how often they are compared with others.

Table 6.4: Companies Classification Based on their Efficiency

	2011	**2012**	**2013**	**2014**
ALG	7	48	46	41
APM	2	3	47	42
BAL	43	45	42	36

CAP	41	25	29	24
CON	32	27	33	27
COS	15	15	12	10
CHI	17	20	19	21
DAM	12	10	9	11
DAN	42	30	27	43
DIA	27	34	39	35
DRY	40	32	30	16
DSN	3	2	3	3
EAG	28	40	38	39
EUR	18	18	25	17
EVE	45	6	5	43
FRE	30	39	44	43
FRO	13	14	14	8
GEN	39	43	48	43
GLO	36	35	16	22
GOL	44	42	40	37
GOH	23	24	23	29
GUL	48	46	43	32
HEL	22	44	41	43
HYU	5	4	2	2
MAL	24	33	36	43
MIT	6	7	6	6
NAV	20	17	24	20
NEP	1	1	1	1
NEW	35	47	45	40
NIP	4	5	4	4
NOR	47	38	17	14
OVE	16	16	15	15
PAR	21	37	34	34
PRE	31	26	18	26
QAT	46	41	37	33
REG	9	8	7	5
SAF	19	21	20	30
SCO	29	19	35	31
SEA	10	13	11	9
STA	37	36	28	38
STE	26	22	31	28
PAN	33	29	32	25
TBS	14	12	13	13
TEE	25	23	26	23
TOP	38	31	21	18
TOR	11	11	10	12
TSA	34	28	22	19
WIL	8	9	8	7

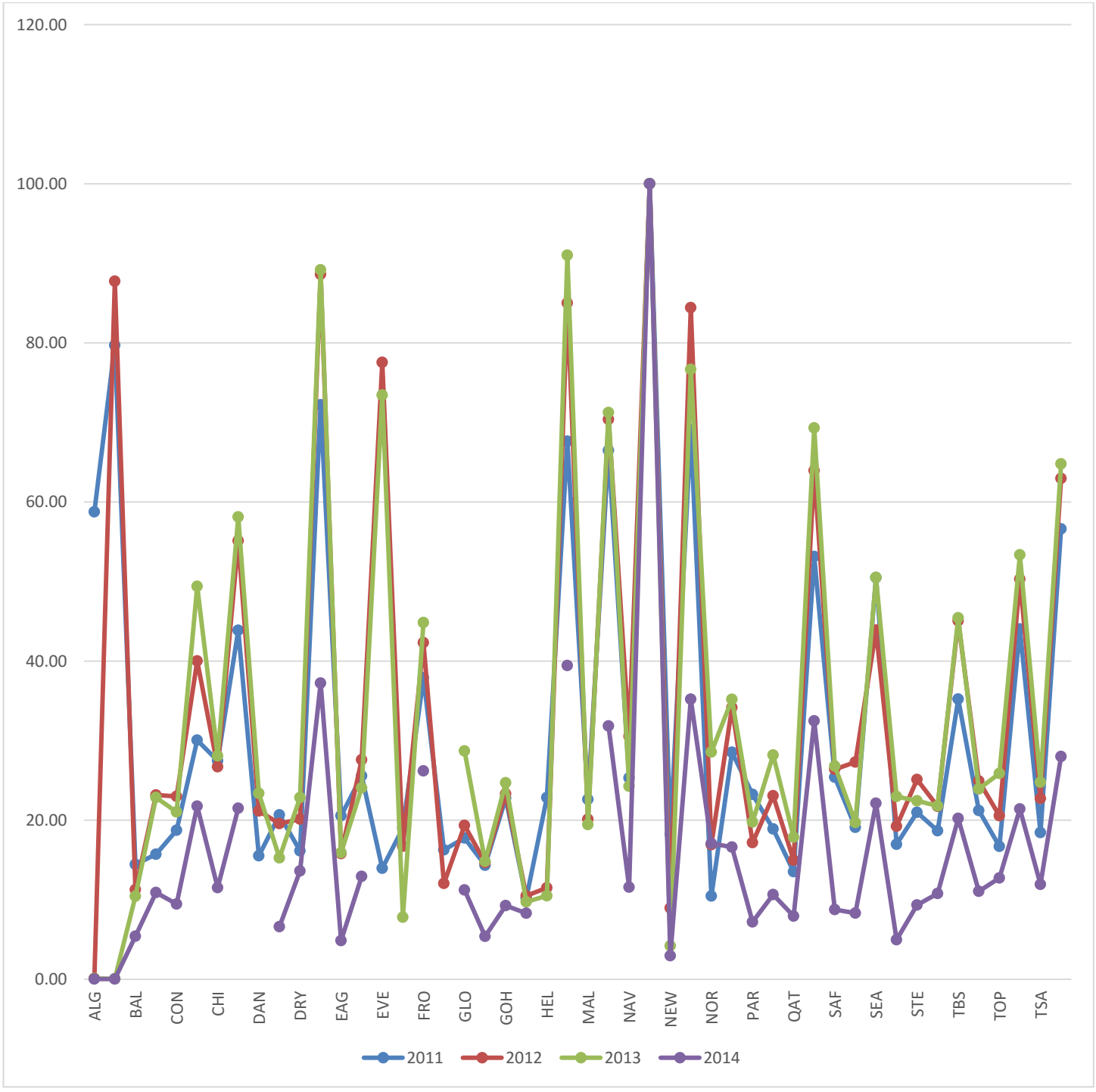
The previous comment is depicted clearly on table 6.5, which shows the common companies for all the years of analysis in the quartered parts of the sample, which was divided into four equal parts. Based on the companies' classification, we can notice which company is located in the same quartered part of the sample. DAM, DSN, HYU, MIT, NEP, NIP, REG, SEA, TOR and WIL are constantly the best companies of the 4th quartered part. GHI, NAV, OVE and CON, PAN, STE, TEE are constantly between the 3rd and 2nd quartered parts, which means that they display a relatively mediocre efficiency. Finally, GEN and GOL are the ones occupying the lowest positions of the sample (1st quartered part).

Table 6.5: Common Companies in the same quartered parts during 2011-2014

	>Q3 [ΘΕΣΕΙΣ 1-12]	M-Q3 [ΘΕΣΕΙΣ 13-24]	Q1-M [ΘΕΣΕΙΣ 25-36]	<Q1 [ΘΕΣΕΙΣ 37-48]
COMPANIES	DAM DSN HYU MIT NEP NIP REG SEA TOR WIL	CHI NAV OVE	CON PAN STE TEE	GEN GOL
Actual Number	10	3	4	2
Percentage	83.3%	25%	33.3%	16.6%

Diagram 6.2 depicts the results of efficiency per company as they were presented in table 6.1

Diagram 6.2: Efficiency per Company per Year



Next, the companies are divided into 4 groups based on their cargo:

4. Companies with dry cargo
5. Companies with wet cargo
6. Companies with multiple cargo
7. Companies with container cargo

Table 6.6 presents efficiency results per year for companies of dry cargo in comparison with the other companies of the sample. Out of these, the most productive is Neprure Orient Lines, which is one of the largest shipping companies owing bulk carriers. The next most efficient company is Nippon Yusen KK, which is also an extremely large company. The rest companies are not as efficient as we can observe that most of them have an average less than 20%.

Table 6.6: Efficiency Results for Dry Cargo Companies per Year

	Companies	2011	2012	2013	2014	AV.
dry	Baltic Trading Ltd.	14,45	11,27	10,44	5,41	***10,39***
dry	Eagle Bulk Shipping	20,56	15,80	15,91	4,86	***14,28***
dry	Freeseas Inc.	19,01	16,73	7,80	0,00	***10,88***
dry	Genco Ship & Trad. Ltd.	16,27	12,05	0,00	0,00	***7,08***
dry	Globus Maritime Ltd.	17,76	19,34	28,70	11,22	***19,26***
dry	Golden Ocean Group Ltd.	14,34	14,67	14,84	5,40	***12,31***
dry	Hellenic Carriers Ltd.	22,85	11,50	10,50	0,00	***11,21***
dry	Navios Maritime Holding	25,32	30,55	24,25	11,58	***22,92***
dry	Nepture Orient Lines	100,00	100,00	100,00	100,00	***100,00***
dry	Nippon Yusen KK	69,13	84,43	76,67	35,20	***66,36***
dry	Paragon Shipping Inc.	23,24	17,18	19,76	7,20	***16,85***
dry	Precious Shipping Pcl.	18,90	23,07	28,19	10,65	***20,20***
dry	Safebulkers Inc.	25,40	26,39	26,81	8,76	***21,84***

dry	Star Bulk Carriers Corp.	16,97	19,24	22,99	4,98	***16,04***
dry	TBS International Plc.	35,23	45,06	45,44	20,23	***36,49***
	AV.	***29,29***	***29,82***	***28,82***	***15,03***	

Table 6.7 displays the results of multiple cargo companies per year. It was expected that these companies would show higher efficiency in comparison to the other ones which are specialized in one type of cargo as their versatility would help them not to be so seriously affected by economic crisis in various sectors and to continue to have revenues in difficult conditions. The most efficient company was Diana Shipping Inc with an avarage rate of 97,40% following by Cosco Shipping Co. Ltd. Both of them are large companies.

Table 6.7: Efficiency Results for Multiple Cargo Companies per Year

	Companies	**2011**	**2012**	**2013**	**2014**	**AV.**
multiple	Algoma Central Corp.	81,37	0,11	0,10	0,10	***20,42***
multiple	AP Moller-Maersk A/S	21,76	26,13	25,11	27,67	***25,17***
multiple	Baltic Trading Ltd.	41,64	45,16	54,27	55,19	***49,06***
multiple	Capital Product Partners	38,04	30,14	30,85	29,22	***32,06***
multiple	Concordia Maritime AB	22,35	22,72	25,09	34,54	***26,17***
multiple	Cosco Shipping Co. Ltd.	100,00	100,00	97,97	94,42	***98,10***
multiple	China Shipping Dev. Co.	35,42	31,14	26,43	32,79	***31,44***
multiple	D' Amico Int. Shipping S.A.	31,53	26,31	27,14	23,50	***27,12***
multiple	Danaos Corp.	14,10	11,84	10,70	21,06	***14,43***
multiple	Diana Shipping Inc.	93,67	95,92	100,00	100,00	***97,40***
multiple	Dryships Inc.	31,33	22,71	21,37	0,00	***18,85***
multiple	DS Norden	92,06	79,42	78,27	80,76	***82,63***
multiple	Eagle Bulk Shipping	25,29	10,11	4,63	7,52	***11,89***
multiple	Euroseas Ltd.	69,91	49,54	55,49	56,10	***57,76***
multiple	Evergreen Marine Corp.	25,85	24,52	23,94	27,35	***25,42***

multiple	Freeseas Inc.	78,40	71,05	71,18	71,03	***72,92***
	AV.	***50,17***	***40,43***	***40,78***	***41,33***	

Table 6.8 presents efficiency results for wet cargo companies per year. The companies that excel in this sector are D' Amico Int. Shipping S.A, Frontline Ltd. And Torm. More analytically, D' Amico Int shipping S.A has an average efficiency of 95,01%, Forntline has an average efficiency of 85,01% an Torm has an efficiency of 91,20%. On the other hand, the lowest in efficiency companies are Concordia Maritime AB, Qatar Gas Transport Co and Scorpio Tankers Inc. with an average level of efficiency 39,14%, 29,73 % and 39,64% respectively.

Table 6.8: Efficiency Results for Wet Cargo Companies per Year

	Company	**2011**	**2012**	**2013**	**2014**	**AV.**
wet	Concordia Maritime AB	42,55	41,72	36,19	36,13	***39,14***
wet	D' Amico Int. Shipping S.A.	99,61	100,00	100,00	82,11	***95,43***
wet	Frontline Ltd.	86,09	76,77	77,15	100,00	***85,01***
wet	Nordic American Tankers	23,77	30,71	49,15	65,20	***42,21***
wet	Overseas Shipping Group	64,79	61,97	60,56	63,47	***62,70***
wet	Qatar Gas Transport Co.	30,73	27,16	30,73	30,30	***29,73***
wet	Scorpio Tankers Inc.	43,38	49,53	33,92	31,76	***39,64***
wet	StealthGas Inc.	47,67	45,55	38,59	35,66	***41,87***
wet	Teekay Corp.	48,17	45,21	41,16	42,26	***44,20***
wet	Top Ships Inc.	37,94	37,29	44,53	48,63	***42,10***
wet	Torm	100,00	91,23	91,79	81,79	***91,20***
wet	Tsakos Energy Navigation	41,89	41,25	42,63	45,53	***42,82***
	AV.	***55,55***	***54,03***	***53,87***	***55,24***	

Table 6.9 shows the efficiency results for container cargo companies per year by comparing all the companies of the sample. The only productive (100%) during those years was Algoma Central Corp, which is one of the biggest cargo container

company worldwide. It is followed by concordia Maritime AB with 80,87% on average efficiency during those four years. While AP Moller-Maersk A/S shows the lowest efficiency (18,67%), although it is a large company in this sector.

Table 6.9: Efficiency Results for Container Cargo Companies per Year

	Company	2011	2012	2013	2014	AV.
container	Algoma Central Corp.	100,00	100,00	100,00	100,00	100,00
container	AP Moller-Maersk A/S	19,48	24,11	31,09	0,00	18,67
container	Baltic Trading Ltd.	25,94	22,31	20,31	18,67	21,81
container	Capital Product Partners	17,52	88,37	97,67	0,00	50,89
container	Concordia Maritime AB	66,69	72,87	92,18	91,74	80,87
	AV.	45,93	61,53	68,25	42,08	

Table 6.10 presents data coming from the previous tables and presents the average efficiency rates in percentages of all companies per category and per year. Data from table 6.10 is depicted in diagram 5.3.

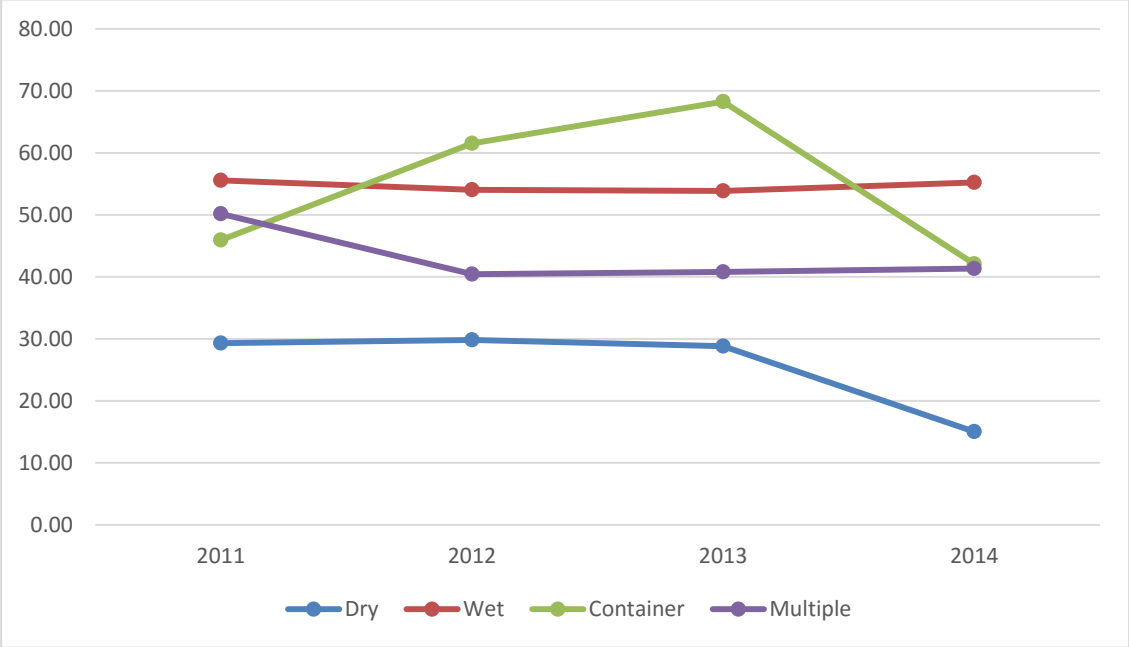
Table 6.10: Average Rate of Efficiency per Category per Year

	2011	2012	2013	2014	MO
Dry	29,29	29,82	28,82	15,03	25,74
Wet	55,55	54,03	53,87	55,24	54,67
Container	45,93	61,53	68,25	42,08	54,45
Multiple	50,17	40,43	40,78	41,33	43,18

According to diagram 5.3, it can be seen that during 2011 – 2014, container companies seem to be the most efficiency in general. This could be attributed to the nature of markets in which these companies operate, liner markets, which are characterized by the presence of monopolies and big corporations and which lead to the increase of their revenues. This constitutes the output which analyzed for the

purposes of this study. In the second position, wet cargo companies follow. During the study period, wet cargo market was more profitable than dry cargo market so, dry cargo companies and multiple – cargo companies were less productive.

Diagram 6.3: Efficiency per Category



Taking the above into consideration, it is apparent that the size of a company affects its efficiency. That is why we divide the companies according to their size into 3 groups of similar volume based on their assets.

1. Small Companies
2. Middle- sized Companies
3. Big Companies

Table 6.11 presents the efficiency results for small companies per year in terms of the whole set of the sample. Wilson ASA show the highest efficiency with 100% on avaerage rate. The rest of the companies show less than 50% on average rate.The last company in terms of efficiency was Hellenic Carriers Ltd with 13,39%.

Table 6.11: Efficiency Results for Small Companies

	Companies	2011	2012	2013	2014	AV.
small	Baltic Trading Ltd.	22,29	17,90	16,11	19,31	***18,90***
small	Euroseas Ltd.	38,90	43,83	37,13	46,16	***41,51***
small	Freeseas Inc.	92,10	26,56	12,04	0,00	***32,67***
small	Globus Maritime Ltd.	22,20	30,71	44,30	40,06	***34,32***
small	Goldenport Holdings Inc.	36,12	37,03	38,14	33,08	***36,09***
small	Gulf Navigation Hold. Pisc.	70,17	16,67	15,03	29,65	***32,88***
small	Hellenic Carriers Ltd.	19,10	18,26	16,20	0,00	***13,39***
small	Malaysian Bulk Carriers	29,61	31,96	30,02	0,00	***22,90***
small	Newlead Holdings Ltd.	26,99	14,23	6,51	10,59	***14,58***
small	Precious Shipping Pcl.	25,47	36,64	43,51	38,04	***35,91***
small	Wilson ASA	100,00	100,00	100,00	100,00	***100,00***
	AV.	***43,90***	***33,98***	***32,64***	***28,81***	

Similarly, table 6.12 displays efficiency results for medium companies per year. In the first position is Algoma Central Corp with 100% followed by D' Amico Int Shipping S.A with 81,42%. Genco Ship & Trad. Ltd is in the lowest position with 11,41%.

Table 6.12: Efficiency Results for Medium Companies

	Companies	2011	2012	2013	2014	AV.
medium	Algoma Central Corp.	100,00	100,00	100,00	100,00	***100,00***
medium	Capital Product Partners	26,74	34,50	35,48	39,92	***34,16***
medium	D' Amico Int. Shipping S.A.	74,65	82,13	90,23	78,68	***81,42***
medium	Frontline Ltd.	64,52	63,05	69,62	95,82	***73,25***
medium	Genco Ship & Trad. Ltd.	27,68	17,95	0,00	0,00	***11,41***

medium	Golden Ocean Group Ltd.	24,40	21,86	23,04	19,74	***22,26***
medium	Nordic American Tankers	17,82	25,22	44,35	62,48	***37,47***
medium	Qatar Gas Transport Co.	23,03	22,30	27,73	29,03	***25,52***
medium	Safebulkers Inc.	43,22	39,32	41,62	32,04	***39,05***
medium	Scorpio Tankers Inc.	32,51	40,68	30,60	30,43	***33,55***
medium	Seacore Holding Inc.	85,92	65,41	78,41	80,95	***77,67***
medium	StealthGas Inc.	35,73	37,41	34,82	34,17	***35,53***
medium	Pan Ocean Co. Ltd.	31,77	32,38	33,83	39,46	***34,36***
medium	TBS International Plc.	59,95	67,13	70,55	74,01	***67,91***
medium	Top Ships Inc.	28,44	30,63	40,18	46,60	***36,46***
	AV.	***45,09***	***45,33***	***48,03***	***50,89***	

Table 6.13 shows the results of efficiency for large companies per year. It can be seen that only Nepture Orient Lines has an average efficincy for all years 100%. The lowest average rate during those four years come from Danaos Corp (15,01%).

Table 6.13: Efficiency Results for Large Companies

	Company	**2011**	**2012**	**2013**	**2014**	**AV.**
large	AP Moller-Maersk A/S	79,69	87,75	75,19	35,41	***69,51***
large	Concordia Maritime AB	18,74	23,00	21,03	9,46	***18,06***
large	Cosco Shipping Co. Ltd.	30,07	40,02	49,40	21,77	***35,31***
large	China Shipping Dev. Co.	27,47	26,71	28,08	11,52	***23,45***
large	Danaos Corp.	15,52	21,16	23,38	0,00	***15,01***
large	Diana Shipping Inc.	20,67	19,58	15,27	6,61	***15,53***
large	Dryships Inc.	16,14	20,13	22,84	13,62	***18,18***
large	DS Norden	72,22	88,62	89,18	37,24	***71,81***
large	Eagle Bulk Shipping	20,56	15,80	15,91	4,86	***14,28***
large	Evergreen Marine Corp.	13,96	77,55	73,44	0,00	***41,24***

large	Hyundai Merchant Marine	67,64	85,01	91,03	39,44	***70,78***
large	Mitsui O.S.K. Lines	66,48	70,38	71,25	31,85	***59,99***
large	Navios Maritime Holding	25,32	30,55	24,25	11,58	***22,92***
large	Nepture Orient Lines	100,00	100,00	100,00	100,00	***100,00***
large	Nippon Yusen KK	69,13	84,43	76,67	35,20	***66,36***
large	Overseas Shipping Group	28,53	34,16	35,20	16,62	***28,63***
large	Paragon Shipping Inc.	23,24	17,18	19,76	7,20	***16,85***
large	Regional Container Lines	53,14	63,94	69,31	32,49	***54,72***
large	Star Bulk Carriers Corp.	16,97	19,24	22,99	4,98	***16,04***
large	Teekay Corp.	21,21	24,92	23,92	11,07	***20,28***
large	Torm	44,04	50,29	53,35	21,42	***42,28***
large	Tsakos Energy Navigation	18,45	22,74	24,78	11,92	***19,47***
	AV.	***42,41***	***47,08***	***47,41***	***25,85***	

Table 6.14 presents the data of the previous tables and shows the average rate of efficiency of all the companies per category, per year in relation to other companies of the sample. Data from table 614 is depicted in diagram 6.4.

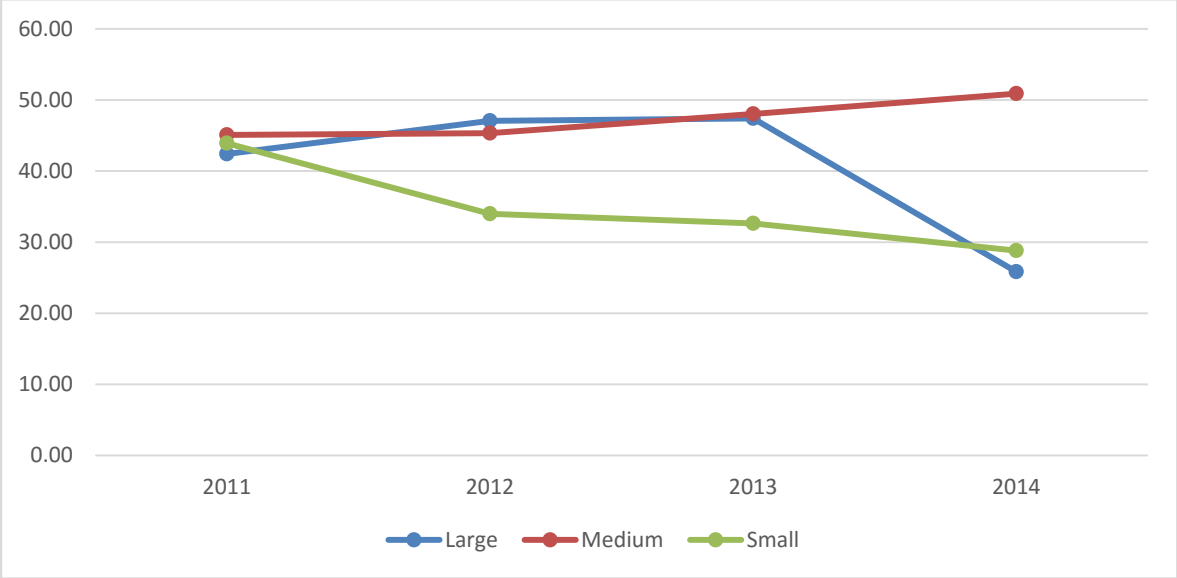
Table 6.14: Average Rate per Size per Year

	2011	**2012**	**2013**	**2014**	**MO**
Large	42,41	47,08	47,41	25,85	40,69
Medium	45,09	45,33	48,03	50,89	47,34
Small	43,90	33,98	32,64	28,81	34,83

According to diagram 6.4, it can be observed that throughout the years under observation, the medium companies are clearly the most efficient followed by the large ones and at the lowest come the small ones. It has become apparent based on

the data we have received so far that among the most efficient companies most of them were the medium ones. This could most probably be attributed to the fact that during the crisis the middle-sized companies are more flexible.

Diagram 6.4: Average Rate per Size per Year



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6.3.2 Results of model 2 ' Vessels Profit Efficiency'

This sub-unit presents the results of model 1 – ' vessels profit efficiency'. The variables used as inputs were Vessels value and operating Cost while as output the gross profit was used. The efficiency of every company was measured in comparison with the other companies of the sample according to DEA for variables returns to scale by putting emphasis on input orientated for the years 2011,2012,2013 and 2014.

The total results per company per year are displayed in table 6.15. it can be noticed that CAP, FRE, MAL and NEW were productive in one of the four years.

Table 6.15: Total Efficiency Results per Company per Year

	2011	2012	2013	2014	MO
ALG	5,17	6,96	10,19	7,84	***7,54***
APM	0,12	0,22	1,50	1,16	***0,75***
BAL	15,03	13,71	18,82	26,94	***18,63***
CAP	8,15	6,26	6,47	100,00	***30,22***
CON	9,43	14,39	21,46	15,68	***15,24***
COS	2,37	3,02	3,84	2,93	***3,04***
CHI	0,84	1,15	1,52	1,06	***1,15***
DAM	5,31	6,96	10,34	10,34	***8,24***
DAN	1,38	1,57	2,31	-	***1,75***
DIA	4,19	4,97	6,42	4,63	***5,05***
DRY	2,24	2,92	3,66	2,93	***2,93***
DSN	1,35	2,18	2,83	2,07	***2,11***
EAG	3,38	4,92	7,35	3,97	***4,90***
EUR	17,07	26,41	64,03	47,42	***38,73***
EVE	2,45	1,08	1,39	-	***1,64***
FRE	45,41	67,07	100,00	-	***70,83***
FRO	2,60	3,90	6,23	6,70	***4,86***
GEN	1,57	2,24	-	-	***1,91***
GLO	18,02	39,98	60,01	43,90	***40,48***
GOL	10,26	21,73	31,66	7,61	***17,81***
GOH	8,14	14,29	25,08	21,49	***17,25***
GUL	9,56	13,88	38,22	32,99	***23,66***
HEL	38,41	70,50	66,57	-	***58,49***
HYU	0,42	0,54	0,90	0,69	***0,64***
MAL	100,00	39,73	55,29	-	***65,01***
MIT	0,15	0,36	0,31	0,25	***0,27***
NAV	2,09	2,91	4,00	2,96	***2,99***
NEP	0,44	0,58	0,73	0,51	***0,57***
NEW	12,18	100,00	70,82	40,36	***55,84***
NIP	0,17	0,23	0,38	0,27	***0,27***
NOR	4,16	5,75	7,63	5,85	***5,85***
OVE	1,07	1,46	2,42	2,33	***1,82***
PAR	14,29	19,03	25,40	16,32	***18,76***
PRE	14,27	11,52	14,17	9,32	***12,32***
QAT	0,59	0,87	1,19	0,91	***0,89***
REG	4,63	6,86	10,36	8,88	***7,68***
SAF	6,70	7,36	9,80	6,66	***7,63***
SCO	10,77	12,45	12,90	3,13	***9,81***
SEA	1,44	2,42	3,79	3,10	***2,69***
STA	6,03	9,59	23,86	4,39	***10,97***
STE	13,50	16,01	16,82	8,89	***13,80***
PAN	1,03	1,38	2,08	1,87	***1,59***
TBS	4,53	5,82	7,51	5,45	***5,83***
TEE	0,48	0,68	1,20	0,96	***0,83***
TOP	6,11	9,44	12,24	9,18	***9,24***

TOR	1,29	1,93	3,22	3,66	***2,52***
TSA	1,77	2,54	3,49	2,71	***2,63***
WIL	7,38	11,82	16,08	11,96	***11,81***
MO	***8,92***	***12,53***	***16,95***	***11,67***	

Table 6.16 presents the characteristic measures of the efficiency results deriving from table 6.21. It can be seen that the minimum rate of efficiency fluctuates from 0,12% in 2011 to 0,31% in 2013. The maximum rate of efficiency is stable for all years and it is 100%. What is more, the average rate of efficiency fluctuates from 8,92% in 2011 to 16,95% in 2013. Furthermore, the median rate of efficiency fluctuates from 4,36% in 2011 to 7,51% in 2013. However, efficiency measurements are in general much lower in comparison with sample 1, something that can be attributed to different inputs-outputs used and could justify partly some low efficiencies. Besides, the low efficiency of some companies can be attributed to the fact that the variables of sample 2 concern only the companies' vessels and did not take consideration other profitable activities, which were included in sample 1.

Table 6.16: Special Efficiency Measures

	2011	**2012**	**2013**	**2014**
Minimum	0,12	0,22	0,31	0,25
Maximum	100,00	100,00	100,00	100,00
Average	8,92	12,53	16,95	11,67
Median	4,36	5,79	7,51	5,04

Table 6.17 shows the allocation of efficiency frequencies and it shows in detail what ha`s been mentioned before, while all these figures are depicted and in diagram 6.6. It can be clearly seen that there was a drop in productive companies the last year.

Table 6.17: Allocation Efficiency Rates

	2011	**2012**	**2013**	**2014**
0-10%	36	31	27	37
10-20%	9	10	9	4
20-30%	0	2	4	2

30-40%	1	2	2	1
40-50%	1	0	0	3
50-60%	0	0	1	0
60-70%	0	1	3	0
70-80%	0	1	1	0
80-90%	0	0	0	0
90-100%	1	1	1	1

Diagram 6.5: Allocation Efficiency Rates

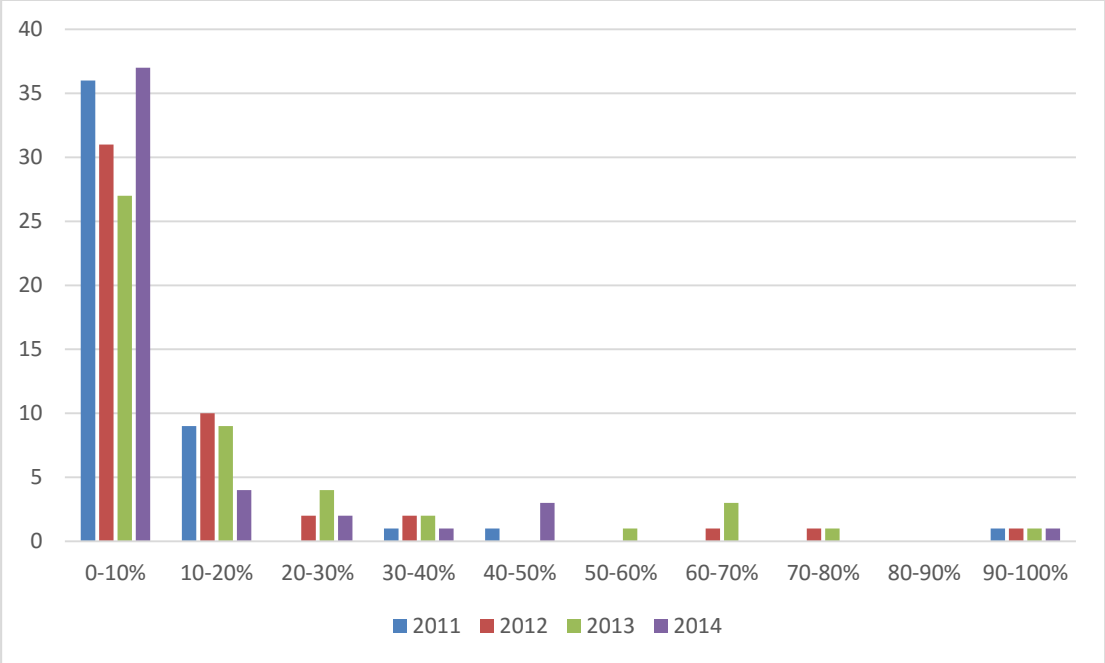


Table 6.18 presents like in sample 1 the classification of every company based on their efficiency in comparison with the other companies per year. It can be clearly seen that some companies like CAP, GEN and STA show a considerable fluctuation in their classification per year. In contrast, some others like DAN, DSN, EAG, EUR, GLO, NEP, NOR, PAR and TOP are classified in very close positions every year.

Table 6.18: Companies Classification Baised on Their Efficiency

	2011	2012	2013	2014
ALG	22	21	21	16
APM	48	48	40	35
BAL	6	13	13	6
CAP	15	23	26	1
CON	14	10	12	9
COS	30	29	30	30
CHI	41	40	39	36
DAM	21	20	20	11
DAN	36	37	37	43
DIA	25	26	27	22
DRY	31	30	32	29
DSN	37	35	35	33
EAG	27	27	25	24
EUR	5	6	4	2
EVE	29	41	41	43
FRE	2	3	1	43
FRO	28	28	28	18
GEN	34	34	48	43
GLO	4	4	5	3
GOL	12	7	8	17
GOH	16	11	10	7
GUL	13	12	7	5
HEL	3	2	3	43
HYU	45	45	44	39
MAL	1	5	6	43
MIT	47	46	47	42
NAV	32	31	29	28
NEP	44	44	45	40
NEW	10	1	2	4
NIP	46	47	46	41
NOR	26	25	23	20
OVE	39	38	36	32
PAR	7	8	9	8
PRE	8	16	16	12
QAT	42	42	43	38
REG	23	22	19	15
SAF	18	19	22	19
SCO	11	14	17	26
SEA	35	33	31	27
STA	20	17	11	23
STE	9	9	14	14
PAN	40	39	38	34
TBS	24	24	24	21
TEE	43	43	42	37
TOP	19	18	18	13

TOR	38	36	34	25
TSA	33	32	33	31
WIL	17	15	15	10

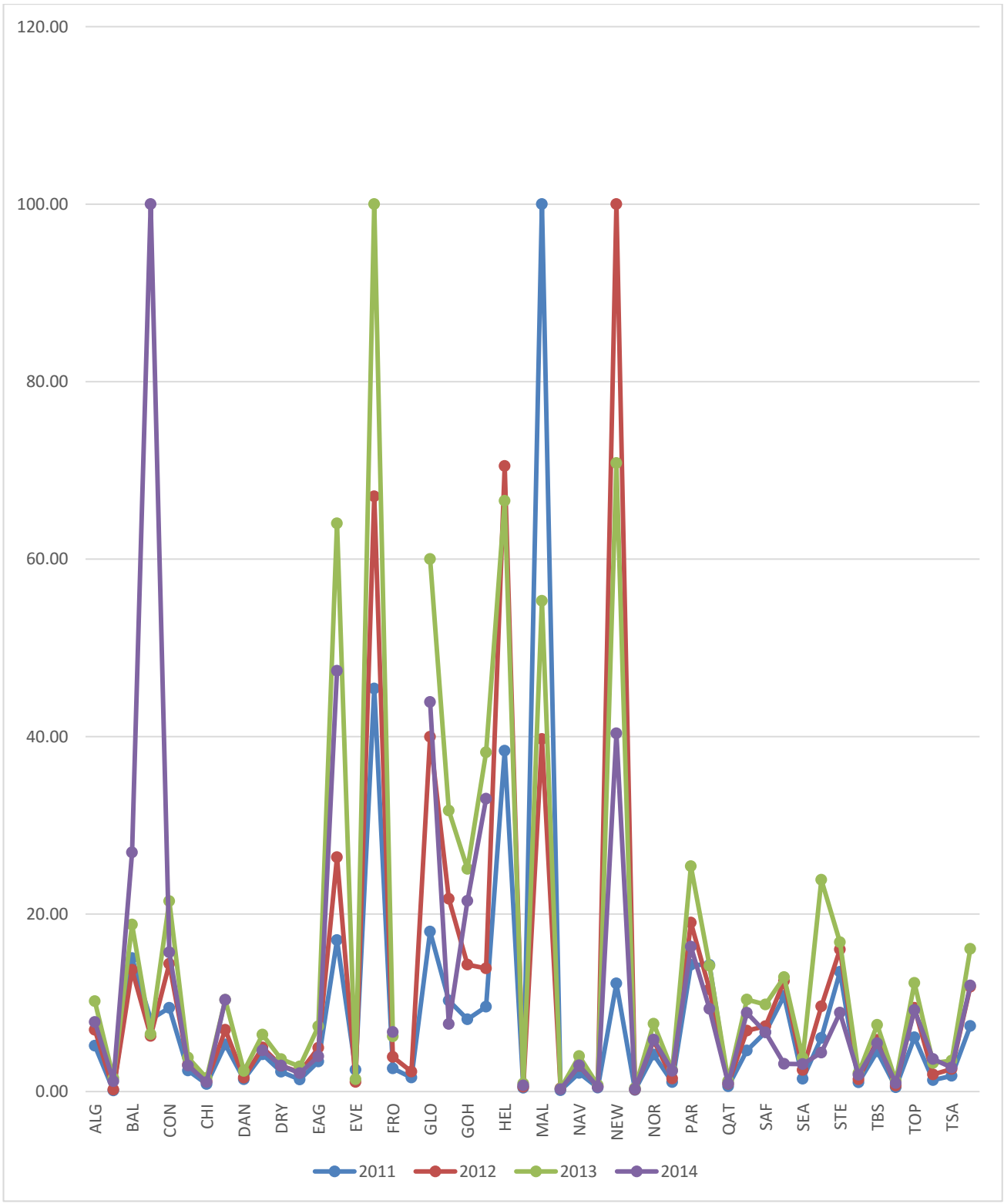
The last observation can be clearly seen in table 6.19 which presents the common companies throughout all those years of study in the sample's quartered parts. EUR, GLO, NEW and PAR are constantly the best companies of the sample every year (4th quartered part). ALG, DAM, REG, SAF, TBS and TOP are in the 3rd quartered part of the sample and it shows relatively average efficiency, while COS DIA, DRY, EAG, NAV, NOR, SEA and TSA are the companies appearing all the years in the 2nd quartered part. Finally, CHI, DAN, DSN, HYU, MIT, NEP, NIP,QAT and TEE are constantly in the lowest positions of this classification (1st quartered part).

Table 6.19: Common Companies in the Same Quatered Parts During 2011-2014

	>Q3 [ΘΕΣΕΙΣ 1-12]	M-Q3 [ΘΕΣΕΙΣ 13-24]	Q1-M [ΘΕΣΕΙΣ 25-36]	<Q1 [ΘΕΣΕΙΣ 37-48]
COMPANIES	EUR GLO NEW PAR	ALG DAM REG SAF TBS TOP	COS DIA DRY EAG NAV NOR SEA TSA	CHI DAN DSN HYU MIT NEP NIP QAT TEE
Actual Number	4	6	8	9
Percentage	33.3%	50%	66.6%	75%

Diagram 6.6 illustrates the efficiency results per company, per year as they were presented in table 6.15.

Diagram 6.6: Efficiency per Company per Year



Next, like in sample 1, the companies were divided into four groups depending on their fleet: **dry cargo, multiple cargo , wet cargo** and **container cargo**.

Table 6.20 presents the efficiency results per year for dry cargo companies in comparison with the other companies of the sample. From these, the most productive companies are Freeseas Inc, Hellenic Carriers Ltd and Globus Maritime Ltd, from which all of them are under Greek management. All of them have fleets with small-sized vessels, which could justify their higher ability to make profits compared to other companies and why they show high efficiency. On the other hand, the worst in terms of efficiency companies were Genco Ship & Trad. Ltd. (1,74%), Nepture Orient Lines (1,20%) and Nippon Yusen KK (0,66%).

Table 6.20: Efficiency Results for Dry Cargo Companies per Year

	Companies	**2011**	**2012**	**2013**	**2014**	**AV.**
dry	Baltic Trading Ltd.	33,26	19,53	19,07	61,38	***33,31***
dry	Eagle Bulk Shipping	7,48	6,85	7,60	9,04	***7,74***
dry	Freeseas Inc.	100,00	94,91	100,00	0,00	***73,73***
dry	Genco Ship & Trad. Ltd.	3,68	3,29	0,00	0,00	***1,74***
dry	Globus Maritime Ltd.	39,82	57,13	60,73	100,00	***64,42***
dry	Golden Ocean Group Ltd.	22,78	31,14	32,10	17,34	***25,84***
dry	Hellenic Carriers Ltd.	84,78	100,00	66,97	0,00	***62,94***
dry	Navios Maritime Holding	4,81	4,52	4,16	6,74	***5,06***
dry	Nepture Orient Lines	1,27	1,39	0,99	1,17	***1,20***
dry	Nippon Yusen KK	0,72	0,60	0,70	0,63	***0,66***
dry	Paragon Shipping Inc.	31,65	27,23	25,66	37,18	***30,43***
dry	Precious Shipping Pcl.	31,76	16,69	14,54	21,24	***21,06***
dry	Safebulkers Inc.	15,12	11,04	10,28	15,17	***12,90***
dry	Star Bulk Carriers Corp.	13,19	11,70	24,24	10,01	***14,78***
dry	TBS International Plc.	10,06	8,42	7,68	12,41	***9,64***
	AV.	***26,69***	***26,30***	***24,98***	***19,49***	

Table 6.21 presents the efficiency results for multiple- cargo companies per year. Eagle Bulk Shipping shows the highest efficiency (61,34%) while DS Norden, which has a large fleet, shows the lowest efficiency with an average rate 0,53%.

Table 6.21: Efficiency Results for Multiple Cargo Companies per Year

	Companies	2011	2012	2013	2014	AV.
multiple	Algoma Central Corp.	3,45	8,01	17,43	7,80	***9,17***
multiple	AP Moller-Maersk A/S	5,43	7,16	11,06	100,00	***30,91***
multiple	Baltic Trading Ltd.	1,58	3,31	6,16	2,82	***3,47***
multiple	Capital Product Partners	0,56	1,52	3,03	1,19	***1,58***
multiple	Concordia Maritime AB	1,49	3,51	6,21	2,95	***3,54***
multiple	Cosco Shipping Co. Ltd.	0,90	2,61	4,44	1,63	***2,40***
multiple	China Shipping Dev. Co.	11,38	27,68	99,34	44,00	***45,60***
multiple	D' Amico Int. Shipping S.A.	5,43	15,01	39,51	19,93	***19,97***
multiple	Danaos Corp.	6,38	14,25	58,71	30,66	***27,50***
multiple	Diana Shipping Inc.	0,28	0,80	2,63	0,94	***1,16***
multiple	Dryships Inc.	100,00	42,56	89,13	0,00	***57,92***
multiple	DS Norden	0,10	0,71	0,86	0,43	***0,53***
multiple	Eagle Bulk Shipping	8,12	100,00	100,00	37,25	***61,34***
multiple	Euroseas Ltd.	0,96	2,95	6,98	3,33	***3,55***
multiple	Evergreen Marine Corp.	0,69	1,47	3,34	1,85	***1,84***
multiple	Freeseas Inc.	4,92	12,85	26,27	11,43	***13,87***
	AV.	***9,48***	***15,28***	***29,69***	***16,64***	

Table 6.22 shows the efficiency results for wet – cargo companies. It can be clearly seen that Concordia Maritime AB has 100% efficiency, which it was also one of the most productive companies in sample 1. Stealthgas Inc. follows with 52,93 %, which can be attributed to its lowest performance in 2014. Overseas Shipping Group, Qatar Gas Trasport Co. and Teekay Corp were the lowest in efficiency companies with 4,73%, 5,88% and 5,49% respectively.

Table 6.22: Efficieny Results for Wet Cargo Companies per Year

	Company	2011	2012	2013	2014	AV.
wet	Concordia Maritime AB	100,00	100,00	100,00	100,00	***100,00***
wet	D' Amico Int. Shipping S.A.	38,90	35,55	41,54	56,83	***43,21***
wet	Frontline Ltd.	24,05	19,04	21,79	34,54	***24,86***
wet	Nordic American Tankers	22,73	20,45	23,59	28,15	***23,73***
wet	Overseas Shipping Group	3,67	0,32	3,50	11,44	***4,73***
wet	Qatar Gas Transport Co.	5,26	4,91	6,71	6,63	***5,88***
wet	Scorpio Tankers Inc.	54,14	44,62	43,29	15,33	***39,35***
wet	StealthGas Inc.	88,08	65,88	57,77	0,00	***52,93***
wet	Teekay Corp.	4,13	2,38	7,30	8,14	***5,49***
wet	Top Ships Inc.	33,98	34,52	39,74	43,33	***37,89***
wet	Torm	6,97	3,98	9,04	15,48	***8,87***
wet	Tsakos Energy Navigation	9,01	9,14	11,55	13,78	***10,87***
	AV.	***32,58***	***28,40***	***30,48***	***27,81***	

Table 6.23 shows the efficiency results for container-cargo companies in comparison with the other companies of the sample. The most efficient (100%) during those four years was Concorida Maritime AB. In model 1 the most efficient company was Algoma Central Corp and in model 2 was the less efficient company with an average rate of 8,72%.

Table 6.23: Efficiency Results for Container Cargo Companies per Year

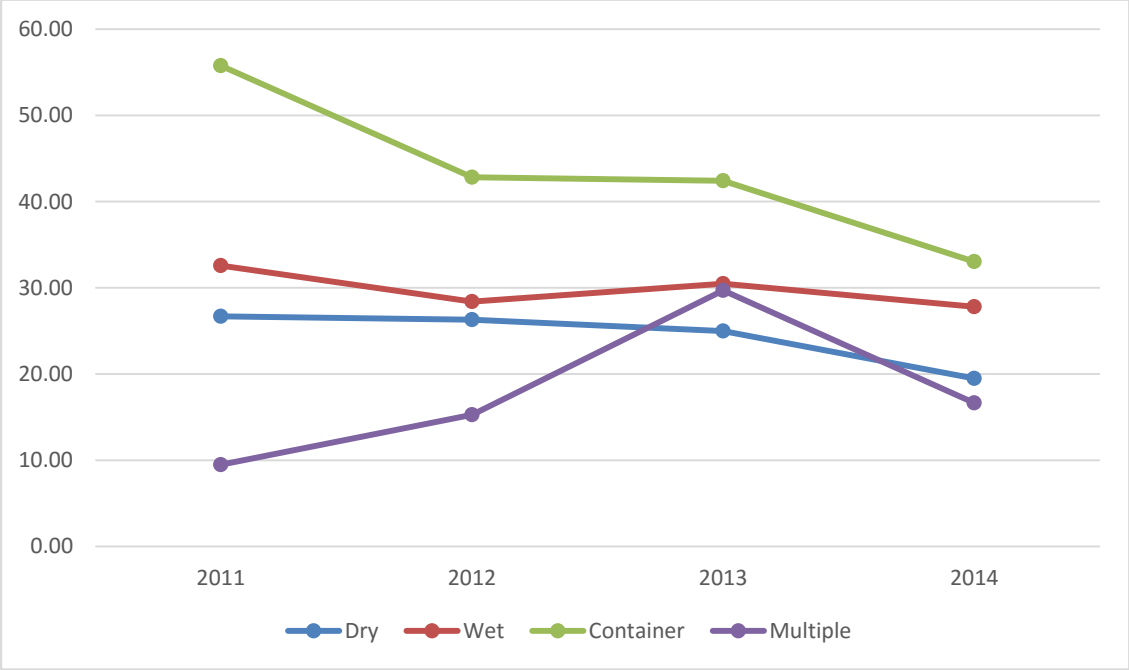
	Companies	2011	2012	2013	2014	AV.
container	Algoma Central Corp.	4,09	3,22	14,48	13,08	8,72
container	AP Moller-Maersk A/S	30,20	22,84	22,28	0,00	18,83
container	Baltic Trading Ltd.	91,39	72,38	61,97	52,15	69,47
container	Capital Product Partners	53,08	15,70	13,37	0,00	20,54
container	Concordia Maritime AB	100,00	100,00	100,00	100,00	100,00
	AV.	55,75	42,83	42,42	33,04	

Table 6.24 displays data of the previous tables per year, per category as well as the average efficiency rates of all companies of the sample. Data from table 6.24 is depicted clearly in diagram 6.7.

Table 6.24: Average Rate of Efficiency per Category per Year

	2011	2012	2013	2014	AV.
Dry	26,69	26,30	24,98	19,49	24,36
Wet	32,58	28,40	30,48	27,81	29,82
Container	55,75	42,83	42,42	33,04	43,51
Multiple	9,48	15,28	29,69	16,64	17,77

Diagram 6.7: Efficiency per Category



From diagram 6.7, it can be noticed that according to sample 2 during 2011-2014, container companies seem to be the most efficient ones in general. In the second position come wet cargo companies and behind are dry-cargo and multiple

companies. It can also be observed the majority of the caregories fluctuates a lot. Only the dry cargo companies were stable as the dry-cargo market althought it was lower than other categories it was more stable.

After that, like in model 1, the companies were divided into three equal groups according to their size and their assets: Large Companies, Medium Companies and Small Companies.

Table 6.25 shows efficiency results for small companies per year. Malaysian Bulk Carriers and Globus Maritime Ltd are the ones with highest efficiency with 74,32% and 61,74% respectively. Precious Shipping Pcl with 20,40% is in the last position.

Table 6.25: Efficiency Results for Small Companies

	Companies	2011	2012	2013	2014	AV.
small	Baltic Trading Ltd.	7,00	22,35	24,64	56,82	***27,70***
small	Euroseas Ltd.	8,24	52,10	72,22	100,00	***58,14***
small	Freeseas Inc.	17,22	87,18	81,33	0,00	***46,43***
small	Globus Maritime Ltd.	7,94	71,17	75,25	92,58	***61,74***
small	Goldenport Holdings Inc.	4,66	28,82	35,03	45,31	***28,46***
small	Gulf Navigation Hold. Pisc.	35,67	21,34	36,57	69,58	***40,79***
small	Hellenic Carriers Ltd.	16,18	100,00	68,91	0,00	***46,27***
small	Malaysian Bulk Carriers	100,00	97,28	100,00	0,00	***74,32***
small	Newlead Holdings Ltd.	1,09	98,71	0,03	0,00	***24,96***
small	Precious Shipping Pcl.	8,36	28,42	25,15	19,66	***20,40***
small	Wilson ASA	31,23	32,90	32,46	25,21	***30,45***
	AV.	***21,60***	***58,21***	***50,14***	***37,20***	

Similarly, table 6.26 presents efficiency results for middle-sized companies per year. Golden Ocean Group Ltdcomes first with 83,49% followed by StealthGas Inc with 78,28%. Qatar Gas Transport Co with 7,86% and Pan Ocean Co Ltd with 9,26% occupy the last positions.

Table 6.26 : Efficiency Results for Medium Companies

	Companies	2011	2012	2013	2014	AV.
medium	Algoma Central Corp.	38,30	42,24	37,21	66,91	***46,16***
medium	Capital Product Partners	60,36	37,29	23,58	43,24	***41,12***
medium	D' Amico Int. Shipping S.A.	39,31	50,79	42,11	100,00	***58,05***
medium	Frontline Ltd.	19,29	26,73	21,58	59,31	***31,73***
medium	Genco Ship & Trad. Ltd.	11,66	12,12	0,00	0,00	***5,95***
medium	Golden Ocean Group Ltd.	76,01	100,00	100,00	57,96	***83,49***
medium	Nordic American Tankers	30,83	24,57	22,80	47,00	***31,30***
medium	Qatar Gas Transport Co.	4,39	7,26	7,10	12,70	***7,86***
medium	Safebulkers Inc.	49,62	0,00	34,86	0,00	***21,12***
medium	Scorpio Tankers Inc.	79,84	53,88	42,54	25,80	***50,52***
medium	Seacore Holding Inc.	10,65	16,91	15,55	31,16	***18,57***
medium	StealthGas Inc.	100,00	85,85	57,02	70,25	***78,28***
medium	Pan Ocean Co. Ltd.	7,62	6,78	6,82	15,82	***9,26***
medium	TBS International Plc.	33,56	28,46	24,41	40,69	***31,78***
medium	Top Ships Inc.	45,28	42,21	38,80	71,72	***49,50***
	AV.	***40,45***	***35,67***	***31,63***	***42,84***	

Table 6.27 presents the efficiency results for large companies. The most efficient company was Paragon Shipping Inc with an average rate of 100%. It can be observed that the majority the companies are shown to be less efficient in contrast with model 1. Most of the companies have an average efficiency less than 15%. The less efficient company was Nepture Orient Lines (3,07%), which was the most efficient company in model 1.

Table 6.27: Efficiency Results for Large Companies

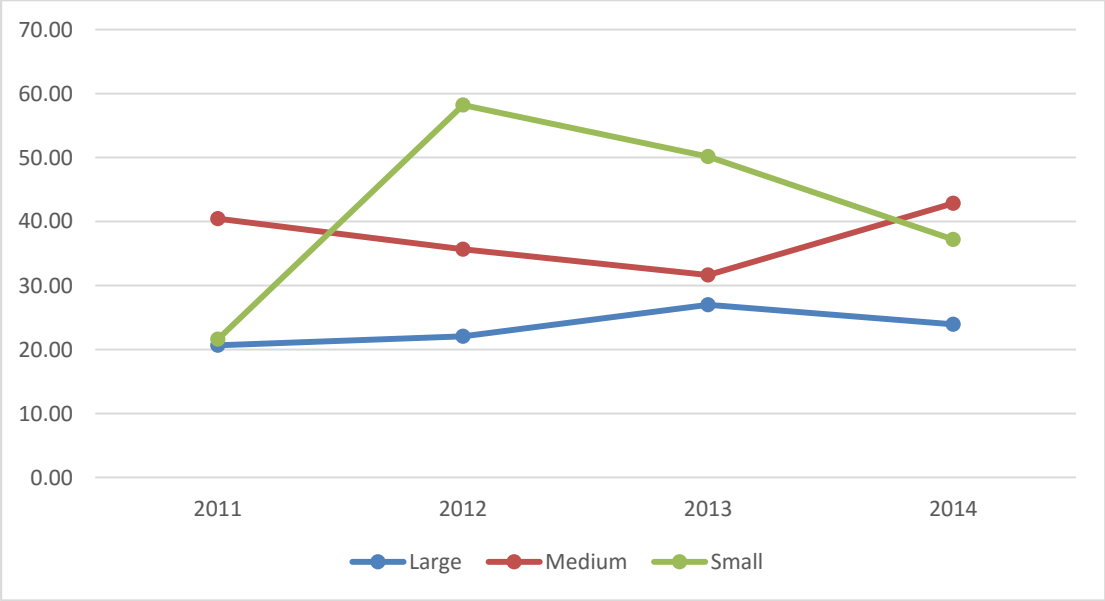
	Company	2011	2012	2013	2014	MO
large	AP Moller-Maersk A/S	1,32	1,16	5,91	7,05	***3,86***
large	Concordia Maritime AB	66,92	75,60	84,48	95,15	***80,54***
large	Cosco Shipping Co. Ltd.	16,60	15,85	15,10	17,76	***16,33***
large	China Shipping Dev. Co.	5,95	6,05	6,00	6,46	***6,11***
large	Danaos Corp.	9,77	8,23	9,09	0,00	***6,77***
large	Diana Shipping Inc.	29,55	26,09	25,28	28,10	***27,26***
large	Dryships Inc.	15,80	15,32	14,39	17,79	***15,82***
large	DS Norden	9,50	11,46	11,16	12,56	***11,17***
large	Eagle Bulk Shipping	23,66	25,86	28,92	24,07	***25,63***
large	Evergreen Marine Corp.	17,16	5,66	5,46	0,00	***7,07***
large	Hyundai Merchant Marine	3,02	2,83	3,53	4,21	***3,40***
large	Mitsui O.S.K. Lines	1,16	1,90	1,22	1,53	***1,45***
large	Navios Maritime Holding	14,74	15,26	15,73	17,95	***15,92***
large	Nepture Orient Lines	3,22	3,07	2,88	3,12	***3,07***
large	Nippon Yusen KK	1,38	1,22	1,50	1,67	***1,44***
large	Overseas Shipping Group	7,43	7,68	9,52	14,12	***9,69***
large	Paragon Shipping Inc.	100,00	100,00	100,00	100,00	***100,00***
large	Regional Container Lines	32,34	36,05	40,80	53,89	***40,77***
large	Star Bulk Carriers Corp.	42,15	50,40	93,96	26,65	***53,29***
large	Teekay Corp.	3,40	3,56	4,72	5,81	***4,37***
large	Torm	9,03	10,12	12,67	22,21	***13,51***
large	Tsakos Energy Navigation	12,35	13,36	13,77	16,43	***13,98***
	MO	***20,65***	***22,06***	***26,98***	***23,94***	

Table 6.28 illustrates data of the previous tables which is presented per year, per company size the average rates of efficiency of all companies of each category in comparison with all the companies of the model. The data of table 6.28 is depicted in diagram 6.8.

Table 6.28: Average Efficient Rate per Size per Year

	2011	2012	2013	2014	AV.
Large	20,65	22,06	26,98	23,94	23,41
Medium	40,45	35,67	31,63	42,84	37,65
Small	21,60	58,21	50,14	37,20	41,79

Diagram 6.8: Average Efficient rate per Size per Year



6.4 Conclusion

In this chapter, a presentation of the two models used for DEA method on shipping companies was shown. As it has already been mentioned previously, maritime industry is a type of industry which is very sensitive to changes since it is affected by a great number of factors some of which could be totally unpredictable.According to model 1 results, in which the inputs were the total assets and the operating cost and the output was the revenues and the companies efficiency in terms of revenues is examined. Furthermore, if we classify the companies based on their productivity, it

can be seen that many companies during those 4 years keep the same positions (quartered parts of the sample) something that it is confirmed by their productivity. Next, we examined the companies' efficiency per category by dividing the sample: dry, multiple, wet and container. During 2011-2014 the container cargo companies were more efficient in general followed by wet cargo and at the end were dry cargo and multiple. These results might be attributed to the nature of freight market in which the companies operate and to the conditions prevailing the particular years of our study. Similarly, the companies were separated according to their size in a sample of three groups of equal total assets. The medium companies were the most productive during those years followed by the large ones very closely and last the small ones. In addition, the results are reliable as companies presenting high changes in their efficiency were examined and indeed these changes were due to equivalent changes of their input-output. Finally, the conclusions drawn after such a meticulous study will prove a usefull tool for future references as well as further studies.

Based on model 2 results in which the inputs were the vessels value and the vessels operating cost and output was gross profit from the vessels operation and companies efficiency is examined in terms of profitability. As for the companies classification based on their productivity, it can be noticed that many companies for all those four years kept the same position in the first and forth quartered part of the sample, something which confirms their performance. In the second and third quarter part, not many common companies appear like in the first sample due to the high variability of profits in relation to revenue. Moreover, we examine the companies' efficiency per category by dividing them into four groups: dry, wet, multiple and container. Similarly with the results of the first sample during 2011-2014, it can be noticed that container companies were more efficient in general followed by wet cargo while in the third position are dry cargo companies and at the end in the multiple cargo. The differentiation of the first position is attributed to different variables used and to the fact that some of a multiple cargo companies show liabilities in 2011, while dry cargo companies appear to be more productive in terms of making profits. Similarly, the companies were examined by size and they were divided into three groups of equal size depending on their total asset. Here, the results were different from model 1 as the small companies were more productive

followed by the medium ones. If we notice that the efficiencies measured are relative, as they concern a particular group of companies. Also, the analysis result proved that are reliable because the companies, which were examined, presented considerable fluctuations in their efficiency that were due to fluctuations of input-output. To sum up, an element which makes the above study cretible is that the meassurements and evaluation were conducted under certain conditions which reflect nothing but reality, which will might be used as a usefull study tool for future measurements.

Chapter 7

LIQUIDITY RATIO

7.1 Introduction

The companies' financial situations like their balance sheets, income statements and cash flows provide an important source of information for financial analysts. This happens as the financial conditions can be used to analyse the total productivity of a company, to evaluate each financial condition and to predict a potential future development. In other words, they provide useful information not only for the current financial condition but also for the estimation of potential profits, dividends and cash flows.

Financial ratios constitute a useful tool to exploit and use this type of information. Financial ratios are the relative figures of two numerical values, which derive from the company's financial condition. In this way the strengths of a company can be recognised so that they can be used to the company's benefit as well as each weaknesses in order to avoid them in future.

The term financial ratio analysis can be defined as " the relationship between various financial figures, mainly accountancy ones so that the previous, current and future financial efficiency of a company can be evaluated" [1]. This provides opportunity to the financial investors to work on two types of analyses.

1. Time series analysis, in which they can compare a company's current financial data with the previous or the projected one for the future. In this case, they can check better whether a company's financial condition has improved or deteriorated in terms of time.
2. Cross-sectional analysis, in which they can compare the financial figures of a company with a similar company or with an average company of the same nature for the same period. In this case, an analyst can have an overall informative report of a financial condition of a company.

The use of ratios is very useful for the following:

1. Mangers and share holders of a company who can use financial ratios to evaluate the company's development to predict future financial conditions and to plan strategies which can lead to the better development of the company in future.
2. Financial analysts, who can compare the strengths and weaknesses between different companies in order to draw a conclusion about their capacity so that they can respond to their financial challenges in the future.
3. Investors, who are interested in gaining control of the company's efficiency as well as its developments prospects so that they can choose the most optimal capital investment.

As it can be realised, in this way a considerable number of financial ratios can be calculated. In order these ratios to be used to the most credible way the following must be take into consideration:

1. To be a reasonable relationship between the financial figures appeared in the numerator and denominator so as to produce an exploitative size.
2. The figures of both numerator and denominator to respond accordingly to a common size they refer to.

The main characteristic of financial ratio analysis is the fact that ratios appear in the form of a fraction. The use of the fractions provides the opportunity to eliminate problems appearing during the companies' comparison that have a difference in their sizes during a particular period. As a result, the use of financial ratios allows the comparison between all companies' sizes as it adapts their data by taking into consideration their sizes' influence.

However, the use of these ratios has certain restrictions that should be known by the experts that are thinking of dealing with their analysis so as to overcome them easily.

7.2 The Liquidity Ratios

The term Liquidity refers to the speed and easiness with which an asset of a company can be converted to cash. How "liquid" an asset of a company is, it

depends on how quickly this can be converted to numeracy units without loosing its value. Liquidity Ratio of a company has to do with its ability to respond properly to its long-term obligations. They need the correlation between a company's obligations with the duration of its assets in order to satisfy the needs for payment to suppliers and funders. The level of liquidity of a company is directly related both with its need for capital and with the discipline it operates. For its evaluation, the previous financial obligations of a company are calculated with the current liquidity level, the future needs for financial input as well as the possibility of reducing capital funds or getting new capitals.

Finally, it can be added that bigger companies have better liquidity control in comparison with the smaller ones, as they have bigger access to capital markets and bigger capital input from their activities.

Liquidity ratios, which present a considerable interest, are the following:

1. **Current Ratio**, which is calculated by dividing current assets by current liabilities. In other words:

$$\text{Current Ratio} = \frac{Current\ Assets}{Current\ Liabilites}$$

Current assets include available, inventories and demands while short-term obligations include note payable, loans, taxes, interest rates, insurance expenses and dividends, elements that will be completed in the next balance sheet.

This ratio shows to which degree these elements of current asset can cover the short-term obligations. It is about one of the most important ratios concerning the short-term solvency, as well as it presents the degree to which short-term investors are covered by the current asset which can be easily converted to cash.

Generally, it can be said that funders wish this ratio to have a high value as this automatically means high liquidity. Nevertheless, this ratio can change depending on the factor every company operates in. High ratio values, close to 3, are not desirable as its shows inefficient use of the company's sources that cannot be liquidated easily

resulting in the slow development of the company. It can also show the existence of inventories whose value has not appeared in the company's books or the company's difficulty to collect its financial demands.

Finally, this ratio presents certain disadvantages such as:

- It constitutes a statistical approach but in reality the both elements of current asset keep changing as well as short-terms obligations.
- It does not separate the elements of current assets among which some of them might show higher liquidity than the others.

2. **Quick Ratio or Acid-Test Ratio,** this ratio is defined as the result of current asset excluding inventories divided by current liabilities.

$$\text{Quick ratio} = \frac{Current\ Assets - Inventories}{Current\ Liabilites}$$

This ratio presents a degree to how vulnerable a company is in case of sudden changes of financial situation of the industry it operates as the lower the ratio value is, the more expose to danger of losing liquidity the company is. The utility of this ratio lies in its ability to display properly the relationship between easily liquidated assets and the short-term obligations. The subtraction of inventories happens because these are the elements with smaller liquidity among the other elements of current asset and to those that can suffer from liabilities during their liquidation.

If the ratio is greater than one, then we can conclude that the company's inventories can be fully used by net current asset. On the contrary, a ratio value lower than one can lead the company to a weakness to cover short-terms obligations and the need to ask for credit or loans. The lower value of this ratio can only be justified in case of having a high pace in collecting revenues and in which it should be compared.

7.3 Statistical data used for Liquidity Ratio

As it has already been mentioned before, the statistical sample consists of some of the leading, listed shipping companies all over the world. The data that will be presented are variables of the sample analysis (inputs-outputs) concerning the financial figures of the companies and are presented in millions USD. The results of the analysis are for the years 2011, 2012, 2013 and 2014 so as throughout that period an all-time analysis of the companies' efficiency can be achieved.

As it has already been presented, the sample constitutes of shipping companies focusing on different maritime disciplines: dry, wet, multiple and container cargo. Table 7.1 shows certain statistical data for the analysis input. It can be noticed that the sample is consisted of companies of different financial sizes, something that can be depicted by each company's fleet size.

The definition of three variables representing each company's data in the analysis are followed.

Table 7.1:

Variable	Average	Median	Lowest Value	Highest Value
2011				
Current Assets	948,349	247,722	13,467	13452,117
Current Liabilities	1403,344	231,693	10,456	33752,572
Inventories	1290,740	11,083	0,403	45205,000
2012				
Current Assets	999,468	224,029	12,225	13540,000
Current Liabilities	1376,726	179,100	11,498	33982,210
Inventories	137,578	14,356	0,081	2274,000
2013				
Current Assets	1137,019	232,541	10,589	18328
Current Liabilities	1414,085	181,1	6,158	31996
Inventories	101,326	12,6	0	1251
2014				
Current Assets	2327,558	204,871	1,943	48600
Current Liabilities	2267,259	169,2535	6,479	39600
Inventories	95,335	13,8055	0,166	1139

Current Assets: it refers to the cash and other assets expected to be converted to cash or consumed either in a year or in the operating cycle (whichever is longer), without disturbing the normal operations of a business.

Current Liabilities: it refers to a company's debts or obligations that are due within one year. Current liabilities appear on the company's balance sheet and include short-term debt, accounts payable, accrued liabilities and other debts.

Inventories: it refers to the raw materials, work-in-process goods and completely finished goods that are considered to be the portion of a business's assets that are ready or will be ready for sale. Inventory represents one of the most important assets that most businesses possess, because the turnover of inventory represents one of the primary sources of revenue generation and subsequent earnings for the company's shareholders/owners.

Table 7.2: Data per Company In 2011

Company	Current Assets	Current Liabilities	Inventories
Algoma Central Corp.	247,722	85,491	-
AP Moller-Maersk A/S	13452,117	33752,572	2206,862
Capital Product Partners	62,291	55,637	4,01
Concordia Maritime AB	494,82	246,05	-
China Shipping Dev. Co.	937,748	1036,714	131,833
D' Amico Int. Shipping S.A.	657,55	261,37	45.205
Danaos Corp.	93,291	231,693	16,187

Diana Shipping Inc.	432,691	48,095	4,808
Dryships Inc.	570,077	756,263	80,052
DS Norden	715,829	220,819	89,28
Eagle Bulk Shipping	55,891	69,121	11,083
Euroseas Ltd.	38,877	21,101	2,606
Evergreen Marine Corp.	1382,84	853,654	144,443
Freeseas Inc.	52,675	99,861	0,603
Frontline Ltd.	410,405	167,384	40,37
Globus Maritime Ltd.	13,467	10,456	0,554
Golden Ocean Group Ltd.	66,378	11,147	3,791
Goldenport Holdings Inc.	55,453	56,634	0,403
Gulf Navigation Hold. Pisc.	65,041	329,872	5,633
Hellenic Carriers Ltd.	54,843	15,158	2,237
Hyundai Merchant Marine	2106,382	1663,096	371,443
Malaysian Bulk Carriers	126,176	22,502	40,21
Mitsui O.S.K. Lines	3346,715	3636,504	566,346
Navios Maritime Holding	370,974	252,003	6,339
Nepture Orient Lines	1765,707	2125,715	326,993

Newlead Holdings Ltd.	33,723	583,604	1,686
Nippon Yusen KK	6839,477	4885,012	653,405
Nordic American Tankers	83,1	17,946	7,586
Overseas Shipping Group	715,529	398,552	12,911
Paragon Shipping Inc.	37,457	40,486	0,823
Regional Container Lines	259	240,1	144,8
Safebulkers Inc.	37,959	51,673	2,653
Scorpio Tankers Inc.	61,45	18,234	2,696
Seacore Holding Inc.	1040,547	401,526	37,462
Star Bulk Carriers Corp.	31,397	52,154	3,867
StealthGas Inc.	56,521	56,1	2,416
Pan Ocean Co. Ltd.	1009,402	1750,09	94,2
Teekay Corp.	199,778	146,835	4,36
Torm	369,281	2045,879	85,548
Tsakos Energy Navigation	287,633	279,712	19,835
Wilson ASA	244,109	540,271	3,524

Table 7.3: Data per Company In 2012

Company	Current Assets	Current Liabilities	Inventories
Algoma Central Corp.	275,18	67,64	-
AP Moller-Maersk A/S	13540	33982,21	2274
Capital Product Partners	49,489	35,773	2,333
Concordia Maritime AB	565	261	-
China Shipping Dev. Co.	1033,748	1011,675	149,467
D' Amico Int. Shipping S.A.	608,228	277,71	70,281
Danaos Corp.	98,673	365,252	17,731
Diana Shipping Inc.	466,986	61,477	5,275
Dryships Inc.	903,529	1573,529	122,775
DS Norden	883,64	207,921	110,783
Eagle Bulk Shipping	43,799	33,988	12,083
Euroseas Ltd.	45,07	27,367	1,812
Evergreen Marine Corp.	1673,071	901,331	156,99
Freeseas Inc.	35,583	106,556	0,521
Frontline Ltd.	392,03	186,621	57,505
Globus Maritime Ltd.	15,88	25,018	0,658

Golden Ocean Group Ltd.	85,849	11,498	1,181
Goldenport Holdings Inc.	34,937	40,926	0,097
Gulf Navigation Hold. Pisc.	36,192	273,3	2,508
Hellenic Carriers Ltd.	53,159	23,534	0,264
Hyundai Merchant Marine	2172,346	1862,482	288,333
Malaysian Bulk Carriers	91,899	28	14,019
Mitsui O.S.K. Lines	3759,58	3136,912	661,102
Navios Maritime Holding	467,937	186,746	24,704
Nepture Orient Lines	2524,126	2157,593	267,309
Newlead Holdings Ltd.	12,225	177,426	0,081
Nippon Yusen KK	6584,508	5505,447	740,778
Nordic American Tankers	78,573	14,974	4,048
Overseas Shipping Group	744,116	440,299	15,532
Paragon Shipping Inc.	31,333	21,971	0,92
Regional Container Lines	160,3	179,1	68,6
Safebulkers Inc.	171,829	47,493	5,9
Scorpio Tankers Inc.	77,288	20,123	1,286

Seacore Holding Inc.	718,624	265,641	52,437
Star Bulk Carriers Corp.	37,963	42,45	3,613
StealthGas Inc.	56,263	55,808	3,152
Pan Ocean Co. Ltd.	1304,99	2051,704	105,99
Teekay Corp.	202,965	61,83	9,101
Torm	384,58	134,169	28,328
Tsakos Energy Navigation	224,029	258,907	14,356
Wilson ASA	332,687	322,381	69,698

Table 7.4: Data per Company In 2013

Company	Current Assets	Current Liabilities	Inventories
Algoma Central Corp.	303,204	68,808	-
AP Moller-Maersk A/S	18328	31996	1251
Capital Product Partners	73,732	38,928	2,74
Concordia Maritime AB	486,537	320,527	-
China Shipping Dev. Co.	807,032	1805,686	142,125
D' Amico Int. Shipping S.A.	557,9	287,504	63,144
Danaos Corp.	126,866	369,888	14,496
Diana Shipping Inc.	251,868	62,297	5,959

Dryships Inc.	1184,199	2171,714	133,875
DS Norden	846,053	225,857	111,349
Eagle Bulk Shipping	61,931	1192,219	9,61
Euroseas Ltd.	16,951	18,812	1,474
Evergreen Marine Corp.	1702,232	1028,291	155,455
Freeseas Inc.	15,798	74,839	0,032
Frontline Ltd.	260,153	130,772	44,532
Globus Maritime Ltd.	10,589	16,371	0,633
Golden Ocean Group Ltd.	104,741	7,417	1,729
Goldenport Holdings Inc.	41,893	31,037	0
Gulf Navigation Hold. Pisc.	119,423	308,305	1,712
Hellenic Carriers Ltd.	34,598	6,158	0,458
Hyundai Merchant Marine	2130,996	3932,712	248,421
Malaysian Bulk Carriers	82,023	21,516	8,254
Mitsui O.S.K. Lines	4996,56	4136,465	577,506
Navios Maritime Holding	339,986	149,767	2,041
Nepture Orient Lines	2466,643	2311,967	254,232
Newlead Holdings Ltd.	12,422	291,701	0,288

Nippon Yusen KK	7137,306	4410,291	627,295
Nordic American Tankers	131,396	19,263	24,281
Overseas Shipping Group	817,313	377,84	16,884
Paragon Shipping Inc.	44,22	23,655	1,145
Regional Container Lines	134,1	181,1	53,4
Safebulkers Inc.	173,185	57,304	12,6
Scorpio Tankers Inc.	239,17	60,486	2,857
Seacore Holding Inc.	862,283	254,419	27,615
Star Bulk Carriers Corp.	63,679	29,734	1,726
StealthGas Inc.	97,885	63,07	2,461
Pan Ocean Co. Ltd.	770,321	891,877	79,276
Teekay Corp.	215,071	70,194	10,765
Torm	295,294	261,451	29,109
Tsakos Energy Navigation	232,541	228,272	19,66
Wilson ASA	41,666	42,965	11,583

Table 7.5: Data per Company In 2014

Company	Current Assets	Current Liabilities	Inventories
Algoma Central Corp.	341,75	66,731	-
AP Moller-Maersk A/S	16225	26619	1139

Capital Product Partners	172,115	45,568	3,434
Concordia Maritime AB	48600	39600	-
China Shipping Dev. Co.	1032,859	2194,854	133,648
D' Amico Int. Shipping S.A.	-	-	-
Danaos Corp.	103,073	328,082	11,665
Diana Shipping Inc.	238,234	98,092	7,313
Dryships Inc.	1277,277	1621,76	125,464
DS Norden	557,035	285,831	72,499
Eagle Bulk Shipping	76,591	41,001	5,749
Euroseas Ltd.	30,847	25,19	1,758
Evergreen Marine Corp.	1718,068	1219,592	134,784
Freeseas Inc.	1,943	32,792	0,166
Frontline Ltd.	233,243	328,588	28,92
Globus Maritime Ltd.	10,235	48,436	0,441
Golden Ocean Group Ltd.	64,279	34,779	13,243
Goldenport Holdings Inc.	33,315	35,326	1,44
Gulf Navigation Hold. Pisc.	17,049	197,262	2,047
Hellenic Carriers Ltd.	15,032	6,479	0,77

Hyundai Merchant Marine	1468,842	3482,137	181,221
Malaysian Bulk Carriers	58,134	29,804	0,368
Mitsui O.S.K. Lines	5184,998	4178,439	576,652
Navios Maritime Holding	416,009	198,115	2,564
Nepture Orient Lines	2609,822	2228,622	175,244
Newlead Holdings Ltd.	11,763	247,462	0,791
Nippon Yusen KK	8470,482	5116,246	701,004
Nordic American Tankers	176,499	24,035	22,223
Overseas Shipping Group	707,668	109,286	7,987
Paragon Shipping Inc.	26,688	28,482	2,131
Regional Container Lines	127	169,2	49,3
Safebulkers Inc.	135,892	28,718	11,185
Scorpio Tankers Inc.	273,704	190,368	6,075
Seacore Holding Inc.	833,403	271,953	22,783
Star Bulk Carriers Corp.	134,43	140,198	14,368
StealthGas Inc.	89,447	57,009	2,02
Pan Ocean Co. Ltd.	883,977	718,149	53,76
Teekay Corp.	253,614	79,718	35,254
Torm	153,275	169,307	44,637

Tsakos Energy Navigation	289,799	327,282	15,941
Wilson ASA	48,933	66,467	14,878

7.3.1 Current Ratio Results

In this sub-unit, the results of Current Ratio are presented. The variables used were Current Assets and Current Liabilites. Efficiency of every shipping company in comparison with the other ones was calculated based on Liquidity Ratio for variable returns to scale and input orientated for the years 2011, 2012, 2013 and 2014.

The total results per company, per year are displayed on table 7.6. Every company is mentioned by writing the first four letters of its commercial name. We notice that 1 company (DIA) is productive in two of the four years and 2 companies (GOG,Nor) are productive for one of the four years.

Table7.6: Total Efficiency Results per Company per Year

	2011	2012	2013	2014	AV.
APM	4,43	5,25	4,06	8,30	5,51
Cap.	12,44	18,21	13,41	51,44	23,88
CSD	10,05	13,45	3,16	6,41	8,27
DAM	27,96	28,83	13,74	-	23,51
DAN	4,48	3,56	2,43	4,28	3,68
Dia.	100,00	100,00	28,63	33,07	65,43
DRY	8,38	7,56	3,86	10,73	7,63
DS	36,03	55,95	26,53	26,54	36,26
Eag.	8,99	16,96	0,37	25,44	12,94
EUR	20,48	21,68	6,38	16,68	16,30
Eve.	18,01	24,44	11,72	19,18	18,34
FRE	5,86	4,40	1,49	0,81	3,14
FRO	27,25	27,65	14,09	9,67	19,67
Glo.	14,32	8,36	4,58	2,88	7,53
GOG	66,19	98,29	100,00	25,17	72,41
Gol.	10,88	11,24	9,56	12,84	11,13
GNH	2,19	1,74	2,74	1,18	1,96
Hel.	40,22	29,74	39,79	31,59	35,33
Hyu.	14,08	15,35	3,84	5,74	9,75
Mal.	62,33	43,21	27,00	26,56	39,77

Mit	10,23	15,78	8,55	16,90	12,86
Nav.	16,36	32,99	16,08	28,59	23,51
Nep.	9,23	15,40	7,56	15,95	12,03
New.	0,64	0,91	0,30	0,65	0,62
Nip.	15,56	15,74	11,46	22,55	16,33
Nor.	51,47	69,08	48,30	100,00	67,21
Ove.	19,96	22,25	15,32	88,18	36,43
Par.	10,28	18,77	13,24	12,76	13,76
Reg.	11,99	11,78	5,24	10,22	9,81
SAF	8,17	47,63	21,40	64,44	35,41
Sco.	37,46	50,56	28,00	19,58	33,90
Sea.	28,81	35,61	24,00	41,73	32,54
SBC	6,69	11,77	15,17	13,06	11,67
Ste.	11,20	13,27	10,99	21,37	14,21
POC	6,41	8,37	6,12	16,76	9,42
TEE	15,12	43,21	21,70	43,32	30,84
TOR	2,01	37,73	8,00	12,33	15,02
Tsa.	11,43	11,39	7,21	12,06	10,52
WIL	5,02	13,59	6,87	10,03	8,88

Table 7.7 shows the distinctive measurements in percentages of efficiency results deriving from table 7.6. It can be observed that the minimum efficiency degree is high and fluctuates from 0,30% in 2013 to 0,91% in 2012. The maximum efficiency degree is 100% for all the years. The average efficiency degree fluctuates from 15,20% in 2013 to 25,94% in 2012. Finally, the median efficiency degree luctuates from 10,99% in 2013 to 16,96 in 2012.

Table 7.7: Special Efficiency Measures

	2011	2012	2013	2014
MIN	0,64	0,91	0,30	0,65
MAX	100,00	100,00	100,00	100,00
AVERAGE	19,81	25,94	15,20	22,87
Median	11,99	16,96	10,99	16,72

Table 7.8 displays the allocation of efficiency rates and it depicts clearly all the above mentioned, while all this data is also illustrated in table 7.6. It can be noticed that the majority of the companies are not as efficient as it is the most efficient company.

Table 7.8: Allocation Efficiency Rates

	2011	2012	2013	2014
0-10%	14	8	20	9
10-20%	14	14	9	14
20-30%	4	6	7	7
30-40%	2	3	1	2
40-50%	1	3	1	2
50-60%	1	2	0	1
60-70%	2	1	0	2
70-80%	0	0	0	0
80-90%	0	0	0	1
90-100%	1	2	1	1
Total	39	39	39	39

Diagram 7.1: Allocation Efficiency Rates

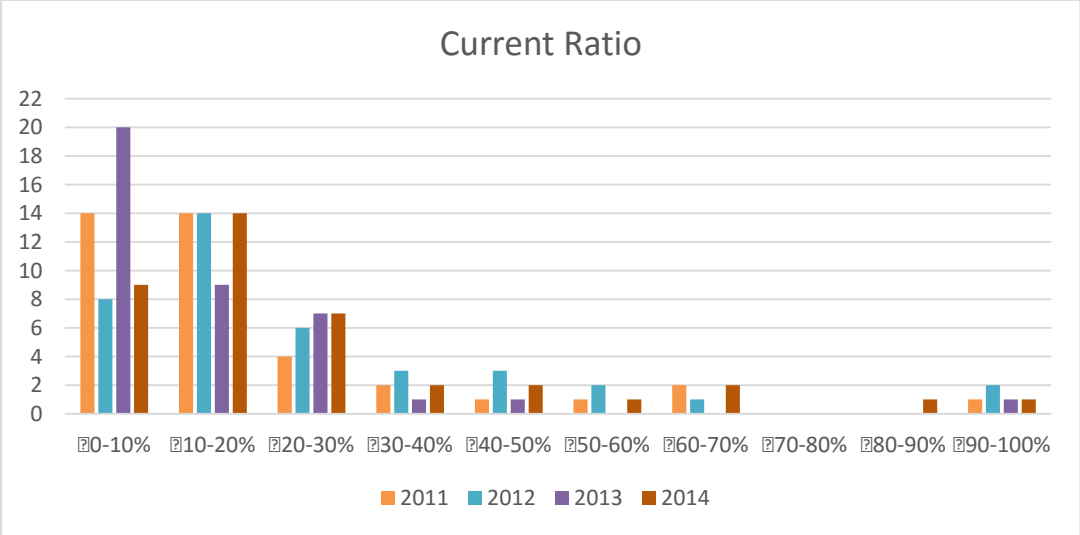


Table 7.9 presents the position of every company in comparison with the other ones of the same sample per year according to its efficiency. The classification is in decreasing order: the most effective company is no 1 position and the least effective in the lowest position (39). It can be noticed that some companies like Safebulkers, Euroseas and Wilson Asa show a great fluctuation in their classification per year. On the contrary, some other companies like AP-Moller, Danaos Corp,Gulfare, Newlead Holdings and Mitsui classified in a close position every year. It is also worth mentioning the fact that for the productive companies, their classification was carried out based on the fact to how often they are compared with others.

The previous comment is depicted clearly on table 7.10, which shows the common companies for all the years of analysis in the quartered parts of the sample, which was divided into four equal parts. Based on the companies' classification, we can notice which company is located in the same quartered part of the sample.

Table 7.9: Companies Classification Based On Their Efficiency

Company	2011	2012	2013	2014
AP Moller-Maersk A/S	36	35	31	32
Capital Product Partners	19	19	16	4
Concordia Maritime AB	26	26	34	20
China Shipping Dev. Co.	9	13	15	33
Danaos Corp.	35	37	36	35
Diana Shipping Inc.	1	1	4	7
Dryships Inc.	29	34	32	28
DS Norden	7	4	7	11
Eagle Bulk Shipping	28	20	38	12
Euroseas Ltd.	11	17	27	21
Evergreen Marine Corp.	13	15	18	17
Freeseas Inc.	33	36	37	38
Frontline Ltd.	10	14	14	31
Globus Maritime Ltd.	17	33	30	36

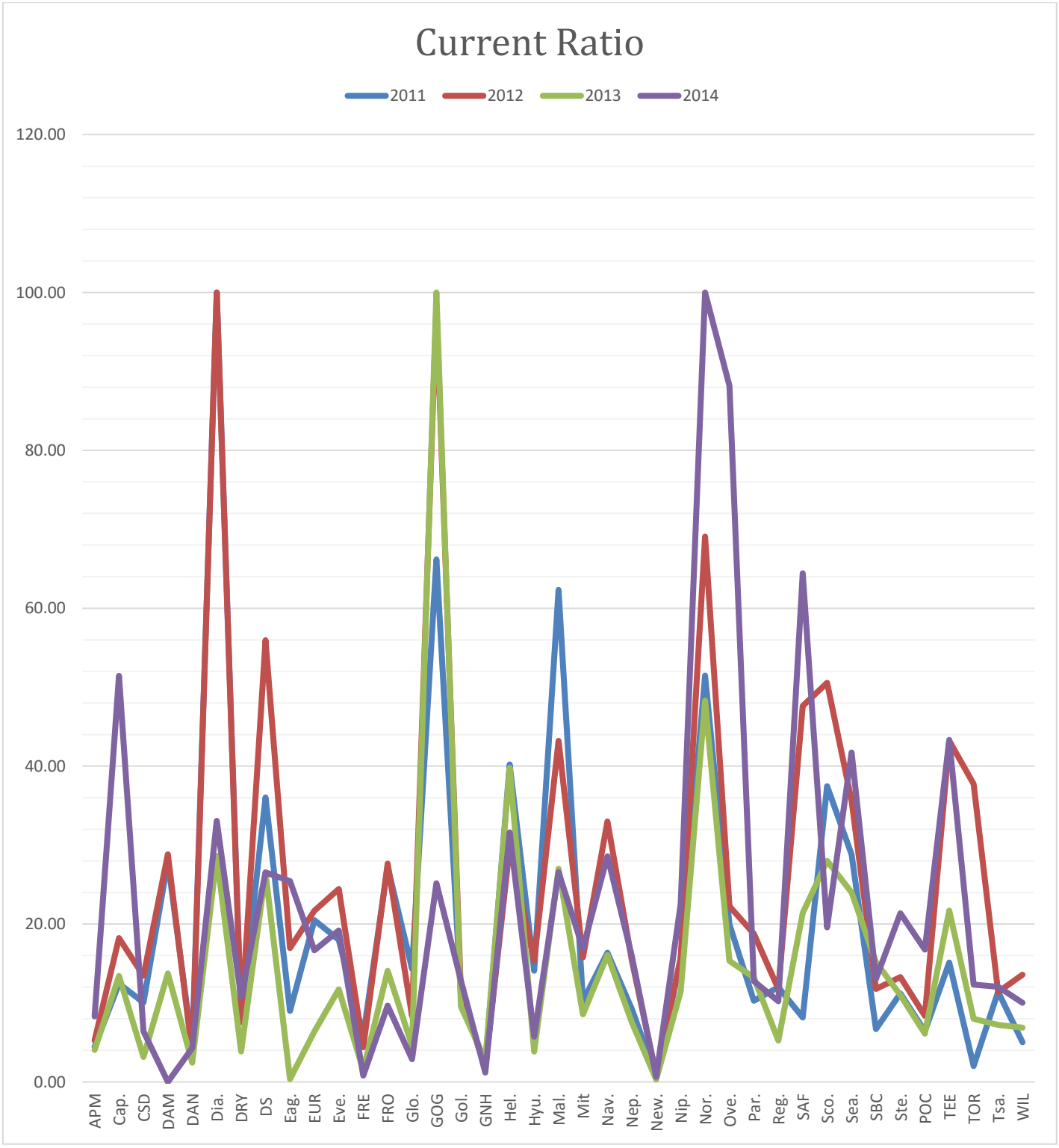
Golden Ocean Group Ltd.	2	2	1	13
Goldenport Holdings Inc.	23	31	21	24
Gulf Navigation Hold. Pisc.	37	38	35	37
Hellenic Carriers Ltd.	5	12	3	8
Hyundai Merchant Marine	18	24	33	34
Malaysian Bulk Carriers	3	8	6	10
Mitsui O.S.K. Lines	25	21	22	18
Navios Maritime Holding	14	11	11	9
Nepture Orient Lines	27	23	24	22
Newlead Holdings Ltd.	39	39	39	39
Nippon Yusen KK	15	22	19	14
Nordic American Tankers	4	3	2	1
Overseas Shipping Group	12	16	12	2
Paragon Shipping Inc.	24	18	17	25
Regional Container Lines	20	28	29	29
Safebulkers Inc.	30	6	10	3
Scorpio Tankers Inc.	6	5	5	16
Seacore Holding Inc.	8	10	8	6
Star Bulk Carriers Corp.	31	29	13	23
StealthGas Inc.	22	27	20	15
Pan Ocean Co. Ltd.	32	32	28	19
Teekay Corp.	16	7	9	5
Torm	38	9	23	26
Tsakos Energy Navigation	21	30	25	27
Wilson ASA	34	25	26	30

Table 7.10: Common Companies In The Same Quartered Parts During 2011-2014

	>Q3 [ΘΕΣΕΙΣ 1-10]	M-Q3 [ΘΕΣΕΙΣ 11-20]	Q1-M [ΘΕΣΕΙΣ 21-30]	<Q1 [ΘΕΣΕΙΣ 31-39]
COMPANIES	DIA MAL NOR SEA	EVE	NEP REG TSA	APM DAN FRE GNH NEW
Actual Number	4	1	3	5
Percentage	40%	10%	30%	50%

Diagram 7.2 depicts the results of efficiency per company as they were presented in table 7.6

Diagram 7.2: Efficiency per Company per Year



Next, the companies are divided into 4 groups based on their cargo:

1. Companies with dry cargo
2. Companies with wet cargo
3. Companies with multiple cargo
4. Companies with container cargo

Table 7.11 presents efficiency results per year for companies of dry cargo in comparison with the other companies of the sample. Out of these, the most productive is Golden Ocean Group Ltd, as for the years 2011,2012 and 2013 has 100% efficiency and an average efficiency of 84,76%. This could be the reason that it shows the highest efficiency as it has a flexible fleet which can be best respond to the market needs and to be adapted accordingly. The next best companies are Safebulkers Inc and Hellenic Carriers Ltd with an average efficiency rate around 45% for the four years under study, from which both are of Greek management. On the other hand, the worst companies in terms of efficiency were Freeseas Inc (4,02%) and Globus Maritime Ltd (9,79%), from which both are of Greek management.

Table 7.11: Efficiency Results For Dry Cargo Companies per Year

	Company	2011	2012	2013	2014	*AV.*
dry	Baltic Trading Ltd.	0,00	38,78	54,66	0,00	***23,36***
dry	Eagle Bulk Shipping	13,58	17,26	0,37	39,48	***17,67***
dry	Freeseas Inc.	8,86	4,47	1,49	1,25	***4,02***
dry	Globus Maritime Ltd.	21,63	8,50	4,58	4,47	***9,79***
dry	Golden Ocean Group Ltd.	100,00	100,00	100,00	39,06	***84,76***
dry	Hellenic Carriers Ltd.	60,76	30,25	39,79	49,03	***44,96***
dry	Navios Maritime Holding	24,72	33,56	16,08	44,38	***29,68***
dry	Nepture Orient Lines	13,95	15,67	7,56	24,75	***15,48***
dry	Nippon Yusen KK	23,51	16,02	11,46	34,99	***21,49***
dry	Paragon Shipping Inc.	15,54	19,10	13,24	19,80	***16,92***
dry	Safebulkers Inc.	12,34	48,46	21,40	100,00	***45,55***
dry	Star Bulk Carriers Corp.	10,11	11,98	15,17	20,26	***14,38***
	AV.	***25,42***	***28,67***	***23,82***	***31,46***	

Table 7.12 displays the results of multiple cargo companies per year. It was expected that these companies would show higher efficiency in comparison to the other ones which are specialized in one type of cargo as their versatility would help them not to be so seriously affected by economic crisis in various sectors and to continue to have revenues in difficult conditions.

It can be observed that out of these companies only a little are productive between 2011 and 2014 and the efficiency of the rest of them is rather average in comparison with the rest of the companies. The ones that distinguish from the others are Algoma Central Corp, DS Norden, Malaysian Bulk Carriers and Seacore Holdings Ltd which have on average 71% efficiency level during those four years and which are leading shipping companies with enormous fleets, something that contribute to the increase in productivity. The rest of the companies have on average 15% efficiency level during those four years.

Table 7.12: Efficiency Results For Multiple Cargo Companies per Year

	Company	**2011**	**2012**	**2013**	**2014**	***AV.***
multiple	Algoma Central Corp.	51,68	95,73	100,00	100,00	***86,85***
multiple	Capital Product Partners	19,97	32,55	42,98	73,75	***42,31***
multiple	China Shipping Dev. Co.	16,13	24,04	10,14	9,19	***14,88***
multiple	Dryships Inc.	13,44	13,51	12,37	15,38	***13,68***
multiple	DS Norden	57,81	100,00	85,01	38,05	***70,22***
multiple	Euroseas Ltd.	32,86	38,75	20,45	23,91	***28,99***
multiple	Goldenport Holdings Inc.	17,46	20,09	30,63	18,41	***21,65***
multiple	Gulf Navigation Hold. Pisc.	3,52	3,12	8,79	1,69	***4,28***
multiple	Hyundai Merchant Marine	22,59	27,44	12,30	8,24	***17,64***
multiple	Malaysian Bulk Carriers	100,00	77,23	86,51	38,09	***75,46***
multiple	Mitsui O.S.K. Lines	16,41	28,20	27,41	24,23	***24,06***
multiple	Newlead Holdings Ltd.	1,03	1,62	0,97	0,93	***1,14***
multiple	Seacore Holding Inc.	46,22	63,65	76,91	59,84	***61,66***
multiple	Pan Ocean Co. Ltd.	10,29	14,97	19,60	24,04	***17,22***
multiple	Wilson ASA	8,06	24,28	22,01	14,38	***17,18***
	AV.	***27,83***	***37,68***	***37,07***	***30,01***	

Table 7.13 presents efficiency results for wet cargo companies per year. The company that excel in this sector is Nordic American Tankers with 100% efficiency and which owns one of the largest fleets. More analytically, Nordic American Tankers has 20 vessels, which gives it a major advantage over as it has a huge, well-equipped fleet in a very specialized market and consequently has high revenues. On the other hand, the lowest in efficiency companies are StealthGas Inc and Torm with an average level of efficiency 21,27% and 21,85% respectively.

Table 7.13: Efficiency Results For Wet Cargo Companies per Year

	Company	**2011**	**2012**	**2013**	**2014**	**AV.**
wet	Concordia Maritime AB	43,43	41,25	22,25	16,71	***30,91***
wet	D' Amico Int. Shipping S.A.	54,33	41,74	28,45	0,00	***31,13***
wet	Frontline Ltd.	52,95	40,03	29,16	9,67	***32,95***
wet	Nordic American Tankers	100,00	100,00	100,00	100,00	***100,00***
wet	Overseas Shipping Group	38,77	32,21	31,71	88,18	***47,72***
wet	Scorpio Tankers Inc.	72,78	73,20	57,97	19,58	***55,88***
wet	StealthGas Inc.	21,76	19,21	22,75	21,37	***21,27***
wet	Teekay Corp.	29,38	62,56	44,92	43,32	***45,05***
wet	Torm	3,90	54,63	16,56	12,33	***21,85***
wet	Tsakos Energy Navigation	22,21	16,49	14,93	12,06	***16,42***
	AV.	***44,01***	***48,90***	***38,50***	***34,06***	

Table 7.14 shows the efficiency results for container cargo companies per year by comparing all the companies of the sample. The most productive (79,50%) during those years was Diana Shipping Inc. It is followed by Regional Container Lines with 40,25% on average efficiency respectively during those four years. While AP Moller-Maersk A/S shows the lowest efficiency (58,58%), which is large company in this sector.

Table 7.14: Efficiency Results For Container Cargo Companies per Year

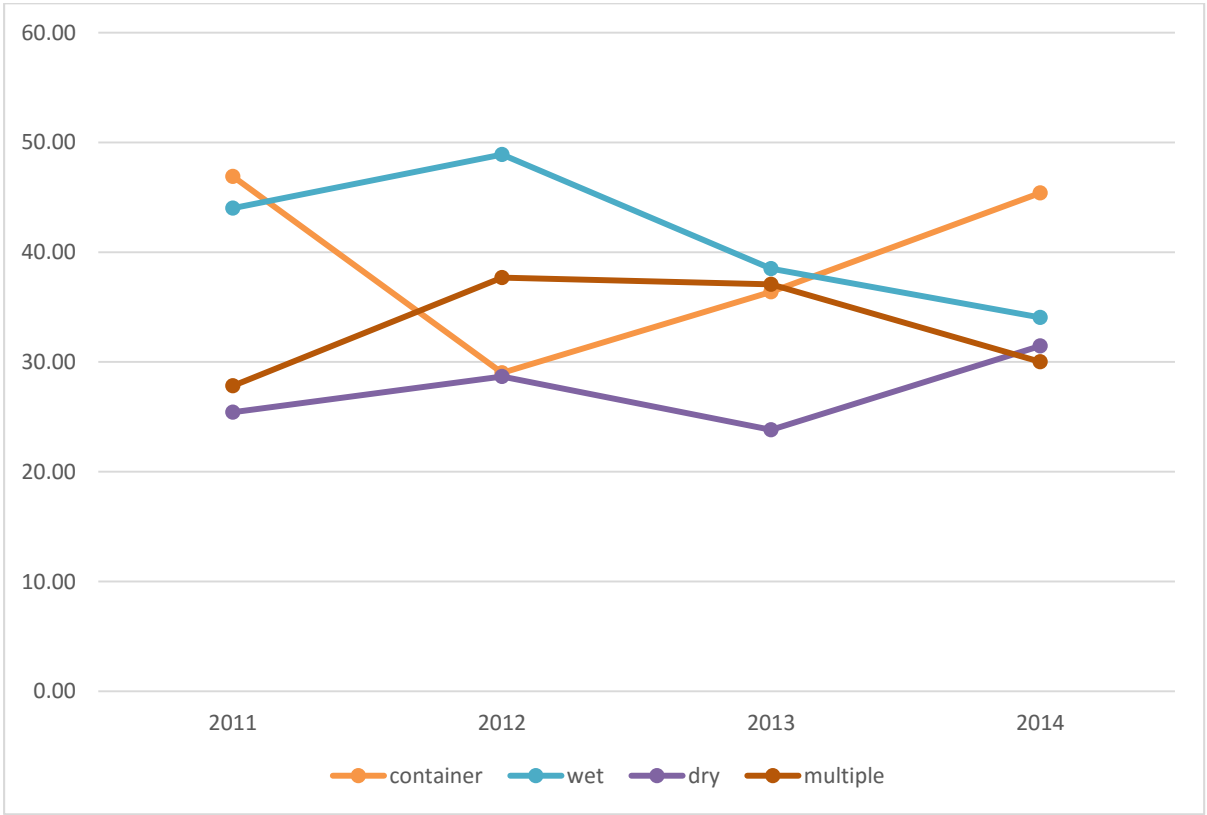
	Company	2011	2012	2013	2014	AV.
container	AP Moller-Maersk A/S	4,48	5,25	14,17	25,10	***12,25***
container	Danaos Corp.	100,00	3,56	8,48	12,94	***31,24***
container	Diana Shipping Inc.	18,01	100,00	100,00	100,00	***79,50***
container	Evergreen Marine Corp.	11,99	24,44	40,94	58,00	***33,84***
container	Regional Container Lines	100,00	11,78	18,31	30,91	***40,25***
	AV.	46,89	29,00	36,38	45,39	

Table 7.15 presents data coming from the previous tables and presents the average efficiency rates in percentages of all companies per category and per year. Data from table 7.15 is depicted in diagram 7.3.

Table 7.15: Average Rate of Efficiency per Category per Year

Vessel's Type	2011	2012	2013	2014
container	46,89	29,00	36,38	45,39
wet	44,01	48,90	38,50	34,06
dry	25,42	28,67	23,82	31,46
multiple	27,83	37,68	37,07	30,01

Diagram 7.3: Efficiency per Category



According to diagram 7.3, it can be seen that during 2011 – 2014, wet cargo companies seem to be the most efficient in general. This could be attributed to the nature of markets in which these companies operate, which are characterized by the presence of monopolies and big corporations and which lead to the increase of their revenues. This constitutes the output which analyzed for the purposes of this study. In the second position container companies follow. During the study period, container market was more profitable than dry cargo market so, dry cargo companies and multiple – dry cargo companies were less productive.

Taking the above into consideration, it is apparent that the size of a company affects its efficiency. That is why we divide the companies according to their size into 3 groups of similar size based on their assets.

3. Small Companies
4. Medium Companies
5. Large Companies

Table 7.16 presents the efficiency results for small companies per year in terms of the whole set of the sample. Baltic Trading Ltd, Hellenic Carriers Ltd and Malaysian Bulk Carriers show the highest efficiency with 100 %(for Baltic Trading Ltd we have informations only for one year) 76,53% and 83,36 % respectively. The latter was productive for the first 2 years but in 2013 showed a considerable fall, almost 50%, in their productivity. The last company in terms of efficiency was Newlead Holdings Ltd with 1,43%.

Table 7.16: Efficiency Results for Small Companies

	Company	**2011**	**2012**	**2013**	**2014**	***AV.***
small	Baltic Trading Ltd.	-	-	100,00	-	***100,00***
small	Euroseas Ltd.	32,86	50,18	11,67	52,78	***36,87***
small	Freeseas Inc.	9,41	10,17	2,73	2,55	***6,22***
small	Globus Maritime Ltd.	22,97	19,34	8,38	9,11	***14,95***
small	Goldenport Holdings Inc.	17,46	26,01	17,48	40,65	***25,40***

small	Gulf Navigation Hold. Pisc.	3,52	4,03	5,02	3,73	***4,07***
small	Hellenic Carriers Ltd.	64,52	68,82	72,78	100,00	***76,53***
small	Malaysian Bulk Carriers	100,00	100,00	49,38	84,07	***83,36***
small	Newlead Holdings Ltd.	1,03	2,10	0,55	2,05	***1,43***
small	Wilson ASA	8,06	31,44	12,56	31,73	***20,95***
	AV.	***28,87***	***34,68***	***28,06***	***36,30***	

Similarly, table 7.17 displays efficiency results for middle-sized companies per year. Golden Ocean Group Ltd, is in the first position with 81,29% followed by Nordic American Tankers with 74,09%. Pan Ocean Co. Ltd is in the lowest position with 10,27%.

Table 7.17: Efficiency Results for Medium Companies

	Companies	2011	2012	2013	2014	***AV.***
medium	Algoma Central Corp.	48,66	54,49	31,20	69,74	***51,02***
medium	Capital Product Partners	18,80	18,53	13,41	51,44	***25,54***
medium	D' Amico Int. Shipping S.A.	42,25	29,33	13,74		***28,44***
medium	Frontline Ltd.	41,17	28,13	14,09	9,67	***23,27***
medium	Golden Ocean Group Ltd.	100,00	100,00	100,00	25,17	***81,29***
medium	Nordic American Tankers	77,76	70,28	48,30	100,00	***74,09***
medium	Safebulkers Inc.	12,34	48,46	21,40	64,44	***36,66***
medium	Scorpio Tankers Inc.	56,59	51,44	28,00	19,58	***38,90***
medium	Seacore Holding Inc.	43,52	36,23	24,00	41,73	***36,37***
medium	StealthGas Inc.	16,92	13,50	10,99	21,37	***15,69***
medium	Pan Ocean Co. Ltd.	9,69	8,52	6,12	16,76	***10,27***
	AV.	***42,52***	***41,72***	***28,30***	***41,99***	

Table 7.18 shows the results of efficiency for large companies per year. It can be seen that the majority of the companies present a low level of efficiency (<30%), especially AP Moller-Maersk A/S, Danaos Corp, Hyundai Merchant Marine and

Regional Container Line. The highest average rate during those four years come from Diana Shipping Inc with 60,27%.

Table 7.18: Efficiency Results for Large Companies

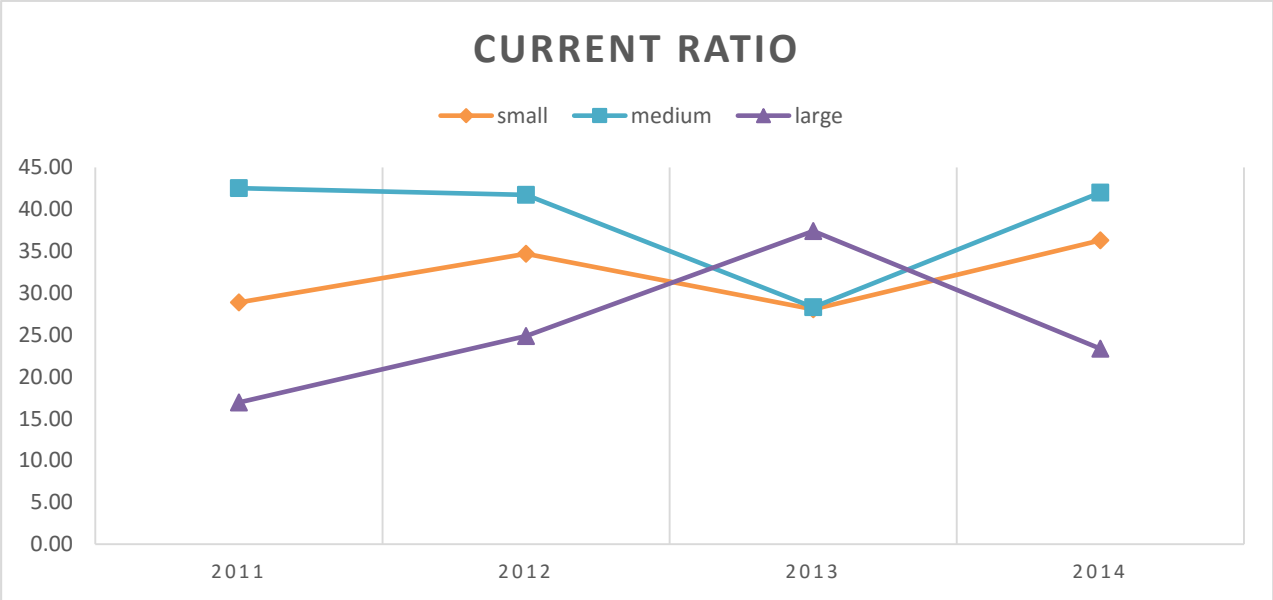
	Company	2011	2012	2013	2014	AV.
large	AP Moller-Maersk A/S	4,43	5,25	14,17	9,41	***8,31***
large	Concordia Maritime AB	22,35	28,50	37,54	18,95	***26,84***
large	China Shipping Dev. Co.	10,05	25,47	11,05	7,27	***13,46***
large	Danaos Corp.	4,48	13,45	8,48	4,85	***7,82***
large	Diana Shipping Inc.	100,00	3,56	100,00	37,51	***60,27***
large	Dryships Inc.	8,38	100,00	13,49	12,16	***33,51***
large	DS Norden	36,03	7,56	92,65	30,10	***41,59***
large	Eagle Bulk Shipping	8,99	55,95	1,28	28,85	***23,77***
large	Evergreen Marine Corp.	18,01	16,96	40,94	21,76	***24,42***
large	Hyundai Merchant Marine	14,08	24,44	13,40	6,51	***14,61***
large	Mitsui O.S.K. Lines	10,23	15,35	29,88	19,16	***18,66***
large	Navios Maritime Holding	16,36	15,78	56,15	32,43	***30,18***
large	Nepture Orient Lines	9,23	32,99	26,39	18,08	***21,67***
large	Nippon Yusen KK	15,56	15,40	40,03	25,57	***24,14***
large	Overseas Shipping Group	19,96	15,74	53,50	100,00	***47,30***
large	Paragon Shipping Inc.	10,28	22,25	46,24	14,47	***23,31***
large	Regional Container Lines	11,99	18,77	18,31	11,59	***15,17***
large	Star Bulk Carriers Corp.	6,69	11,78	52,97	14,81	***21,56***
large	Teekay Corp.	15,12	11,77	75,78	49,13	***37,95***
large	Torm	2,01	43,21	27,94	13,98	***21,78***
large	Tsakos Energy Navigation	11,43	37,73	25,20	13,67	***22,01***
	AV.	***16,94***	***24,85***	***37,40***	***23,35***	

Table 7.19 presents the data of the previous tables and shows the average rate of efficiency of all the companies per category, per year in relation to other companies of the sample. Data from table 7.19 is depicted in diagram 7.4.

Table 7.19: Average Efficiency Rate per Size of the Company

	2011	2012	2013	2014	AV.
small	28,87	34,68	28,06	36,30	31,97
medium	42,52	41,72	28,30	41,99	38,63
large	16,94	24,85	37,40	23,35	25,63

Diagra 7.4: Efficiency Rate per Size of the Company



According to diagram 7.4, it can be observed that throughout the years under observation, the medium companies are clearly the most efficient followed by the small-sized and at the lowest come the large ones. It has become apparent based on the data we have received so far that among the most efficient companies most of them were the medium ones.

7.3.2 Quick Ratio Results

In this sub-unit, the results of Quick Ratio are presented. The variables used were Current Assets, Current Liabilites and Inventories. Efficiency of every shipping company in comparison with the other ones was calculated based on Liquidity Ratio

for variable returns to scale and input orientated for the years 2011, 2012, 2013 and 2014.

The total results per company, per year are displayed on table 7.20. Every company is mentioned by writing the first four letters of its commercial name. We notice that 1 company (DIA) is productive in two of the four years and 2 companies (GOG,Nor) are productive for one of the four years.

Table 7.20: Total Efficiency Results per Company per Year

Companies	2011	2012	2013	2014	AV.
APM	3,74	4,41	3,84	8,83	5,21
Cap.	11,77	17,55	13,13	57,67	25,03
CON	8,74	11,64	2,65	6,38	7,35
CSD	26,33	25,79	12,39	0,00	16,13
DAN	3,74	2,95	2,19	4,34	3,30
Dia.	100,00	100,00	28,42	36,68	66,27
DRY	7,28	6,61	3,48	11,06	7,11
DS	31,89	49,49	23,42	26,41	32,80
Eag.	7,29	12,42	0,32	26,92	11,74
EUR	19,32	21,05	5,92	17,99	16,07
Eve.	16,31	22,40	10,83	20,23	17,44
FRE	5,86	4,38	1,52	0,84	3,15
FRO	24,85	23,87	11,87	9,69	17,57
Glo.	13,88	8,10	4,38	3,15	7,38
GOG	63,11	98,05	100,00	22,86	71,01
Gol.	10,93	11,33	9,72	14,06	11,51
GNH	2,02	1,64	2,75	1,18	1,90
Hel.	39,01	29,93	39,92	34,29	35,79
Hyu.	11,73	13,47	3,45	5,76	8,60
Mal.	42,94	37,03	24,69	30,20	33,71
Mit	8,59	13,15	7,69	17,18	11,66
Nav.	16,26	31,60	16,25	32,51	24,16
Nep.	7,61	13,93	6,89	17,02	11,36
New.	0,62	0,91	0,30	0,69	0,63
Nip.	14,23	14,13	10,63	23,66	15,66
Nor.	47,30	66,27	40,04	100,00	63,40
Ove.	19,82	22,03	15,25	99,74	39,21
Par.	10,17	18,43	13,11	13,43	13,79
Reg.	5,35	6,82	3,21	7,15	5,63
SAF	7,68	46,52	20,18	67,65	35,51

Sco.	36,22	50,29	28,13	21,90	34,13
Sea.	28,08	33,39	23,62	46,44	32,88
SBC	5,93	10,77	15,00	13,34	11,26
Ste.	10,84	12,67	10,89	23,89	14,57
POC	5,88	7,78	5,58	18,01	9,31
TEE	14,96	41,75	20,96	42,67	30,08
TOR	1,56	35,35	7,33	10,00	13,56
Tsa.	10,76	10,78	6,71	13,04	10,32
WIL	5,01	10,86	5,04	7,98	7,22

Table 7.21 shows the distinctive measurements in percentages of efficiency results deriving from table 7.20. It can be observed that the minimum efficiency degree is high and fluctuates from 0,00% in 2014 to 0,91% in 2012. The maximum efficiency degree is 100% for all the years. The average efficiency degree fluctuates from 14,40% in 2013 to 24,35% in 2012. Finally, the median efficiency degree luctuates from 10,63% in 2013 to 17,18 in 2012.

Table 7.21: Special Efficiency Measures

	2011	2012	2013	2014
MIN	0,62	0,91	0,30	0,00
MAX	100,00	100,00	100,00	100,00
AVERAGE	18,14	24,35	14,40	23,46
Median	10,93	14,13	10,63	17,18

Table 7.22 displays the allocation of efficiency rates and it depicts clearly all the above mentioned, while all this data is also illustrated in table 7.20. It can be noticed that the majority of the companies are not as efficient as it is the most efficient company.

Table 7.22: Allocation Efficiency Rates

	2011	2012	2013	2014
0-10%	15	9	19	12
10-20%	14	13	10	9
20-30%	3	6	7	7
30-40%	3	4	1	5
40-50%	2	3	1	2
50-60%	0	1	0	1
60-70%	1	1	0	1
70-80%	0	0	0	0
80-90%	0	0	0	0
90-100%	1	2	1	2

Diagram 7.5: Allocation Efficiency Rates

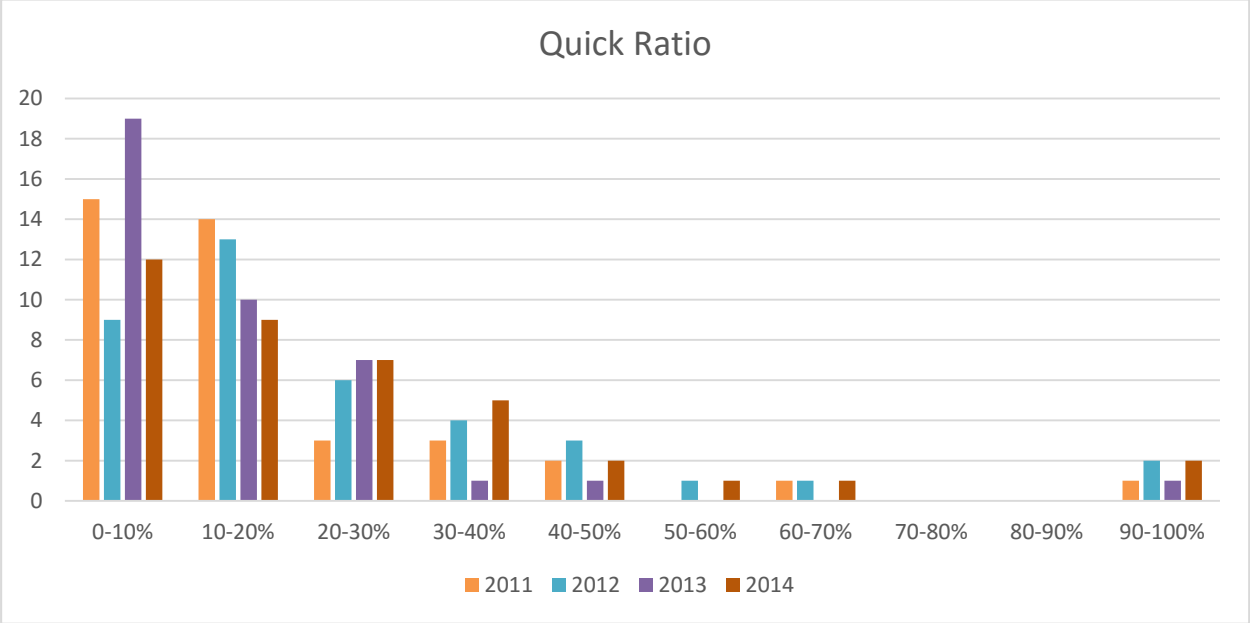


Table 7.23 presents the position of every company in comparison with the other ones of the same sample per year according to its efficiency. The classification is in decreasing order: the most effective company is no 1 position and the least effective in the lowest position (39). It can be noticed that some companies like Safebulkers, Euroseas, Torm, China Shipping Dev. Co. show a great fluctuation in their classification per year. On the contrary, some other companies like AP-Moller, Danaos Corp,Gulfare, Wilson ASA, Newlead Holdings and Mitsui classified in a close

position every year. It is also worth mentioning the fact that for the productive companies, their classification was carried out based on the fact to how often they are compared with others.

The previous comment is depicted clearly on table 7.24, which shows the common companies for all the years of analysis in the quartered parts of the sample, which was divided into four equal parts. Based on the companies' classification, we can notice which company is located in the same quartered part of the sample.

Table 7.23: Companies Classification Based On their Efficiency

Company	2011	2012	2013	2014
AP Moller-Maersk A/S	35	35	30	29
Capital Product Partners	18	19	14	4
Concordia Maritime AB	24	26	35	32
China Shipping Dev. Co.	9	13	16	39
Danaos Corp.	36	37	36	34
Diana Shipping Inc.	1	1	4	7
Dryships Inc.	29	34	31	26
DS Norden	7	5	8	12
Eagle Bulk Shipping	28	25	38	11
Euroseas Ltd.	12	17	26	19
Evergreen Marine Corp.	13	15	19	17
Freeseas Inc.	32	36	37	37
Frontline Ltd.	10	14	17	28
Globus Maritime Ltd.	17	31	29	35
Golden Ocean Group Ltd.	2	2	1	15
Goldenport Holdings Inc.	20	27	21	22
Gulf Navigation Hold. Pisc.	37	38	34	36
Hellenic Carriers Ltd.	5	12	3	8
Hyundai Merchant Marine	19	22	32	33

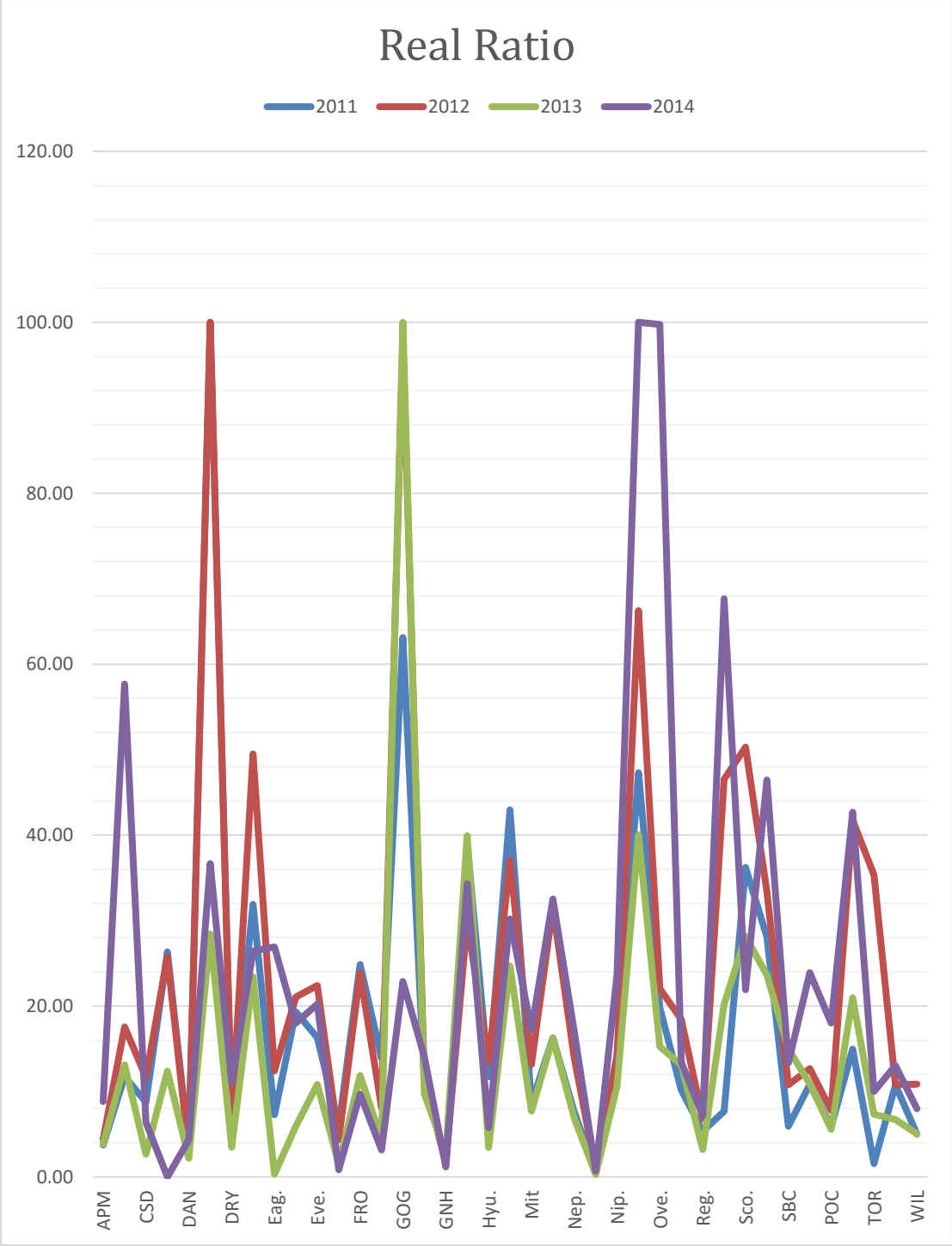
Malaysian Bulk Carriers	4	8	6	10
Mitsui O.S.K. Lines	25	23	22	20
Navios Maritime Holding	14	11	11	9
Nepture Orient Lines	27	21	24	21
Newlead Holdings Ltd.	39	39	39	38
Nippon Yusen KK	16	20	20	14
Nordic American Tankers	3	3	2	1
Overseas Shipping Group	11	16	12	2
Paragon Shipping Inc.	23	18	15	23
Regional Container Lines	33	33	33	31
Safebulkers Inc.	26	6	10	3
Scorpio Tankers Inc.	6	4	5	16
Seacore Holding Inc.	8	10	7	5
Star Bulk Carriers Corp.	30	30	13	24
StealthGas Inc.	21	24	18	13
Pan Ocean Co. Ltd.	31	32	27	18
Teekay Corp.	15	7	9	6
Torm	38	9	23	27
Tsakos Energy Navigation	22	29	25	25
Wilson ASA	34	28	28	30

Table 7.24: Common Companies in the same quartered parts during 2011-2014

	>Q3 [ΘΕΣΕΙΣ 1-10]	M-Q3 [ΘΕΣΕΙΣ 11-20]	Q1-M [ΘΕΣΕΙΣ 21-30]	<Q1 [ΘΕΣΕΙΣ 31-39]
COMPANIES	DIA MAL NOR SEA	EVE	GNH NEP TSA	DAN FRE GULF NEW REG
Actual Number	4	1	3	5
Percentage	40%	10%	30%	50%

Diagram 7.6 depicts the results of efficiency per company as they were presented in table 7.20

Diagram 7.6: Efficiency per Company per Year



Next, the companies are divided into 4 groups based on their cargo:

1. Companies with dry cargo
2. Companies with wet cargo
3. Companies with multiple cargo
4. Companies with container cargo

Table 7.25 presents efficiency results per year for companies of dry cargo in comparison with the other companies of the sample. Out of these, the most productive is Golden Ocean Group Ltd, as for the years 2011,2012 and 2013 has 100% efficiency and an average efficiency of 83,45%. This could be the reason that it shows the highest efficiency as it has a flexible fleet which can be best respond to the market needs and to be adapted accordingly. The next best companies are Safebulkers Inc and Hellenic Carriers Ltd with an average efficiency rate around 45% for the four years under study, from which both are of Greek management. On the other hand, the worst companies in terms of efficiency were Freeseas Inc (4,13%) and Globus Maritime Ltd (9,82%), from which both are of Greek management.

Table 7.25: Efficiency Results for Dry Cargo Companies per Year

	Company	2011	2012	2013	2014	*AV.*
dry	Baltic Trading Ltd.	0,00	0,00	0,00	0,00	***0,00***
dry	Eagle Bulk Shipping	11,55	12,67	0,32	39,79	***16,08***
dry	Freeseas Inc.	9,29	4,47	1,52	1,25	***4,13***
dry	Globus Maritime Ltd.	22,00	8,26	4,38	4,66	***9,82***
dry	Golden Ocean Group Ltd.	100,00	100,00	100,00	33,79	***83,45***
dry	Hellenic Carriers Ltd.	61,81	30,52	39,92	50,69	***45,74***
dry	Navios Maritime Holding	25,77	32,23	16,25	48,06	***30,58***
dry	Nepture Orient Lines	12,05	14,20	6,89	25,16	***14,58***
dry	Nippon Yusen KK	22,55	14,41	10,63	34,97	***20,64***
dry	Paragon Shipping Inc.	16,12	18,80	13,11	19,85	***16,97***
dry	Safebulkers Inc.	12,17	47,45	20,18	100,00	***44,95***
dry	Star Bulk Carriers Corp.	9,40	10,99	15,00	19,72	***13,78***
	AV.	***25,23***	***24,50***	***19,02***	***31,49***	

Table 7.26 displays the results of multiple cargo companies per year. It was expected that these companies would show higher efficiency in comparison to the other ones which are specialized in one type of cargo as their versatility would help them not to be so seriously affected by economic crisis in various sectors and to continue to have revenues in difficult conditions.

It can be observed that out of these companies only a little are productive between 2011 and 2014 and the efficiency of the rest of them is rather average in comparison with the rest of the companies. The ones that distinguish from the others are DS Norden, Malaysian Bulk Carriers and Seacore Holdings Ltd which have on average 79% efficiency level during those four years and which are leading shipping companies with enormous fleets, something that contribute to the increase in productivity. The rest of the companies have on average 17% efficiency level during those four years.

Table 7.26: Efficiency Results for Multiple Cargo Companies per Year

	Company	**2011**	**2012**	**2013**	**2014**	***MO***
multiple	Algoma Central Corp.	0,00	0,00	0,00	0,00	***0,00***
multiple	Capital Product Partners	27,42	35,46	53,19	100,00	***54,02***
multiple	China Shipping Dev. Co.	20,35	23,52	10,74	11,07	***16,42***
multiple	Dryships Inc.	16,96	13,35	12,37	19,19	***15,47***
multiple	DS Norden	74,27	100,00	94,88	45,79	***78,74***
multiple	Euroseas Ltd.	44,99	42,52	24,00	31,20	***35,68***
multiple	Goldenport Holdings Inc.	25,44	22,90	39,37	24,38	***28,02***
multiple	Gulf Navigation Hold. Pisc.	4,71	3,32	11,14	2,05	***5,31***
multiple	Hyundai Merchant Marine	27,31	27,21	13,96	9,99	***19,62***
multiple	Malaysian Bulk Carriers	100,00	74,83	100,00	52,36	***81,80***
multiple	Mitsui O.S.K. Lines	20,01	26,57	31,16	29,79	***26,88***
multiple	Newlead Holdings Ltd.	1,44	1,84	1,21	1,20	***1,42***
multiple	Seacore Holding Inc.	65,39	67,47	95,69	80,52	***77,27***
multiple	Pan Ocean Co. Ltd.	13,69	15,72	22,60	31,23	***20,81***
multiple	Wilson ASA	11,66	21,95	20,42	13,84	***16,97***
	MO	***30,24***	***31,78***	***35,38***	***30,17***	

Table 7.27 presents efficiency results for wet cargo companies per year. The company that excel in this sector is Nordic American Tankers with 100% efficiency and which owns one of the largest fleets. More analytically, Nordic American Tankers has 20 vessels, which gives it a major advantage over as it has a huge, well-equipped fleet in a very specialized market and consequently has high revenues. On the other hand, the lowest in efficiency companies are Concordia Maritime AB and D' Amico Int. Shipping S.A. with an average level of efficiency 5,56% and 3,99% respectively. It is important to mention that in order to calculate the average rate of D' Amico company we excluded the negative value that the company had in 2011.

Table 7.27: Efficiency Results for Wet Cargo Companies per Year

	Company	2011	2012	2013	2014	AV.
wet	Concordia Maritime AB	0,00	0,00	22,25	0,00	***5,56***
wet	D' Amico Int. Shipping S.A.	-4050,49	38,92	30,95	—	***3,99***
wet	Frontline Ltd.	52,54	36,02	29,65	9,69	***31,97***
wet	Nordic American Tankers	100,00	100,00	100,00	100,00	***100,00***
wet	Overseas Shipping Group	41,90	33,25	38,10	99,74	***53,25***
wet	Scorpio Tankers Inc.	76,58	75,89	70,26	21,90	***61,16***
wet	StealthGas Inc.	22,92	19,12	27,21	23,89	***23,29***
wet	Teekay Corp.	31,63	63,00	52,34	42,67	***47,41***
wet	Torm	3,30	53,35	18,31	10,00	***21,24***
wet	Tsakos Energy Navigation	22,75	16,27	16,77	13,04	***17,21***
	AV.	***43,95***	***48,42***	***42,62***	***40,12***	

Table 7.28 shows the efficiency results for container cargo companies per year by comparing all the companies of the sample. The most productive (79,08%) during those years was Diana Shipping Inc. It is followed by Regional Container Lines with 40,25% on average efficiency respectively during those four years. While AP Moller-Maersk A/S shows the lowest efficiency (11,44%), which is large company in this sector.

Table 7.28: Efficiency Results for Container Companies per Year

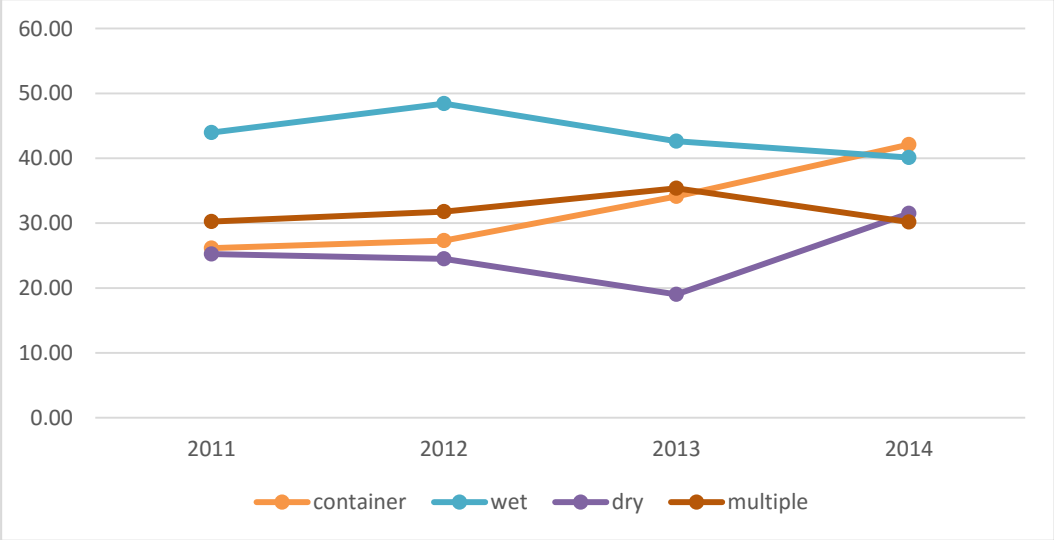
	Company	2011	2012	2013	2014	AV.
container	AP Moller-Maersk A/S	3,74	4,41	13,52	24,07	***11,44***
container	Danaos Corp.	100,00	2,95	7,70	11,84	***30,62***
container	Diana Shipping Inc.	16,31	100,00	100,00	100,00	***79,08***
container	Evergreen Marine Corp.	5,35	22,40	38,11	55,15	***30,25***
container	Regional Container Lines	5,35	6,82	11,29	19,51	***10,74***
	AV.	26,15	27,32	34,12	42,11	

Table 7.29 presents data coming from the previous tables and presents the average efficiency rates in percentages of all companies per category and per year. Data from table 7.29 is depicted in diagram 7.7.

Table 7.29: Average Rate of Efficiency per Category per Year

Vessel's Type	2011	2012	2013	2014
container	26,15	27,32	34,12	42,11
wet	43,95	48,42	42,62	40,12
dry	25,23	24,50	19,02	31,49
multiple	30,24	31,78	35,38	30,17

Diagram 7.7: Efficiency per Category



According to diagram 7.7, it can be seen that during 2011 – 2014, wet cargo companies seem to be the most efficient in general. This could be attributed to the nature of markets in which these companies operate, which are characterized by the presence of monopolies and big corporations and which lead to the increase of their revenues. This constitutes the output which analyzed for the purposes of this study. In the second position container companies follow having an almost parallel trend multiple ones and showing deviation drom 2013-2014. Dry cargo were constantly on the last position leveled of with multiple one sin 2014.

Taking the above into consideration, it is apparent that the size of a company affects its efficiency. That is why we divide the companies according to their size into 3 groups of similar size based on their assets.

1. Small Companies
2. Medium Companies
3. Large Companies

Table 7.30 presents the efficiency results for small companies per year in terms of the whole set of the sample. Baltic Trading Ltd, Hellenic Carriers Ltd and Malaysian Bulk Carriers show the highest efficiency with 100 % (for Baltic Trading Ltd we have informations only for one year) 85,87% and 83,12 % respectively. The latter was productive for the first 2 years but in 2013 showed a considerable fall, almost 50%, in their productivity. The last company in terms of efficiency was Newlead Holdings Ltd with 1,61%.

Table 7.30: Efficiency Results for Small Companies per Year

	Companies	2011	2012	2013	2014	**AV.**
small	Baltic Trading Ltd.	-	-	100,00		100,00
small	Euroseas Ltd.	44,99	56,83	10,66	52,46	41,24
small	Freeseas Inc.	13,65	11,83	2,73	2,46	7,67
small	Globus Maritime Ltd.	32,33	21,88	7,88	9,19	17,82
small	Goldenport Holdings Inc.	25,44	30,61	17,48	40,99	28,63
small	Gulf Navigation Hold. Pisc.	4,71	4,43	4,95	3,45	4,39
small	Hellenic Carriers Ltd.	90,84	80,81	71,82	100,00	85,87
small	Malaysian Bulk Carriers	100,00	100,00	44,41	88,05	83,12
small	Newlead Holdings Ltd.	1,44	2,46	0,54	2,01	1,61
small	Wilson ASA	11,66	29,33	9,07	23,28	18,33
	AV.	***36,12***	***37,57***	***26,95***	***35,77***	

Similarly, table 7.31 displays efficiency results for medium companies per year. Golden Ocean Group Ltd, is in the first position with 80,72% on average showing a remarkable stability in the first three years (100%) and then dropped rapidly to

22,86% in 2014. Next comes Nordic American Tankers with an average 70,64%, which dispite its remarkable fluctuation throuhtout that period occupies the second possition. Finally, Pan Ocean Co. Ltd is in the lowest position with an average 10,21%.

Table 7.31: Efficiency Results for Medium Companies per Year

	Companies	2011	2012	2013	2014	**AV.**
medium	Algoma Central Corp.	51,61	55,25	31,73	79,79	54,59
medium	Capital Product Partners	18,66	17,90	13,13	57,67	26,84
medium	D' Amico Int. Shipping S.A.	-3035,58	26,31	12,39		19,35
medium	Frontline Ltd.	39,37	24,34	11,87	9,69	21,32
medium	Golden Ocean Group Ltd.	100,00	100,00	100,00	22,86	80,72
medium	Nordic American Tankers	74,94	67,59	40,04	100,00	70,64
medium	Safebulkers Inc.	12,17	47,45	20,18	67,65	36,86
medium	Scorpio Tankers Inc.	57,39	51,29	28,13	21,90	39,68
medium	Seacore Holding Inc.	44,49	34,06	23,62	46,44	37,15
medium	StealthGas Inc.	17,18	12,92	10,89	23,89	16,22
medium	Pan Ocean Co. Ltd.	9,31	7,94	5,58	18,01	10,21
	AV.	***42,51***	***40,46***	***27,05***	***44,79***	

Table 7.32 shows the results of efficiency for large companies per year. It can be seen that the majority of the companies present a low level of efficiency (<20%), especially AP Moller-Maersk A/S, Danaos Corp and Regional Container Line. The highest average rate during those four years comes from Diana Shipping Inc with 46,02%.

Table 7.32: Efficiency Results for Large Companies per Year

	Company	**2011**	**2012**	**2013**	**2014**	**AV.**
large	AP Moller-Maersk A/S	3,74	4,41	6,00	8,85	5,75
large	Concordia Maritime AB	22,60	28,82	17,06	19,17	21,91
large	China Shipping Dev. Co.	8,74	21,17	4,14	6,40	10,11
large	Danaos Corp.	3,74	11,64	3,41	4,35	5,79

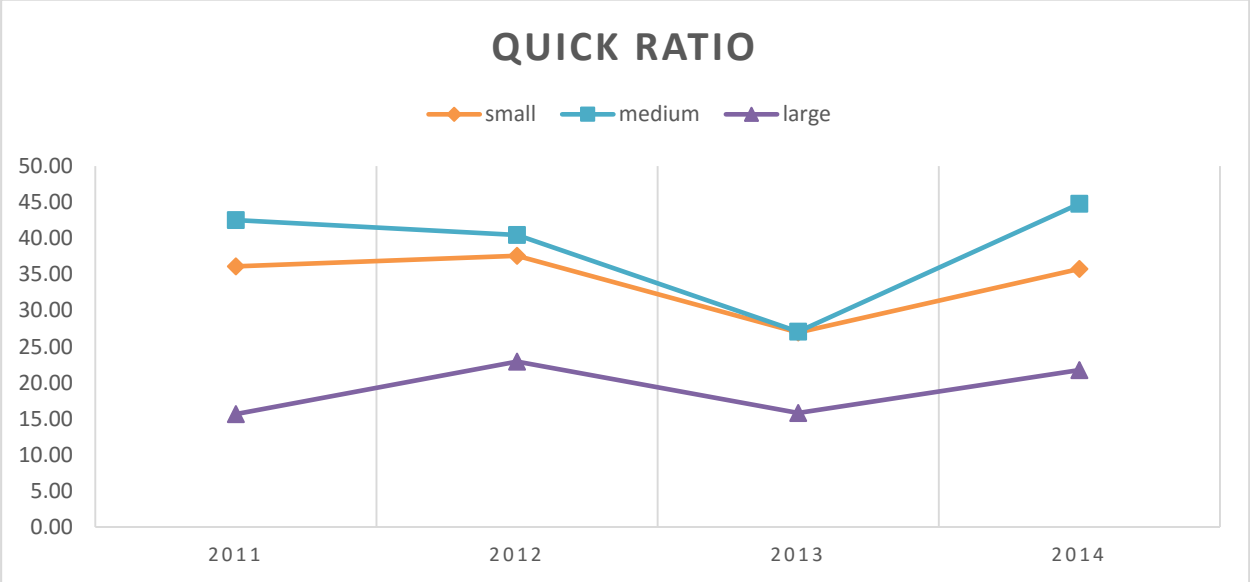
large	Diana Shipping Inc.	100,00	2,95	44,37	36,77	46,02
large	Dryships Inc.	7,28	100,00	5,44	11,09	30,95
large	DS Norden	31,89	6,61	36,56	26,48	25,39
large	Eagle Bulk Shipping	7,29	49,49	0,49	26,99	21,07
large	Evergreen Marine Corp.	16,31	12,42	16,91	20,28	16,48
large	Hyundai Merchant Marine	11,73	22,40	5,38	5,78	11,32
large	Mitsui O.S.K. Lines	8,59	13,47	12,01	17,23	12,82
large	Navios Maritime Holding	16,26	13,15	25,36	32,60	21,84
large	Nepture Orient Lines	7,61	31,60	10,76	17,06	16,76
large	Nippon Yusen KK	14,23	13,93	16,59	23,72	17,12
large	Overseas Shipping Group	19,82	14,13	23,81	100,00	39,44
large	Paragon Shipping Inc.	10,17	22,03	20,47	13,47	16,53
large	Regional Container Lines	5,35	18,43	5,01	7,17	8,99
large	Star Bulk Carriers Corp.	5,93	6,82	23,42	13,38	12,39
large	Teekay Corp.	14,96	10,77	32,72	42,78	25,31
large	Torm	1,56	41,75	11,44	10,02	16,19
large	Tsakos Energy Navigation	10,76	35,35	10,48	13,07	17,42
	MO	***15,65***	***22,92***	***15,80***	***21,75***	

Table 7.33 presents the data of the previous tables and shows the average rate of efficiency of all the companies per category, per year in relation to other companies of the sample. Data from table 7.33 is depicted in diagram 7.8.

Table 7.33: Average Efficiency Rate per Size of the Company

	2011	**2012**	**2013**	**2014**	**AV.**
small	36,12	37,57	26,95	35,77	34,10
medium	42,51	40,46	27,05	44,79	38,70
large	15,65	22,92	15,80	21,75	19,03

Table 7.8: Average Efficiency Rate per Size of the Company



According to diagram 7.4, it can be observed that throughout the years under observation, the medium companies were clearly the most efficient followed by the small-sized and at the lowest came the large ones. It has become apparent, based on the data we have received so far that among the most efficient companies most of them were the medium ones.

7.4 Cocnlusion

In this chapter, the Liquidity ratio was divided into Current ratio and Quick ratio as they form two different types of liquidity ratio which proved a useful tool for our study. Apart from this, the variables used were Current Assets, Current Liabilities and Invetories. All the results were presented in both tables and diagrams to facilitate their interpritation and to help one to draw constructive conclusions.

As for the current ratio, the variables used were the Current Assets and Current Liabilities. According to the results shown in both diagrams and tables, the majority of the companies fluctuates between 0% and 20%. Besides, only a few companies managed to reached a high percentage close to 100%. There could be various explanations for the above results such as the nature of markets and fluctuation in

freight charges as well as unpredictable factors like local economic terms and conditions. Furthermore, wet cargo companies appeared to be the most productive followed by container ones, then the multiple ones while the lowest in efficiency were the dry cargo ones. This could be attributed to the fact that fuel charges increased during that period while for the dry cargo companies a negative factor was for them the economic crisis of several countries leading to the decrease in freight charges. Finally, it can also be seen that the medium companies were leading in terms of efficiency followed by small ones and then the large ones. This can be justified to the fact that small and medium companies presented more flexibility than the large ones as the latter due to economic crisis had considerable liabilities and expenses incontrast to the other two.

Turning to quick ratio, the variables used were the Current Assets, Current Liabilites and Inventories. Based on the results and diagrams presented above, it can be said that the majority of the companies are between 0% and 20% while it is worth mentioning that there is no company between 70% and 90%. Furthermore, throughtout the study period, wet cargo companies appeared to be the most productive, while container and multiple cargo companies had a parallel trend with a considerable divergence between 2013 and 2014. It is also remarkable the fact that dry cargo companies remained steadily in the last position and only in 2014 managed to reach the level of multiple ones. Regarding the companies' sizes, it can be obsereved that medium come first followed by the small ones while the large ones have the lowest position.

Chapter 8

CONCLUSION

It is a common belief that maritime industry is undergoing an economic crisis which affects it in various ways, that is why DEA provides one of the most analytical and constructive tool to improve efficiency and productivity in these times. By comparing shipping companies, useful conclusions can be drawn as efficiency indicators vary considerably. For example, a company might have a high indicator in one section while presenting a low one in another sector. Taking into consideration a number of factors affecting efficicnecy such as inputs, outputs, freight markets, vessels size, charter charge etc., DEA provides the opportuinity to improve the equivelant indicators so that the company can reach its optimal efficiency.

The aim of this study was to develop a model of DEA analysis, which will produce constructive results of such a method in maritime industry. For this purpose, a sample of fifthy worldwide leading, different-sized, shipping companies, listed on stock markets, were analysed, measured in terms of efficiency and productivity.

Two models were used for DEA analysis. Model one was mainly concerned about the revenues efficiency for its company by taking into account the total asset and operating cost as input and the revenues as output. Model two was about efficiency in making profit coming from vessels operation having as inputs the vessels value and their operating cost and as output the gross profit deriving from their operation. The analysis was conducted between 2011 and 2014 so as to provide a more reliable outcome in terms of time duration something which is absolutely necessary in these types of studies.

According to model 1, the companies were classified based on their productivity and it was observed that a great number of companies kept the same positions (quartered parts of the sample) during those 4 years. Next, we examined the companies' efficiency per category by dividing them into dry, multiple, wet and container. The container cargo companies proved more efficient in general followed by wet cargo and at the end were dry cargo and multiple. This might be attributed to the nature of freight market in which the companies operate and to the

conditions prevailing the particular years of our study. Besides, the companies were classified according to their size into three groups of equal total assets. The medium companies were the most productive during those years followed by the large ones very closely and last the small ones. It can be said that the results are reliable as companies presenting considerable fluctuations in their efficiency were examined and indeed these changes were due to equivalent changes of their input-output.

According to model 2, the companies were classified based on their productivity and it can be noticed that many companies kept the same position in the first and forth quartered part of the sample during that time, something which confirms their performance. In the second and third quarter part, not many common companies appear like in the first sample due to the high variability of profits in relation to revenue. Additionally, we examined their efficiency per category by dividing them into four groups: dry, wet, multiple and container. Similarly, it can be noticed that container companies were more efficient in general followed by wet cargo while in the third position are dry cargo companies and at the end in the multiple cargo. The change of the first position is attributed to different variables used and to the fact that some of a multiple cargo companies show liabilities in 2011, while dry cargo companies appeared to be more profitable. Also, the companies were examined by size and they were divided into three groups of equal size depending on their total asset. The results were different from model 1 as the small companies were more productive followed by the medium ones. Efficiency meassuremets were relative, as they concern a particular group of companies.

As for Liquidity ratio, it was divided into Current ratio and Quick ratio as they form two different types of liquidity ratio which proved a useful tool for our study. Apart from this, the variables used were Current Assets, Current Liabilities and Invetories.

Regarding the current ratio, the variables used were the Current Assets and Current Liabilities. According to the results presented previously in both diagrams and tables, it can be seen the majority of the companies fluctuates in low percentages (between 0% and 20%). Additionally, only a few companies wre able to reach a very high percentage close to 100%. Various explanations could be given for these results like the nature of markets and fluctuation in freight charges as well as unpredictable factors like local economic terms and conditions.What is more, wet cargo companies

appeared to be the most efficient followed by container ones, then the multiple ones while the lowest in efficiency were the dry cargo ones. Fuel charges increased during that period, something which played a crucial role while for the dry cargo companies a negative factor was the economic crisis of several countries leading to the decrease in freight charges. Finally, it can also be seen that the medium companies were leading in terms of efficiency followed by small ones and then the large ones. This can be explained by the fact that small and medium companies presented more flexibility than the large ones as the latter had considerable liabilities and expenses due to economic crisis.

Regarding the quick ratio, the variables used were the Current Assets, Current Liabilites and Inventories. It can be seen that the majority of the companies are between a low percentage (0% and 20%) while it is noticable that there is no company between high percentages (70% and 90%). Finally, wet cargo companies appeared to be the most productive, while container and multiple cargo companies had a parallel trend with a considerable divergence between 2013 and 2014. It is also remarkable the fact that dry cargo companies remained steadily in the last position and only in 2014 managed to reach the level of multiple ones. Regarding the companies' sizes, it can be obsereved that medium were first followed by the small ones while the large ones occupied the lowest position.

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