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Monitoring the market segment of container throughput of the Port of Rotterdam

by

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Abstract

The main objective of this research is the provision of a complete report on the container market segment of the Port of Rotterdam. The specific thesis aims at analyzing the port's pivotal role in the Hamburg-Le Havre range, a region, which is mainly characterized by its intense inter-port competition, due to the large number of competitive ports that act in the same trade route, focusing their endeavors on attracting more cargo. Subsequently, the inquiry examines the port's comparative advantages and special attributes, which define it as the leading port in the European submarket of containers. Within the framework of this research, the port's strategic plan as well as its major determinants, which rank it among the top choices of the liner shipping companies, are clearly mentioned. Thereafter, a study of econometric interest is conducted on different types of economic and non-economic indicators in order for the influence of these variables on the container throughput of the Port of Rotterdam to be analyzed. The previous literature mainly contributed to the identification and selection of the aforementioned variables and supported the forecasting attempts in order for future predictions, for a certain period of time, in port's container throughput, to be achieved. To conclude, the thesis's results came from the utilization of a multiple regression analysis model via the SPSS statistical software. Multiple variables found to be statistically significant with a remarkable impact on the dependent variable, while the insignificant ones were basically rejected. Moreover, the initial sample was divided into two subsets, on an attempt to estimate the effect of the global economic crisis on the container throughput, while the last stage of the analysis consists of a forecasting model that assesses future container throughputs.

Keywords: Port of Rotterdam; Hamburg-Le Havre range; inter-port competition; container throughput; multiple regression analysis; economic crisis; forecasting.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 Introduction

The world's trade patterns have started to change in the nineteen sixties with the introduction of containerization, which is generally known as a revolution in transport. Initially, this new trend observed in the trade between the United States and Europe and subsequently, it was spread throughout the rest of the world. Most of the general cargo goods are nowadays carried in steel boxes of standardized dimensions, called containers. Regarding the dimensions, the most common used containers are the Twenty feet Equivalent Units or TEUs with dimensions of 8x8x20 and there are also double sized boxes, known as Forty feet Equivalent Units or FEUs, which are basically used in North America (Haralambides, 2007). Moreover, there is a large variety of different types of containers, concerning the technical characteristics, which are typically used for hazardous, fragile or sensitive goods. Therefore, there are hard-top containers, open-top containers, flat racks, platforms, ventilated containers, insulated and refrigerated containers, bulk containers and tank containers, which were constructed for the storage of chemical substances. It is considerable that the international trade was a very expensive process before containerization, because standard procedures such as crating, insuring, transporting, loading, discharging and storing of goods, cost 25 percent or more in comparison with the real value of the goods. Therefore, under these circumstances trading was completely non-profitable and made no sense (Levinson, 2006). Nevertheless, the most significant advantage of containerization and door-to-door transportation is the bypassing of the waterfront, because containers can easily be stuffed and stripped away from the waterfront in their final destination, which typically is the consignor's and/or consignee's facilities or the Inland Container Depots (ICD), which are widely known as "dry ports" (Haralambides, 2004). In addition, the new trend managed to confront expensive and strong unionized labor, converting the ports from a labor intensive to a capital intensive industry, which typically means that the development was strictly based on technological innovations and not on workforce. Furthermore, containerization contributed to a more efficient exploitation of the port's space and the ship time in port was reduced. As a result, all the aforementioned developments increased dramatically ship and port productivity and constituted the cornerstone for the creation of more reliable port systems. Hence, this trend led the shipyards to construct even bigger ships on behalf of the shipping companies, achieving economies of scale and low transportation costs. Nowadays, containers are carried by cellular containerships, many of which have a carrying capacity of more than 8000 TEUs (Haralambides, 2007).

Another important reason, which mainly contributed to the success of containerization was intermodal transportation, which is basically the optimal integration of different transport modes and the utilization of their capacities, in order to achieve cost effective and reliable door to door services to the final customer, whilst favoring competition between transport and port operators. According to the theory of intermodalism, the same container with the same cargo can be transported to the final destination through a wide variety of transportation modes, more efficiently at the lowest cost. Moreover, it is considerable that intermodal transportation improves sustainability and strictly relies on the appropriate

information systems in order to avoid high transfer costs, unreliability and complexities (Haralambides, 2012).

In addition, containerization provoked vast changes as much in the shipping industry as in ports, because the demand for container shipping was rapidly increased along with the development of global trade. As a result, nowadays, the liner shipping industry is being characterized by larger vessels, more comprehensive geographical coverage and restructuring like mergers, acquisitions and the formation of alliances. On the other hand, ports should find a way to enhance their attractiveness in order to resist the increasing concentrated power of the shipping companies and survive the fierce competition, which has been created. Some of the major determinants of the ports' attractiveness are the geographical location, time efficiency, port infrastructure and the service quality (Ng Adolf, 2006).

The Port of Rotterdam (PoR) is the largest and most important port in Europe. Moreover, it constitutes the gateway to the European market of more than 350 million consumers and one of the most significant junctions of good flows globally, because of its privileged location. This port can easily accommodate the largest vessels with the deepest draught, has great capacity for activities like handling and storage and is connected with a flexible hinterland network, which allows the fast flow of goods to various destinations through different transportation modes. Additionally, the low bunkering costs is a very powerful incentive, which attracts most of the ship owners to buy cheap fuel. Furthermore, a huge capital has been invested in the construction of Maasvlackte 2, which contributes to the port's expansion by 1000 hectares of space for deep-sea related container transshipment, distribution and chemical industry. The project is expected that will increase the port's container capacity by 17 million TEUs (Port of Rotterdam, 2014).

1.2 Research Background and Aim of Thesis

The scope of this research is to help the reader understand the importance of Port of Rotterdam's global market position in terms of container throughput. To accomplish this task, it should be taken into consideration the current infrastructure, the port's strategic location and future estimations about the TEU throughput. Moreover, the estimations, regarding the container throughput will be based on an econometric analysis, which will be vital in order to identify the different types of economic variables that typically influence the container throughput of the port and their usage in providing future estimations.

Subsequently, this report aims to justify the distinguished leading position of the Port of Rotterdam in the Hamburg-Le Havre range, a region, which is mainly characterized by intense inter-port competition among the neighbouring ports. Therefore, the following chapters will provide the reader with an extensive description, based on the existing literature, of all the ports and their cargo handling capacities, which act in the specific region and typically constitute the main competitors in this market segment.

Thereafter, the report quotes a more in depth analysis of the Port of Rotterdam, regarding the container market segment. A flashback in the PoR's history will follows, concerning the development stages of the container trade. In addition, the most significant container trade routes, which are served by the specific port, will be analysed in detail in order to stress the crucial geographical location that defines the port as a gateway to Europe and an important transhipment hub. Subsequently, in

the next sections there is a brief description of the various stakeholders and their roles, regarding the container flows. Hence, this report can accurately offer the reader the entire picture of this type of business.

Finally, the main goal of this research, as it has already been mentioned, is the assessment and forecasting of the container throughput in the PoR. Moreover, the specific inquiry will be achieved by using different types of economic and non-economic variables through a multiple regression model. Hence, the aforementioned indicators will be used in order for the deviations of the dependent variable to be accurately explained. Within the framework of this study, it should also be taken into account that an extensive analysis, with respect to the impact of the economic crisis on the port's container market segment will be conducted. In addition, it is considerable that accurate predictions are necessary for port planning, which typically constitutes a prerequisite procedure for the elaboration of future plans, related to growth and development. Forecasting is very important for every port, which invests a huge amount of money in infrastructure in order to support the increasing cargo handling capacity. In this report, a time series analysis has been used for the specific purpose. Furthermore, the report also includes a table, which illustrates the main points of the literature from previous researchers in order to facilitate the reader to distinguish and better understand the added value.

1.3 Main Research Question

"How much do different types of economic and non-economic indicators influence the container throughput of the Port of Rotterdam and what is their value for future estimations?"

The following sub-research questions, which have been produced from the main research question, will be answered in the subsequent sections of this report.

a) Why Port of Rotterdam is considered as the dominant port in the Hamburg-Le Havre range?
b) Why Port of Rotterdam is considered as one of the most important logistical hubs for the liner shipping globally?
c) How much did the economic crisis affect the specific market segment?

Within the framework of this report, the second chapter provides the answer of the first sub-research question. In addition, the answer for the second sub-research question can be found in chapter three. To conclude, the rest of the chapters aim at answering the third sub-research question as well as the main research question in accordance with the results of the analysis.

Chapter 2: Port of Rotterdam and the Hamburg-Le Havre Range

2.1 The Port of Rotterdam

As it has already been referred in the introduction part, the PoR is undeniably the largest port in Europe with a total annual throughput of 450 million tons of cargo per year. The total territorial area of the port is almost 12500 hectares, including the Maasvlackte 2. Moreover, this port handles over 12 million TEU annually and definitely constitutes the first choice of the liner shipping companies, because of its unrestricted depth. It can also accommodate even the largest vessels for 24/7 and renders great accessibility via the sea, due to its favorable location. In addition, a great number of various industrial clusters perform activities in the port, which in conjunction with the port provided services offer job vacancies to more than 70000 citizens (Port of Rotterdam, 2014).

Moreover, the PoR offers transportation services to a hinterland of more than 150 million consumers living at a distance of 500 km from Rotterdam, and 500 million all over Europe. It is remarkable that the combined purchase power of this enormous market, which is served by the port, is $ 600 billion. Moreover, the goods can be efficiently conveyed in the European hinterland via five different modalities, road, rail, inland shipping, coastal shipping and pipelines. Additionally, the port is directly linked with the most important industrial and economic centers in Western Europe. As a result, the goods can reach their final destination in less than 24 hours. Furthermore, one of the port's main advantages is its favorable, strategic location on the estuary of the rivers Rhine and Maas. Therefore, efficient and cost effective transportation by inland vessels can be easily achieved. It should be also taken into account that the PoR is directly connected with the Betuwe route, which constitutes a 160 km long rail line that links Rotterdam with its neighboring country, Germany (Port of Rotterdam, 2014).

It is considerable that more than 200 European ports are directly connected with the specific port via feeder and shortsea vessels (Port of Rotterdam, 2014). Moreover, the PoR has been characterized as the number one RoRo (Roll on-Roll off) port in Europe, due to the multiple RoRo connections between the port and United Kingdom and the quality of the provided services (Port of Rotterdam, 2014). It is remarkable that Rotterdam has invested a huge capital on an underground pipeline network, which connects the port with the major industrial centers elsewhere in Northwest Europe, providing efficient transportation of bulk, chemicals, crude oil and oil products. Road transportation is also well-supported by the port's physical infrastructure, offering door to door services to more short-distance destinations (Port of Rotterdam, 2014).

Furthermore, safety issues constitute one of the port's first priorities. Almost 34000 deep-sea vessels and 133000 inland vessels call at the specific port, annually. There has been observed an upward trend in the number of ocean-going vessels calling at the port the last years. Hence, ten modern RPA patrol vessels and traffic guidance systems of advanced technology are daily used by the port authority for supervision purposes (Port of Rotterdam, 2014).

In addition, the port's sustainable development as an energy port is of fundamental economic and financial interest. Nevertheless, it should also be taken into account

that Rotterdam's sustainable policy is really important from a social point of view, as it provides the region, the country and Europe with constant and reliable supply of clean and reasonably priced energy (Port of Rotterdam, 2014).

Apart from the priceless economic value, the port also holds great strategic value, which is typically divided in two different parts. The first one is the qualitative part, regarding the substantial contribution to the international innovation-driven competitiveness. Secondly, there is the quantitative part, which is related to the employment, investments and issues of economic importance. It is also remarkable that one of the most significant daily tasks of the port is the provision of evidence about the creation of strategic value, which is based on strategic connectivity and is divided in two dimensions. Moreover, the term strategic connectivity is referred to the multiple connections between the firm and the port. Therefore, there is the structural dimension, which focuses on the structural dimension of connections and the strategic dimension, which focuses on the quality of connections. In addition, inter-organizational cooperation between partners aims at strategic connectivity and contributes to a more sustainable position. It is generally accepted that the PoR shares the know-how and its experiences in order to expand its network and successfully cooperate with other ports and logistic hubs abroad. At this point, it is crucial to underline the synergies of the PoR with some of the most important ports of the country (e.g port of Amsterdam and port of Dordrecht) as well as the PoR's strategic cooperation with ports abroad like the port of Sohar in Oman, the port of Antwerp in Belgium and the port of Nangang in China. Furthermore, large companies in the Netherlands, which are not necessarily located in the port benefit from the advanced transport, handling, storage and distribution options in order to sell their products globally. Another case of vital importance, in which the PoR is involved, is the co-creation with Vopak Chemicals Logistics and customers include Air products like Shin-Etsu and Shell (Rick M.A. Hollen, 2013).

Moreover, the strategic value of the PoR stems from three major determinants, which typically reflect the port's policy. More specifically, the PoR's policy tools are land allocation and investments in infrastructure. The first one consists of port planning and leasing procedures, because one of the main duties of a landlord port, like the PoR, is the leasing of the available land to the private companies. Regarding the infrastructure investments, they are divided in physical and knowledge respectively. The first one is related to dredging and construction activities, while the latter indicates the utilization of development facilities and the provision of IT (Information Technology) services. As a result, the PoR is accurately defined as an innovation-driven port, which has contributed a lot to the maritime sector and has worthily the leading position among European Ports (Rick M.A. Hollen, 2013).

To conclude, the port's main objective is to maintain its leading position. Therefore, the Port authority in conjunction with other key stakeholders in the port of Rotterdam elaborated the port vision plan for 2030. The major parties, which typically contributed to the issue of the Port Vision 2030 were the Municipality of Rotterdam, the Province of South Holland, Deltalinqs and the national government. The specific report explicitly describes trends, estimates, prospects, the vision of port and industry in 2030, the future-oriented, sustainable policy as well as the port's agenda (Port of Rotterdam, 2014).

2.2 The Hamburg-Le Havre Range

It is generally accepted that the Hamburg-Le Havre Range is considered as one of the busiest and most competitive port trade lanes in the world. It is mainly characterized by a unique blend of heterogeneous ports, regarding the size and type, in conjunction with an intense economic hinterland shapes port competition. The most important commercial nodes of this range are 11 ports, including the Port of Rotterdam. According to the total container throughput capacity, the aforementioned ports are classified as follows. The port of Rotterdam, port of Hamburg, port of Antwerp, port of Bremerhaven, port of Le-Havre, port of Zeebrugge, port of Dunkirk, port of Wilhelmshaven, port of Ghent, port of Amsterdam and finally the Zeeland seaports. Nevertheless, it is remarkable that the HLH range stretches out over merely 500 nautical miles along four European countries i.e. Germany, Belgium, France and the Netherlands (Notteboom, 2007). The table below illustrates a comparison of the total container throughput of the major ports of the HLH range between 2012 and 2013.

TEU Throughput of the Hamburg - Le Havre range

	January - December 2012			*January - December 2013*			*Difference*	
	Incoming	*Outgoing*	*Total*	*Incoming*	*Outgoing*	*Total*	*Number*	*%*
Hamburg	4592	4272	8864	4789	4469	9258	394	4.4
Bremerhaven	2947	3168	6115	2812	3019	5831	-284	-4.6
Wilhelmshaven	12	12	24	40	36	76	52	0
Amsterdam	40	29	69	36	29	65	-4	-5.6
Rotterdam	6078	5788	11866	6033	5589	11622	-244	-2.1
Zeeland Seaports	10	11	21	7	11	18	-3	0
Antwerp	4172	4463	8635	4107	4471	8578	-57	-0.7
Ghent	44	44	88	33	37	70	-18	-20.5
Zeebrugge	969	984	1953	1016	1011	2027	74	3.8
Dunkirk	130	131	261	147	145	292	31	11.9
Le Havre	1143	1160	2303	1248	1238	2486	183	7.9
Total	**20137**	**20061**	**40199**	**20268**	**20055**	**40323**	**124**	**0.3**

**Unit: Number of TEU x 1.000*

Table 1: TEU throughput of the Hamburg-Le Havre range

Source: (Port of Rotterdam, 2014)

In addition, the market environment of this economic zone is highly complex and dynamic, because it has incurred tremendous changes during the last decade. Some of the major institutional determinants are the World Trade Organization's (WTO) impact on free trade and the privatization and deregulation in ports and inland transportation, which directly affected the ports' structure and hierarchy. On the other hand, there are some key organizational factors, which affected the ports' operations and the spatial characteristics of the HLH range. The most important are the vertical integration and the adoption of supply chain solutions by the shipping companies, the economies of scale, which led to the utilization of increasingly larger

vessels, the emergence of the global terminal operators and the radical changes in logistics and distribution networks (Notteboom, 2007).

2.3 Ports in the Hamburg-Le Havre Range

The following chapter provides a more analytical description of the major ports, located in the HLH range. The main goal of this chapter is to facilitate the reader, offering a better understanding of the inter-port competition, regarding each ports cargo handling capabilities and different types of facilities.

Port of Hamburg: This port definitely constitutes one of the most important commercial nodes globally. It is located in Germany and has a total surface area of 7200 hectares. Regarding its infrastructure, it is defined as the largest railway port in Europe, because more than 200 freight trains with 5000 trucks visit the port daily. It is a hub and spoke center, which connects 950 ports with 178 countries with each other.
The port is mainly characterized as a major industrial cluster, as it accommodates 1700 transport companies, 20 out of 25 largest liner shipping companies and 110 railway companies. Therefore, the port's existence is of vital importance for the local community. It constitutes one of the main sources of income, as it offers job vacancies to 156000 people. About 10000 ships use the port annually and the total cargo, which were handled in 2011 was 132.2 million tonnes. Regarding the imported products, the port of Hamburg is the biggest import port for coffee in Europe. Moreover, the port is one of the leading transshipment centers for products like paper, tea, cocoa coffee and spices (Hamburg Port Authority, 2014). Furthermore, the total container throughput of the port was 9.3 million TEU in 2013 with a 4.4 percent increase in container traffic in comparison with 2012 (Port of Hamburg, 2014). The port of Hamburg also consists of four main terminals, which are the following. The HHLA container terminal Altenwerder, the HHLA container terminal Tollerort, the HHLA container terminal Burchardkai (CTB) and finally the Eurogate Container Terminal Hamburg. It should be taken into consideration that there some impending expansion projects, within the framework of a development plan named HEP. It is expected that these projects will increase port of Hamburg's container capacity more than 20 million TEU in the following years (Containerization Intenational, 2013).

Why is Rotterdam losing its business to Hamburg every year?

It is generally accepted that the port of Hamburg is Europe's third largest commercial harbor. According to recent statistics, the specific port reported container volume gains in the first quarter that beat market growth, led by Asian traffic, indicating that Russian trade hasn't suffered from the Ukraine crisis. More specifically, the port handled 2.4 million standard containers, or TEUs, an increase of 8 percent, as trade with China and other Asian countries increased by 9 percent to 1.3 million TEU. Furthermore, the traffic between the port and Russia, which typically constitutes Hamburg's second biggest partner after China, grew by 4 percent to 168,000 TEU. The port of Hamburg serves Russia, as a transfer hub, with containers from deep-sea ships from Asia moved to smaller feeder vessels destined for the Baltic Sea. Consequently, an impending increase in the port's total transshipment volume by 6.5 percent in the first quarter, was expected. As a result, Hamburg's above-average total growth led to a 1.4 percentage-point increase in

market share, to 26.8 percent. It is remarkable that Hamburger Hafen and Logistik AG (HHLA), which is the handler of about three-fourths of the total containers at the port of Hamburg, supports that first-quarter volume rose 2.4 percent as traffic from the Far East grew, while warning that the crisis in Ukraine may hurt full-year results. Nevertheless, Russia annexed Crimea from Ukraine in March 2014, and Ukrainian forces are continuing to fight with insurgents in the east after pro-Russian separatists declared that they plan to hold elections (Bloomberg, 2014).

Although the future estimations of the company that owns the largest part of Hamburg's container terminals were quite questionable, HHLA announced a 0.7 percent year-on-year increase in box volumes during the first half of the year, with performance dragged down by its Ukraine terminal and volumes destined for Russia. As a result, the ongoing political situation in Ukraine contributed the most to the decline of the HHLA terminal's volumes in Odessa. In addition, feeder traffic to Russia via the Baltic also decreased for the first time since 2009, as sanctions took hold. Nevertheless, it should be taken into consideration that traffic handled at the port originating from Asia increased by 8 percent compared with the first half of 2013. This was undeniably a remarkable achievement as there is fierce competitive pressure caused by growing idle capacities at northern European terminals and ongoing infrastructure restrictions. Furthermore, the terminal operator also gave a brief update on the congestion issues that have been reported at Hamburg this year. According to the latest reports, the situation on vessel delays resulting in increases in volume peaks, which basically constitutes a serious problem not only for the port of Hamburg, but also for the rest of the ports, acting in the same region. It is considerable that all the major northern European ports are currently affected by these peak loads, which are frequently reflected throughout the entire transport and logistics chain. For this reason, HHLA's terminals have focused their endeavors on dealing with such challenges in various ways. For instance, in August 2014, a new mega-ship berth will become fully operational at the Container Terminal Burchardkai, with five state-of-the-art gantry cranes, which will be able to handle the world's largest vessels with carrying capacities of 18,000 TEU (Lloyd's List, 2014). At this point, it should be mentioned that a judge's decision on the deepening and widening of the River Elbe, which typically constitutes a key part of the port of Hamburg's plans to improve accessibility for the largest vessels, is expected in October 2014. The same strategic plan to dredge the River Elbe from 13.5 m to 14.5 m and have the fairway broadened, offering unrestricted access to the largest containerships into Hamburg, was hampered last year, because of intense protests from environmental groups, who turned to the courts to halt proceedings. Nevertheless, it is obvious that the restrictions to vessel access haven't affected the port's container traffic, with respect to Hamburg's half-year reports. Additionally, the port's 6.8 percent year-on-year growth was well above the market average and above its local rivals, Antwerp and Rotterdam. According to some specialists, this growth pattern is projected to continue (Lloyd's List, 2014). Subsequently, the peak loads can easily be confronted with a series of process improvements in truck handling and a further increase in headcount at the Hamburg terminals. Regarding HHLA's financial performance, one of the bright spots of last year's budget was the increase in revenues by 5.2 percent, during the first half. Moreover, the profits after tax for the period slipped by 5.5% on last year to €44m as a result of a one-off gain in 2013 from the sale of property in the logistics segment. In line with the aforementioned achievements, HHLA also benefited from increased fees from container storage as a result of longer container-dwell times, due to the congestion.

To conclude, in accordance with the latest HHLA's estimations, it is expected a slight increase in container throughput in 2014, given the fact that the current structure of freight flows remains unchanged. Nevertheless, the internal disputes in Ukraine, the volatile political environment as well as the development of strong economic relationships with Russia are issues of augmented significance, which can distort and radically change any forecasting attempt (Lloyd's List, 2014).

Furthermore, the Port Authority of the PoR supports that the port loses 1 million TEU every year, due to "unfair competition" from state-funded rivals in other countries. According to a recent "Level Played field" survey, elaborated by RHV-Erasmus University and Ecorys by order of the Netherlands' Ministry of Infrastructure, the subsidies at Antwerp and Hamburg cost Rotterdam 7 percent of its total container throughput or 10 percent when dredging costs on the Elbe, Maas and Scheldt are taken into consideration. In case of the dredging costs are not included, Flemish ports receive €0.54 per tonne per annum from the government, the German ports €0.81, while the Dutch ports get absolutely nothing. Finally, this case is of fundamental interest, as the Port of Rotterdam Authority finances investments in port infrastructure itself, while the governments in Flanders and Germany contribute or make up the difference if their port managers make a loss. Consequently, that leads to a great distortion of the market, so that the terminals in Rotterdam lose cargo to their rivals in Hamburg and Antwerp in particular (Seatrade Global, 2014).

Port of Antwerp: The Port of Antwerp is located in the middle of the Scheldt-Maas-Rhine delta in Belgium and has the biggest port area in the world, as it stretches out over 13057 hectares (http://www.portofantwerp.com/en/port-area). It is a hinterland port, which offers transportation of goods via sea to 80 kilometers inland in the center of Europe. As a result, this port shows great sensitivity, regarding environmental issues, because the carriage of goods through the port of Antwerp requires less road transportation, which is the major determinant of CO_2 emissions. Therefore, transportation becomes not only cheaper but also very ecological. The port constitutes a very sustainable option, because it focuses its endeavors on protecting the flora and fauna, forcing the accommodated companies to take measures in order to decrease the hazardous emitted substances. In addition, the result of the port's great infrastructure is the extended network with the numerous connections, which defines the port as the main link with more than 500 direct destinations globally. Furthermore, the port supports transportation by different modes, such as road, rail, barges and pipelines (Port of Antwerp, 2014).

Another very important aspect of the strategic added value of the port, is the promotion of Antwerp's know-how and expertise. A crucial part of the port's international policy is the establishment of joint venture agreements with ports abroad. Within the framework of these agreements, Antwerp contributes to the further development of the foreign ports and their logistics infrastructure, assisting the foreign regions with economic growth (Port of Antwerp, 2014).

In addition, the port of Antwerp has the largest covered storage capacity of Western Europe with a total storage area of 6.1 million m^2. It also has 6.9 million m^3 available especially for liquid bulk and 680000 m^3 for polymers. Within the port area act 900 logistics companies, offering a unique added value. Regarding the products, it is considerable that Antwerp is the biggest port of the world for tobacco, rendering a wide range of specialized services with respect of the particular nature of this good.

Moreover, this port has the most automated fruit terminal in the world, where approximately 600000 tonnes of fruit is handled. Antwerp also handles 3 million tonnes of forest products cargo annually, of which 1.2 million tonnes are forest products that cannot be containerized, such as wood pulp, timber fine paper, kraftliner, wood and newsprint. Furthermore, it is Europe's biggest steel port and accommodates dedicated steel centers, where the process of steel occurs in line with the customer's demand. Antwerp has also evolved into a consolidation hub for plastic granulates, due to the strong presence of the various chemical companies, which are a non-detachable part of the port's industrial cluster. It is remarkable that the port area on the left Bank has a dedicated area of more than 1000 silos for the specific product. Finally, the port stores half of the European stock of raw coffee and has state of the art car terminals equipped with vehicle processing centers, where different kind of specialized car services are offered, such as repairing, washing, installing accessories and second stage manufacturing (Port of Antwerp, 2014). The port's car capacity is around 2 million cars and it is remarkable the fact that 1.2 million tonnes out of 3.8 million tonnes of the total annual transshipment, are cars (Port of Antwerp, 2014).
Subsequently, it should be taken into consideration that all the port's terminals are directly accessible by all the different transportation modes, including pipelines. Within the port operate 7 specialized container terminals, with a tri-modal access, equipped with the state of the art technology. The port's total container throughput capacity is 15 million TEU. Antwerp also has terminals for liquid bulk goods with an extensive storage capacity, dry bulk terminals with an annual handling capacity of 40 million tonnes and storage capacity of 1.43 million m^2, where capsize and panama vessels can be accommodated and 17 specialized terminals for break-bulk (Port of Antwerp, 2014).

Port of Bremerhaven: This port is directly located at the mouth of the river Weser in Germany and is the second largest port of the country after the port of Hamburg. It acts as a key port for the offshore wind industry and simultaneously constitutes one of the most important car hubs in Europe (Via Bremen, 2014). Bremerhaven is multifunctional port, which like the aforementioned ports also supports intermodal transportation with the appropriate infrastructure (Via Bremen, 2014). In February of 1968, the port of Bremerhaven had a container terminal with a total quay length of 700 meters. Since then, four expansion projects were conducted in the specific container terminal. As a result, the container terminal of Bremerhaven has completely reconstructed and grown to a total length of 4930 meters with 14 berths, which are able to turn around mega-container vessels with a draught of 15 meters. Moreover, the total container throughput of the port in 2011 were around 5.9 million TEU. Bremerhaven has one of the largest automobile terminals, where storage and operation services, including maintenance, finishing and retrofitting services, for 120000 vehicles are provided. Furthermore, the port has two dedicated fruit terminals at Kaiserhafen with a quay length of 600 meters and a total storage capacity of 33000 pallets for refrigerated frozen goods. Bremerhaven also has a modern cruise terminal, which enhances the attractiveness of this place in order to constitute a good option as a touristic destination. Additionally, the 1100 meters long quay can accommodate 4 cruise liners at the same time and simultaneously offers a wide variety of services, based on fashionable and state of the art facilities. Within the port also acts a dedicated fish and food processing terminal, which definitely constitutes the core of the entire supply chain of the fish industry with a quay wall of 7000 meters and frozen storage capacities of 162000 m^3 and 336000 m^3 for

commercial and operational use respectively. To conclude, the contribution of the port in the wind energy industry is remarkable. The port has an offshore terminal of 498 meters depth, with a quay wall of 500 meters and 2 to 3 berths. The terminal stretches out over a total area of 25 hectares (Via Bremen, 2014).

Port of Zeebrugge: The port of Zeebrugge is a new-build, coastal port, located in Belgium. Because of its advantageous geographical position, this port is able to serve the different markets of Europe and the British Isles. In 2012, the port handled 43.5 million tonnes of cargo in total. In addition, Zeebrugge mainly focusses on RoRo (Roll on/Roll off) and container traffic, as the 3 quarters of the port accommodate facilities especially for the specific market segments. Nevertheless, the port's infrastructure successfully supports other significant market segments, such as conventional cargo, liquefied natural gas, cruises and car traffic. Moreover, this port constitutes a very important source of income for the regional economy, as it decreases the unemployment rate, offering approximately 28000 direct and indirect job vacancies to the citizens (Port of Zeebrugge, 2014).

The port's port authority is APZI (Association Port of Zeebrugge Interests). It is typically a privately owned, non-profitable organization, which represents the private sector of Zeebrugge and promotes the port. In addition, the port houses 130 companies, which are related to APZI and offer a wide variety of services, such as marine, transportation, forwarding, trading and industrial services (Port of Zeebrugge, 2014).

Furthermore, even the biggest vessels can visit the port of Zeebrugge, due to its large water-depth, which allows the new generation of Ultra Large Container Carriers (ULCC) to enter the port. In 2013 the total container throughput was 2026270 TEU. Nevertheless, this number is expected to double the following years with the completion of Albert II dock, which is located in the western outer port (Port of Zeebrugge, 2014). Moreover, the port has three deep-sea container terminals. The first one is the Container Handling Zeebrugge (CHZ), which has a quay length of 1000 meters, 16 meters draft and maximum capacity of 1.1 million TEU (PSA-Zeebrugge, 2012). The second one is the APM Terminals Zeebrugge, which is located directly at the open sea, close to the main trade lanes and supports transportation by different modes (APM TERMINALS, 2014). And last but not least, the Zeebrugge International Port (ZIP), which is the newest, active container terminal of the port (Port of Zeebrugge, 2014).

Port of Ghent: The port of Ghent is also a multifunctional port like the aforementioned ports, located in Belgium. In 2013, the port's total cargo traffic was 48.2 million tonnes of goods, where 26 million tonnes were related to seaborne cargo traffic and 22.2 million tonnes to inland navigation traffic, respectively. It can be characterized as a major transshipment hub, because from the total number of 18141 vessels, which were accommodated by the port in 2013, 2948 were seagoing vessels, while 15193 were smaller feeder vessels, dedicated to inland transportation through the inland waterways. Furthermore, the Ghent-Terneuzen canal with a length of 18 nautical miles has no tidal restrictions and provides great accessibility to Panamax vessels up to 92000 dwt (deadweight tonnes) having a maximum length of 265 meters, beam of 37 meters and 12.5 meters draft. Ghent also includes 5 docks, Grootdok, Sifferdok, Mercatordok, Rodenhuizedok and the brand new Kluizendok, covering 660 hectares of industrial sites. In addition, the port's total

surface area is 4700 hectares, including great infrastructure investments such as 28 km of quay walls, 128 km of roads and 206 km of railway tracks. Moreover, the port of Ghent offers 59759 direct and indirect job vacancies to people in 300 companies and has an added value of 6.3 billion euros, which is the highest in comparison with the other European ports (Port of Ghent, 2014).

Furthermore, the port of Ghent houses the largest integrated steel mill in Europe and the largest newsprint mill in the world, while it has a distinguished position, regarding the dry and liquid bulk throughput. It also has the largest grain storage capacity and the largest fruit juice terminal in Europe. To conclude, assembly factories for cars and trucks are a major part of the port's industrial cluster (Port of Ghent, 2014).

Port of Dunkirk: The port of Dunkirk is the leading port of France, regarding ore, coal, containerized fruit and copper imports. In addition, the port ranks in the second place for trade with Great Britain after the port of Le Havre (Dunkerque port, 2014).

Dunkirk is located on the North Sea at a short distance from the world's busiest trade lane. It is a multifunctional port, which can handle a wide range of cargoes and serve large vessels. It is considerable that the port has two different entrances, one to the east, which has a maximum draft of 14.2 meters and one to the west, which is newer and can basically accommodate even the largest vessels with draft up to 22 meters. Moreover, the port stretches out over 7000 hectares, including ten towns. The geographical position constitutes the cornerstone of the port's success, because it is located very close to the English coast with a distance of only 40 km from the port of Dover, 10 km from the Belgian borders, close to the city of Lille and in the middle of Brussels, London and Paris commercial triangle (Dunkerque port, 2014).

Nowadays, the port of Dunkirk supports intermodal transportation by 60 percent, investing a huge capital in physical infrastructure such as the western European motorway network, which directly benefits road transportation via A25 and A16 motorways. Another important investment plan took place during 2009 – 2013 period, making Dunkirk the most significant rail freight commercial node. Finally, the opening of the Seine-North Europe canal, in 2016, is expected to extend the port's inland waterway connections to Picardy and the area of Paris (Dunkerque port, 2014).

To conclude, it should be taken into consideration that the port of Dunkirk is defined as one of the main electricity providers not only for France, but also for the surrounding countries. In addition, since 2014, after the completion of the new project in the western part of the port, Dunkirk will be able to accommodate LNG carriers of
total capacity of 266000 m^3 (Dunkerque port, 2014).

Port of Amsterdam: The port region of Amsterdam is a cluster of ports, which includes the port of Amsterdam, Beverwijk, Zaandam and Velsen/Ijmuiden. It is a multifunctional port of great regional, national and international economic significance. Amsterdam has an added value of 6 billion euros and ranks second in Europe after the port of Ghent. In addition, it is the largest petrol port in Europe and the largest cocoa port globally, offering 59075 jobs to people. The constant but

steady increase in transshipment of goods, carried by sea as well as the wide range of products, which can be handled within the port, enhance port's immunity to economic fluctuations (Port of Amsterdam, 2014). In terms of infrastructure, the port is defined as one of the world's most important logistic hubs. The Amsterdam Metropolitan Area includes the seaport, the airport (Amsterdam Airport Schiphol), the green port (FloraHolland flower auction) and Dataport, which constitutes a huge investment in knowledge infrastructure. Furthermore, Amsterdam has a great strategic location with no tidal restrictions, making the port easily accessible. The port has also an extended network of inland waterways, which directly connects the port's region with the main European markets, Portugal, the Baltic States, Spain, Scandinavia, Great Britain, Italy and Germany. Rail and road transportation, being vital parts of the port's physical infrastructure, are also well-supported with direct links to the airport and the European hinterland. It is considerable that, in 2013, 8 percent of the HLH range total market share, belonged to the port of Amsterdam (Port of Amsterdam, 2014).

Furthermore, the port of Amsterdam is considered as a major player in the market segment of containers. The port is equipped with 4 container terminals in total. The first one is the Ter Haak Group, which is located in Amerikahaven - United Stevedores Amsterdam and provides all around logistic services. The second is Amsterdam Container Terminals/ Amsterdam Marine Terminals, which is a multipurpose terminal for stevedoring, RoRo and general cargo, located in Westhaven. The third is Amsterdam Container Terminals, which is also located in Amerikahaven and provides stevedoring activities. Last but not least, the Container Terminal De Vrede in Amerikahaven, which has 500 meters long quay wall, 12 meters draught and 120 reefer plugs (Port of Amsterdam, 2014).

Port of Le Havre: This port is located on the right bank of the Seine estuary, in France. It is a multipurpose port, which is well-known for the increased crude oil traffic, the ship repairs and the ferry services to England and Ireland. In addition, Le Havre houses a huge cluster of oil refining, petrochemical, chemical, cement, automotive and aeronautical industries. In the beginning of the 21st century, the port focused its endeavors on becoming a dedicated container port. Nowadays, the port includes 12 new berthing stations with total length of over 4 km and 2 container terminals, Terminal de France and Terminal Porte Oceane (TPO) (World Port Source, 2014).

Furthermore, Le Havre is the largest container port in France and the most important oil port as it handles 40 percent of the country's crude oil cargoes. It stretches out over 10000 hectares, where 2000 hectares are dedicated to environmentally protected lands within the Seine estuary, stressing the ecological character and the sustainable function of the port. In addition, Le Havre has an extensive transportation network with various hinterland connections, supporting the different modes of transport. Regarding the container terminals, the port has considerable depth and the state of the art in crane technology, serving even the largest vessels efficiently. Moreover, the specific port is extremely important, because it is one of the few ports in Europe, which can turn around a fully loaded bulk carrier of 80000 dwt. To conclude, the cruise terminal is built at the entrance of the port and is directly connected with the motorways, providing fast and efficient transportation for the passengers (World Port Source, 2014).

Port of Rotterdam: The port of Rotterdam is the largest port in Europe, located in the second biggest city of the Netherlands, Rotterdam. Rotterdam was home for more than 584 thousand citizens, while the urban region contained approximately 896 thousand citizens. From its unique strategic position, the port typically constitutes the main engine of the local economy. Moreover, it is Europe's largest distribution center, located in the heart of the European hinterland and only a few nautical miles away from important commercial nodes like the port of Moerdijk, the port of Amsterdam and the port of Felixstowe in England (World Port Source, 2014).

Regarding the cargo volumes, in 2010, the port ranked fourth among the world's busiest ports. During the same year, the port of Rotterdam handled almost 430 million tonnes of cargo in total, where 84.6 million tonnes were dry bulk, 209.4 million tonnes were liquid bulk, 23.7 million tonnes were break-bulk cargo and 112.3 million tonnes were containerized cargo (World Port Source, 2014).

In terms of physical infrastructure, the port has 122 jetties and 23 berths on buoys. Furthermore, 162 multipurpose cranes, 103 container gantry cranes, 25 floating cranes, 22 ship-to-shore bulk cranes, 12 container cranes and 10 sheer leg cranes compose the port's cargo handling equipment. In addition, Rotterdam contains not less than 90 terminals, which are specialized in different types of cargoes. Within the port, there are 17 multipurpose terminals, 35 terminals, specialized in liquid bulk and 15 terminals for dry bulk. In addition, the port contains 9 container terminals, supporting the various types of shipping (deep-sea, short sea and inland), 3 juice terminals, 7 RoRo terminals and 2 fruit terminals. Additionally, Rotterdam has one terminal each for paper and steel, cruise vessels and cars (World Port Source, 2014).

It should be also taken into consideration that the intense traffic, concerning the different types of cargo, must be well-supported by adequate storage capacity. In this way, ports can achieve the optimum levels of efficiency and productivity. Therefore, the port of Rotterdam has a wide range of dedicated storage facilities. It contains tank storage for liquids, storage space for agribulk cargoes, refinery and independent storage for mineral oil products and crude oil as well as independent storage for chemicals and vegetable oils and fat. To conclude, 3 million m^2 of capacity are dedicated in conventional sheds. The port has more than 250 thousand pallet places for storage of frozen goods and not less than 600 pallet places for temperature-controlled storage (World Port Source, 2014).

Port of Wilhelmshaven: This port lies on Jade Bay in northwest Germany and constitutes the third largest port of the country (World Port Source, 2014). In 2007, the total cargo throughput of the port was approximately 42.7 million tonnes, of which 33.4 million tonnes corresponded to imported products and 9.3 million tonnes to exported products respectively. In addition, the largest part of the imports was based on petroleum and petroleum products, while other significant imported products were coal, rock salt and petroleum distillates such as gasoline and ethylene. The main exported products were gasoline and diesel oil, while less part of the exports corresponded to products like fuel oil, petroleum products, caustic soda and LNG (Liquefied Natural Gas) (World Port Source, 2014).

Zeeland seaports: Zeeland seaports is typically a cluster of two ports, the port of Vlissingen and the port of Terneuzen. These ports form the wider port area, which is

located in the North-West Europe. In addition, the port is accessible for vessels with maximum draft of 16.5 meters, provides great hinterland connections and houses around 200 companies, related to industrial, logistics and maritime services. It is also considerable that the port is responsible for 18 percent of the total employment of the region, offering jobs to circa 15000 citizens (Zeeland ports, 2014).

The ports in Zeeland have a total cargo throughput of 33 million tonnes of goods annually, of which 23.5 million tonnes corresponded to imports and only 9.5 million tonnes to exports. Due to its impressive annual throughput, the port ranks third in the Netherlands. Furthermore, Zeeland seaports is a multifunctional port, which handles a wide variety of cargo, such as dry bulk, liquid bulk and break-bulk (Zeeland ports, 2014).

Furthermore, the terminals of Ovet and Verbrugge are the port's dedicated facilities, where the process of dry bulk cargo takes place. In 2013, Zeeland ports handled approximately 10.6 million tonnes of dry bulk cargo (Zeeland ports, 2014). Moreover, some of the most popular companies, which are active in the liquid bulk sector of the port, are Vesta, Vopak and Oiltanking. The aforementioned companies in conjunction with the port's industrial cluster of manufacturing companies require liquid bulk cargoes in order to perform their activities. In 2013, the port's total throughput of liquid bulk cargo was approximately 12.8 million tonnes (Zeeland ports, 2014). Additionally, the ports in Zeeland contain specialized terminals, where RoRo vessels can be anchored. Around 1.5 million tonnes of RoRo cargo handled by the port, during 2013 (Zeeland ports, 2014). It is remarkable that the port is the European market leader, regarding the general cargo market segment of aluminum and wood products, such as paper and pulp. In 2013, the port handled around 8 million tonnes of general cargo (Zeeland ports, 2014). To conclude, Zeeland ports is defined as a transshipment center of offshore objects, while houses dedicated facilities, concerning the storage, distribution and transshipment of food (Zeeland ports, 2014).

2.4 Inter-Port Competition in the Hamburg-Le Havre Range

According to (H. Arjen Van Klink, 1998), one of the major determinants of port competition is the rise of intermodal transportation, which has been strongly stimulated by the removal of national frontiers, within the framework of globalization. The theory of intermodalism is of augmented significance, due to the growing interactions among the different regions, the threat of gridlock traffic in metropolitan areas, the economies of scale, which typically allowed the scale enlargement in the transport industry and the government initiatives. In addition, the author supports that the competitiveness of a port, regarding a specific inland market segment, is not directly determined by the monetary costs. There are also other types of costs, related to major factors such as risk and time, which must be considered. Moreover, all the aforementioned costs in conjunction with externalities basically constitute the concept of generalized transport costs, which contributes to port's hinterland demarcation, indicating the spatial dimension of the hinterland.

Furthermore, (Ng Adolf, 2006) stresses the pivotal role of ports' attractiveness, regarding port competition. The author describes the advantages of Europe's Northern ports and investigates their attractiveness as transshipment hubs. In addition, the paper explicitly quotes the most important factors, which influence the

ports' attractiveness. The monetary costs and time are some of the factors that can be easily identified, but they do not constitute the only port choice determinants. There are also attributes like the quality of services, which are less obvious and hard to quantify, whose role in measuring the port's attractiveness is of fundamental interest. According to the author, Benelux and German ports are the most attractive options, operating with decent efficiency, while Felixstowe and Le Havre require substantial improvements. With respect to geographical location, Hamburg and Bremerhaven are the dominant ports in serving the Scandinavian-Baltic region, although the port of Rotterdam seems to be quite competitive in serving this market. For the UK and Iberian Peninsula regions, the shipping lines have to decide among many different reasonable options, Felixstowe, Le Havre, Rotterdam and Antwerp. Concerning these regions, the competitive position of ports is determined by the quality of services that are provided to the customers.

Furthermore, (Kenyon, 1970) examines the various elements, which led to the intense inter-port competition among the United States deep-sea ports that constitute the heart of foreign and domestic trade. Some of the major determinants, which have been identified by the author, are the economic changes in the various layers of hinterland and in rail rate territory, as well as the railroad mergers, the rise of road transportation via motor trucks, the containerization of oceangoing freight, the expansion in port facilities, the investments on physical infrastructure and finally the efforts to simplify the business and administrative contacts in ocean trade within the port, avoiding bureaucracy.

Subsequently, (Bart W. Wiegmans, 2008) cites that the port and terminal selection issues can be approached by three different dimensions, which are the buying decision characteristics, the port choice strategy and the terminal selection. The first dimension is basically related to port selection, terminal investment and handling capacity. According to the author, the most important criteria, which typically define the port choice from a deep-sea container operator, are the availability of hinterland connections, the reasonable tariffs and the immediacy of consumers, which is directly correlated with the hinterland's size. Moreover, the author supports that shipping lines' decisions are also affected by neglected determinants like feeder connectivity, the port's total portfolio and environmental issues. Furthermore, the study distinguishes port selection from terminal selection, where the latter is defined by factors, such as handling speed, handling costs, reliability and hinterland connections. (Slack, 1994) supports that container ports are strongly affected by fierce inter-port competition. Within the same framework, (Blumenhagen, 1981) describes the two major attributes of container shipping, which mainly determine the hinterland structure of the seaports. Therefore, the author stresses that container ships require a greater concentration of port calls in order to operate economically in comparison with the conventional general cargo liners. Additionally, (Blumenhagen, 1981) addresses that the optimum advantage of the box system can be reaped only by maximum penetration, which typically means that the further a container load can go through the distribution system before being broken down into its components, the higher the profit will be. The aforementioned attributes, which are analytically described in Blumenhagen's report, constitute major determinants of the competitive market, in which the port of Rotterdam acts.

In another inquiry, (Slack, 1985) analyzes the criteria that the shippers take into consideration during the port selection process, regarding the containerized traffic between the North American Mid-West and Western Europe region. According to this report, the major incentives for decision makers are the competitive pricing and

the quality of services, provided by the land and ocean carriers. Moreover, (Fung, 2001) appraises the short-run dynamic and long-run equilibrium of the market for container handling services in East and Southeast Asia, using a structural vector error correction model (VECM). The specific structural model not only constitutes a tool to study the interactive relationship between the ports of Singapore and Hong Kong, but its regional perspective in estimating the container throughput also accurately reflects the real world facts. In addition, (Wei Yim Yap, 2006) explicitly describes the developments in container port competition in East Asia. The study is of fundamental interest for this report, because it reveals, through evidences from container shipping services, how the Chinese ports managed to enhance their attractiveness, regarding the cargo flows. Nowadays, this situation is perfectly reflected in the competition market of the Hamburg-Le Havre range.

Moreover, (Notteboom, 2010) mentions that European ports are not anymore considered as places, where a vessel can simply be handled, but they have also focused their endeavors on the adoption of supply chain incentives, which typically offer a more vertical integration along the supply chain. Furthermore, the author stresses that the dominant assumption that containerization would lead to further port concentration does no longer exist, because the European port system, composed by most of the multiport gateway regions, is mostly characterized by a steady cargo deconcentration process. According to the author, comodal bundling effects, connectivity effects and aggregated service quality effects constitute the key factors in order to understand the current routing of containerized goods in Europe. Therefore, the distance of the port from the hinterland region is of minor importance, concerning the port selection. The paper also identifies that the port's success depends on the ability of the wider port community to create and fully exploit synergies with other transport nodes and other major players within the logistics networks.

Subsequently, (Jean-Claude Thill, 2010) stresses that the implementation of intermodal networks copes with the accessibility problem among regions, as it simultaneously improves the connections to container ports. With respect to freight cost savings, the specific study identifies how beneficial intermodal transportation, especially for the distant places, can be. Finally, the author concludes that one of the major advantages of intermodalism is that it can promote decentralization of economic activities by balancing accessibilities to export gateways. As a result, intremodalism offers connections to new, foreign, distant markets. With his study, (C. M. Anderson, 2008) creates a game-theoretic best response framework in order to understand how competitor ports will respond to development at a focus port, as well as weather the focus port will be able to handle the increased market share by building additional capacity. In addition, the specific model was implemented to investment and competition between the ports of Shanghai and Busan and it was based on real time facts.

According to (Peter De Langen, 2007), measuring the performance of ports can be a very demanding task. In addition, the author emphasizes that the ports' development contributed to the creation of new port performance indicators (PPIs), such as throughput volume and added value, which constitute very useful tools in order to measure performance, development and make comparisons among the different ports. Moreover, the constant development of the ports produces

increasingly more port performance indicators, which typically means that more research, regarding the PPIs must be conducted.

Summary of literature review

Within the framework of the literature review, various authors present their inquiries, regarding the criteria that every port should include in order to enhance its attractiveness and competitive position, against its competitors. According to the researches, the dominant features, which were identified, are the physical and knowledge infrastructure, the multimodal connections with the hinterland, the quality of the provided services, the prices and finally the infrastructure investments, concerning connectivity and additional capacity. It should be taken into consideration that the port of Rotterdam meets all the aforementioned criteria in comparison with its competitors and worthily considered as the market leader of the Hamburg-Le Havre range. Furthermore, the port's comparative advantage is a result of two factors. The first one is the inherent, favorable strategic position of the port, which renders direct access to the North Sea. Moreover, the wide canals and the huge depth make the port totally accessible for all types of vessels. Additionally, the second important factor is related to the port's good command and strategic planning. It is remarkable that Rotterdam's Port Authority focuses its endeavors on investments and strategic plans in order to maintain and ensure the port's leading position. The Port Authority's increased competencies and constant efforts accrue from the intense inter-port competition within the HLH range. The most representative example of the port's innovative plans is the construction of Maasvlackte 2, which typically constitutes a port's expansion project.

Chapter 3: Containers

3.1 Container Trade Lanes

It should be taken into consideration that the global container trade is classified into three main trade lanes, Transpacific trade, Far East-Europe trade and Transatlantic trade. The classification facilitates the business analysts and the various researchers to understand the world's container flows, elaborate strategic plans on behalf of the liner shipping companies, make predictions and accurately analyze the specific market segment.

Transpacific trade: The specific ocean shipping market constitutes North America's largest trade lane, accounting for approximately 20 million TEU in the US trade alone in 2012 (JOC.COM, 2014). In addition, this trade lane mainly focusses on the commercial activities among the USA, Canada and Mexico to/from Asia (Clarkson Research Services Limited, 2014). Furthermore, the market is dominated by imports of large retailers such as Wal-Mart, Target, Best Buy, Home Depot and Lowe's, which typically bypass the forwarders, making arrangements straight with the ocean carriers. As a result of the one-year contracts between the retailers and the large shippers, there has been observed less volatility in the Transpacific eastbound trade in comparison with the Asia-Europe trade. One of the key factors, which is expected to have a great impact on the trade lane, is the expansion of the Panama Canal. The impending expansion is estimated that will provoke a tremendous increase in the flow of goods to/from Asia. Finally, the main exporting products of the trade lane are low value commodities such as scrap and wastepaper, which are of great importance for the Chinese manufacturing and packaging companies (JOC.COM, 2014).

Transatlantic trade: The specific trade lane includes the commercial activities among the USA, Canada and Mexico to/from Europe (Clarkson Research Services Limited, 2014). Moreover, it is remarkable that the trade between North America and Europe has stagnated in recent years, because of the recession and Asia's increased manufacturing process. Nevertheless, various analysts support that the trade in this lane is stable, which means that the carriers and shippers can plan their strategies without fear of the severe volatility. In addition, after the completion of the Panama Canal expansion project in 2015, even bigger vessels could be accommodated by the Canal's new locks. Therefore, the expanded Canal will contribute to the introduction of 10000 plus TEU vessels on the Asia-Europe trade. This shift will definitely provide a boost to Transatlantic carriers such as Savannah, Virginia, Charleston and New York-New Jersey in a market, which is mainly characterized by stability and slow growth rates. On the other hand, European ports still have to cope with the recession's consequences, which has hurt imports and exports (JOC.COM, 2014).

Far East-Europe trade: This trade lane includes the commercial activities between Asia and Europe (Clarkson Research Services Limited, 2014). It basically constitutes the main link between the developed economies of Northern Europe and the rapidly developing economies in the East such as China, Japan, Indonesia and Thailand. According to Maersk, the westbound volumes of the Asia-Europe trade increased almost by 8 percent in the latter half of 2013 in comparison with the

corresponding period of 2012. Furthermore, the global carriers cannot ignore the specific trade lane as it constitutes

the big money-spinner over the years. It should also be taken into account that the Asia-Europe trade lane was strongly affected by the Lehman Brothers collapse and the subsequent economic crisis, but historically, it has been proved as the most profitable trade lane for the container lines (Lloyd's list , 2014).

Apart from the East-West trade, there is also the North-South trade, which includes non-main trade routes and typically connects the major commercial centers of North America, Asia and Europe with the developing countries in the southern hemisphere. Finally, the intraregional trade is considered as one of the bright spots of the global container trade with a substantial growth rate in the last decade. According to this type of trade, the most representative example is the Intra-Asia trade, which is expected to reach a total value of 35.7 million TEU in 2014, regarding the local imports/export exchanges, excluding the feeder traffic (Lloyd's list, 2012). The following table depicts the year on year progress of the global container trade in each of the three mainlane container trade routes, including separate results about the eastbound and westbound trade.

	MAINLANE CONTAINER TRADE											
	Transpacific Trade				Far East-Europe Trade				Transatlantic Trade			
million TEU	e/b	% year-on-year	w/b	% year-on-year	e/b	% year-on-year	w/b	% year-on-year	e/b	% year-on-year	w/b	% year-on-year
2007	14426		6711		5448		13800		3122		3566	
2008	13448	-6.80%	7064	5.30%	5379	-1.30%	13766	-0.20%	3206	2.70%	3248	-8.90%
2009	11415	-15.10%	6951	-1.60%	5627	4.60%	11739	-14.70%	2401	-25.10%	2756	-15.10%
2010	13123	15.00%	7201	3.60%	5796	3%	13757	17.20%	2666	11.10%	3032	10.00%
2011	13209	0.70%	7597	5.50%	6231	7.50%	14214	3.30%	2758	3.40%	3288	8.40%
2012	13277	0.50%	7569	-0.40%	6501	4.30%	13618	-4.20%	2629	-4.70%	3468	5.50%
2013	13832	4.20%	7871	4%	6840	5.20%	14151	3.90%	2684	2.10%	3566	2.80%
2014	**14535**	**5.10%**	**8208**	**4.30%**	**7230**	**5.70%**	**14883**	**5.20%**	**2774**	**3.40%**	**3681**	**3.20%**
2015	15425	6.10%	8640	5.30%	7706	6.60%	15746	5.80%	2870	3.50%	3802	3.30%

Table 2: Mainlane Container Trade

Source: (Clarkson Research Services Limited, 2014)

3.2 World Container Trade

According to recent statistics, the global container trade is expected to grow by 5.8 percent in 2014 and 6.7 percent in 2015, respectively. The total increase in comparison with the previous year is estimated to be approximately 4.7 percent. It is remarkable that an upward trend seems to characterize the mainlane trade, which is projected to grow by 4.8 percent this year, while the growth of the non-mainlane East-West trades is expected to be a combined 6.3 percent in full year 2014 to

reach 118 million TEU. In addition, the Intra-regional trade is projected to expand by 6.7 percent this year to 67.5 million TEU, because of the strong forces, exerted by the growth of Intra-Asian trade. Additionally, volumes on North-South trades are appraised to increase by 5.2 percent in 2014. It should also be taken into account that the growth of the North-South trade volumes is directly affected by the robust demand from the Southern Hemisphere. Furthermore, the volumes on the Far East-Europe route and Peak-leg transpacific route are expected to increase by 5.2 percent and 5.1 percent this year, respectively (Clarkson Research Services Limited, 2014).

In accordance with recent forecasts, the global container trade is currently projected to grow by 6.7 percent in 2015 to 180.7 million TEU, although the predictions cannot be completely accurate, due to the high rate of risk. Nevertheless, it is considerable that there are concerns about an impending slowdown across some major emerging economies. Routes of short distance such as those within the Intra-Asian network should continue to marginally outperform deep-sea trade lanes, although the global pattern of trade growth seems to be more balanced this year. In addition, the following figure illustrates the container trade growth from 2002 to 2015, including the recession of 2009 (Clarkson Research Services Limited, 2014).

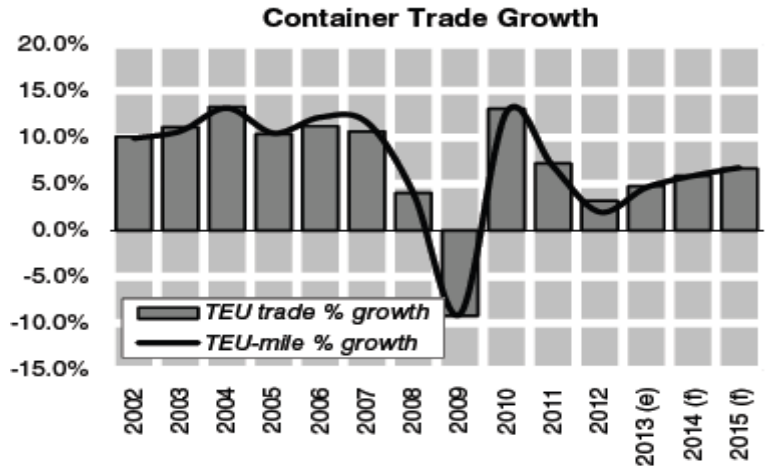

Figure 1: Container Trade Growth

Source: (Clarkson Research Services Limited, 2014)

3.3 Stakeholders in the Container Business

It is considerable that the transportation of containers is a global business. Various stakeholders are involved in this type of business. The following chapter will provide the reader with an analytic description of the different parties involved and their competencies.

Shipper: According to the (United Nations, 1978), shipper is defined as the person that enters into a contract of carriage with a carrier. The cargo shipper is the owner of the goods, being transported to the final destination (consignee) by the various

modes of transport. In addition, the shipper is responsible for ensuring the delivery of the freight to the final customer, in the right condition, at the right price, at the right time and in the most efficient way. The nature of international trade and transport is the major determinant, which contributed the most to the constant changes in the cargo shippers' definition over the years. Nowadays, the global economy shippers contract either with third party logistics providers or with freight forwarders in order to procure and manage their freight shipments and they are totally responsible for arranging and managing that contract. Nevertheless, many shippers seek to make arrangements directly with carriers, regardless they are the importer or exporter. Furthermore, sales terms rule the contract and allow the shippers to take control of the shipment and the goods as well as the liability, regarding the carriage of goods either from their source or from a place of delivery. In some cases, the shippers are charged with extra responsibilities, such as import or export duties, freight charges, insurance or requirements under the various, strict rules of international trade. To conclude, it should be taken into consideration that the shippers have the ultimate responsibility for the goods in their possession and must always comply with the national and international rules of trade and commerce (European Shippers' Council, 2013).

Consignee: The consignee is defined as the party, who receives the goods. When the goods are delivered to the consignee then this person is considered as the legal owner. Moreover, the moment the consignment has been completed the goods are at the consignee's risk. The persons, employed in the transportation of the goods on behalf of the customer, are the agents. Additionally, when the goods are not in the consignee's possession, then this party is forced to follow the shipper's instructions. In the bills of lading, it is clearly stated that the goods must be delivered to the consignee or his assigns. Hence, when the goods reach the final destination, given the agreed conditions, the consignee or his assigns are bound to pay the freight (The Lectric Law Library, 2014).

Container Shipping Lines: In general, liner shipping is defined as the service of transporting goods by means of high capacity such as ocean-going vessels that transit regular routes on fixed schedules. Nowadays, there are approximately 400 liner services, which provide weekly departures from a great number of ports. It is considerable that 60 percent of the world's total value of goods are carried by container vessels, annually (World Shipping Council, 2014). Moreover, the liner shipping companies may have their own fleet or may charter the number of vessels that they need. In the specific type of business, there are also carriers, known as Non Vessel Operating Common Carriers (NVOCC), who do not have their own vessels and simply charter slots on foreign vessels. Apart from the chartering of the vessels, most of the times, the liner shipping companies also charter containers of other companies in order to transport the goods to the final customer.

Container Terminals: According to (Saanen, 2014), terminal is defined as the organization, which basically offers a total package of various activities and services in order to handle, store and control cargo to/from transportation models with a balance in handling and services to the transportation modes against minimized costs. On the one hand, there are terminals, whose main functions are focused on the transfer of containers to/from ships. These terminals are generally known as maritime container terminals. On the other hand, there are other types of container terminals, known as inland container terminals, which facilitate rail and road transportation. Nowadays, in the global economy, container terminals are struggling under a highly competitive environment. Therefore, the intense pressure and the

fierce competition were the major determinants, which led the terminal operators to optimize their services in the most efficient way, adopting complex software systems in order to enhance automation (Port Technology International, 2014).

Third Party Logistics Providers (3PL): According to (Pietro Evangelista, 2006), the logistics service provider conducts third party logistics activities on behalf of the shipper, which consist of at least transportation. Moreover, a wide range of activities, such as warehousing, inventory management, information related activities and value added supply chain activities, can also be included into the service offering. In general, customers cooperate with 3PL companies in order to outsource some of their activities, which typically cannot be performed due to the lack of the necessary space or resources. It should be taken into consideration that, in many cases, 3PL companies are responsible for activities, related to the consolidation of cargo, regarding the LCL shipments.

3.4 The Port of Rotterdam – Europe's Largest Container Port

History and Achievements: It is generally accepted that containerization contributed the most to the port of Rotterdam's evolution, regarding the physical and knowledge infrastructure. In 1974, the port handled 1 million TEU annually, which is an outrageous number, given the technology and the infrastructure of that age. Then, in 1997, the total container throughput reached 5 million TEU, while in 2007, the number was doubled. Another important milestone for the port's performance is considered the fact that, in 2011, the port of Rotterdam became Europe's first port, which managed to handle 1 million TEU in a month. This record was achieved in the last day of March on the vessel, called Ital Oriente. The port turned around 47 vessels in total that day, which means a total of approximately 50000 TEU. It is considerable that this was the most important milestone of the port of Rotterdam as a container port, since 1966. According to some estimations, it is projected that the total container throughput handled by the port will reach 30 million TEU, annually. Furthermore, there has been observed a peak in the spring, around May and in the autumn, around September, concerning the container handling activities. It should be taken into account that summer and winter are considered the peak seasons, because of the vast amounts of products, imported from Asia and South America (Port of Rotterdam, 2011).

Container terminal facilities in the PoR: The port offers a wide variety of different terminal facilities in order to meet its customers' demands. In total, the port area includes 7 container terminals. Four container terminals are located at the Maasvlackte (ECT Delta Terminal, APMT, Euromax Terminal Rotterdam and RWG), while the rest are located at the Waalhaven/Eemhaven (ECT City Terminal, RST and Uniport).

ECT Delta Terminal: The specific terminal is located at the Maasvlackte, offering direct accessibility from the North Sea. The ECT Delta Terminal covers a total surface area of 265 ha, including a quay of 3.6 km long with 17.5 m of maximum draught. In addition, there are no tidal restrictions or locks, while the terminal operates for 24/7 and can easily accommodate even the largest vessels. It serves the world's major liner shipping companies and constitutes the first port of call in Europe. It should be taken into consideration that this terminal is considered as the

leading feeder hub of Europe. Because of its infrastructure, the feeder vessels can successfully maintain high frequent connections with a great number of ports spread across the whole of Europe and North Africa (ECT-Europe Container Terminals, 2014).

Furthermore, this terminal constitutes the world's first automated terminal. A huge fleet of 265 AGVs (Automated Guide Vehicles) is responsible for the transportation of the containers from the waterside to the yard, where approximately 140 ASCs (Automated Stacking Cranes) take care of the storage functions. Moreover, the container yard has 3250 connections for reefer containers, which are efficiently handled for 24/7 by the company Delta Reefer Care. It is remarkable that technology constitutes the cornerstone of such a capital intensive industry. Therefore, the entire automated cluster is strictly based on an advanced Process Control System, which is the main engine for all the functions inside the cluster (ECT-Europe Container Terminals, 2014).

In addition, the specific terminal is considered as one of the most prominent hubs of Europe. Each week, a huge number of feeder vessels, rail and barge shuttles as well as approximately 20000 trucks visit the terminal complex. Moreover, the feeder vessels and the barges are shared the same deep-sea quays with the largest vessels at the dedicated Delta Barge Feeder Terminal, which is located at the northern point of the Delta complex. Nevertheless, barges can also be handled at the separate barge terminal on the Hartelkanaal. Additionally, part of the terminal's infrastructure constitutes the two rail dedicated terminals, the Eastern Rail Terminal and the Rail Terminal West, which are directly linked with the international rail network. Furthermore, trucks are efficiently handled, because of a fully automated system, which facilitates the visiting drivers (ECT-Europe Container Terminals, 2014).

To conclude, ECT facilitates its customers, providing the European Gateway Services. These are dedicated services for the integrated, safe, sustainable and efficient transportation of containers from the deep-sea terminals in Rotterdam to the European hinterland. In addition, the European Gateway Services network currently consists of 10 inland terminals, MCT – Moerdijk, TCT Venlo, ACT – Amsterdam, TCT Belgium – Willebroek, AVCT – Avelgem, LCT – Luik, DeCeTe – Duisburg, Neuss Trimodal, Container Terminal Dortmund and TriCon Container-Terminal Nürnberg (ECT-Europe Container Terminals, 2014).

Euromax Terminal Rotterdam: Similar to the ECT Delta Terminal, the Euromax Terminal Rotterdam is also located at the Maasvlackte, is directly accessible from the North Sea and has no locks or tidal restrictions. It is considered as one of the most advanced and ecofriendly terminals, globally. In addition, the terminal stretches out over 84 ha, including a quay wall of 1.5 km long with 16.8 m draft. It is remarkable that the terminal can be further deepened to 19.6 m in order to be able to handle even bigger vessels with larger draught. Currently, the specific terminal offers dedicated services to the vessels of the Green Alliance, which is a cooperation among four liner shipping companies, Cosco, "K" line, Yang Ming and Hanjin. Moreover, the Euromax Terminal Rotterdam is equipped with the state of the art container cranes, which have a reach of 23 containers wide (ECT-Europe Container Terminals, 2014).

Regarding the terminal's container handling equipment, all the quay cranes are semi-automatic. Additionally, part of the cranes' equipment constitutes a second

trolley, which is typically used in order for the highest possible productivity levels to be achieved. Furthermore, a fleet of Automated Guide Vehicles (AGVs) takes care of the transportation of the containers from the waterside to the yard. With respect to the yard's structure, there is a great number of stacking lanes, where, in each one of them, the work is conducted by two Automated Rail Mounted Gantry cranes (ARMGs), one on the waterside and one on the landside, respectively. Moreover, the yard includes 2150 connections for reefer containers, which are efficiently handled for 24/7 by the company Delta Reefer Care (ECT-Europe Container Terminals, 2014).

Concerning the hinterland transportation, the deep-sea quay at the Euromax Terminal Rotterdam is equipped with dedicated barge/feeder cranes, which can efficiently handle barges and feeder vessels. In addition, the trains are handled at the rail terminal, which contains two cranes and six tracks, while it is directly linked with the Port Railway Line and Betuwe route, offering easy access to the European hinterland. Moreover, the terminal is supported by an electronic identification system for the truck drivers, which accelerates the transportation procedures, avoiding obstacles and additional delays. To conclude, the customers of the specific terminal can also benefit from the aforementioned ECT's European Gateway Services (ECT-Europe Container Terminals, 2014).

APMT: The APM Terminal Rotterdam is scheduled to start its operations in November 2014 with a total container throughput capacity of 2.7 million TEU per year. The terminal is part of the Danish AP Moller-Maersk Group and will mainly support the container handling needs of its sister company, Maersk line, in the port of Rotterdam. Moreover, it is expected that the specific terminal will constitute the world's most technologically advanced container terminal, containing a quay wall of 1 km long with 20 meters of maximum draught. Furthermore, the terminal will be well-supported by Maasvlackte 2's on-dock rail terminal, which will initially include four tracks with capabilities of expansion to eight tracks. Another important characteristic of the rail terminal is the direct connection with the Betuwe route, which is a dedicated double track electric-powered freight line of 160 km long that connects the port of Rotterdam with the German border at Zevenaar-Emmerich. In addition, the APM terminal is considered as one of the most sustainable and ecofriendly terminals, because it has been designed to use equipment based only on electric power and green energy generated power. Therefore, the environmental pollution can be restricted to a greater extent. It should be also taken into consideration that the specific terminal is equipped with a quay of 500 m long, especially for barges, providing direct access to the European river transportation network. According to the APM terminal's global commitments, the terminal's top priority will be the traffic diversion from the road to the sea in order for bottlenecks and congestion to be averted (APM TERMINALS, 2014).

RWG: The Rotterdam World Gateway (RWG) is the fourth container terminal, which is located at the Maasvlackte. It is expected that the specific terminal will start its operations in October 2014. RWG stretches out over 108 ha, including a quay wall of 1150 m long with 20 m of maximum draft. It has a total container throughput capacity of 2.35 million TEU per year, while the total amount of this investment is estimated to be approximately € 700 million (RWG, 2014).

Moreover, the terminal includes a dedicated barge/feeder quay of 550 m long with 11 m of maximum draught. Regarding the cargo handling equipment, RWG is equipped with 11 deep-sea quay cranes, 3 barge/feeder cranes, 2 rail cranes, 50

Automated Stacking Cranes (ASCs) and 59 Automated Guide Vehicles (AGVs). Additionally, the terminal's quay cranes are electric powered and remote controlled. Therefore, the cargo handling operations will be fully automated and environmental friendly. Furthermore, RWG's construction philosophy has based on a fail-safe design, which means that there are many redundant systems, offering technical backup in case of system failure. As a result, the terminal is able to limit the loss of productivity at a lesser extent. The terminal's cranes are able to handle the largest vessels with a total reach of 24 containers wide. In addition, they are equipped with a "double trolley" system, which allows containers to be unloaded from the vessel onto an AGV in two steps. In this way, higher efficiency can be achieved and more time can be saved, during the loading and unloading procedures. It should be taken into consideration that all the operational procedures will be carefully monitored by process operators from the terminal's control room, while RWG can also offer highly automated cargo handling services to barges, trains and trucks (RWG, 2014).

Finally, Rotterdam World Gateway constitutes an international consortium between one of the world's largest terminal operators, DP World (Dubai) and four big liner shipping companies, APL (Singapore), MOL (Japan), HMM (South Korea) and CMA/CGM (France) (RWG, 2014).

ECT City Terminal: The terminal is located at the Eemhaven, at a distance of only 30 km from the North Sea. It covers a total area of 65 ha and includes a quay wall of 1.4 km long with a maximum draft of 14.15 m. Moreover, the terminal can handle vessels with maximum capacity up to 8000 TEU. It is considerable that the vessels, which enter the port, totally need two hours in order to anchor alongside the terminal's quay wall, while they are not hindered by bridges, locks or tides. The ECT City Terminal's position is of strategic importance, especially for reefer cargo, because the terminal is located close to the city center and distribution centers (ECT-Europe Container Terminals, 2014).

Most of the ECT City Terminal's customers are big liner shipping companies, operating on the North-South non-main trade routes, which typically means that the terminal is specialized in the handling of reefer cargo. Hence, the terminal's yard has more than 1350 connections for reefer containers, which are efficiently handled for 24/7 by the company Home Reefer Care (ECT-Europe Container Terminals, 2014).

Furthermore, the deep-sea quays of the terminal can efficiently handle barges and feeder vessels, while the Rail Service Center Rotterdam, which is located near the terminal, offers dedicated cargo handling services to the trains. In addition, the ECT City Terminal has an automated inspection gate, where the inspection of the cargo is conducted, while the electronic identification system takes care of the drivers' identification procedure. Similar to the aforementioned ECT's facilities, the terminal's customers can also benefit from ECT's European Gateway Services (ECT-Europe Container Terminals, 2014).

RST: The Rotterdam Shortsea Terminal is also located in the port of Rotterdam and is considered to be one of the fastest growing terminals and the market leader in shortsea container transshipment, due to the fact that the largest part of all shortsea transshipment activities in Rotterdam is carried out by this terminal (RST, 2014). Due to its favorable strategic location, the terminal is directly connected to the sea and the rivers, Rhine and Meuse, while it is also linked with an extensive railroad network and motorway network, offering fast and efficient services to the European

hinterland (RST, 2014). Moreover, the Rotterdam Shortsea Terminal stretches out over 46 ha. It should be also taken into account that, the terminal has divided its docks into two different operations, North side and South side, in order to optimize the cargo handling process. Therefore, the optimal transit times can easily be achieved. Furthermore, the terminal is equipped with modern STS (Ship to Shore) cranes and operates for 24/7 (RST, 2014).

Uniport: Uniport Multipurpose Terminals B.V. is an independent container stevedoring terminal, which was constructed in 1971. The terminal is located at the Waalhaven, in the urbanized area of the port of Rotterdam (Uniport, 2014). Due to its favorable position, Uniport is directly accessible from the sea, at a short distance of only 13 miles. In addition, the terminal handles approximately 1.2 million TEU per year, while it has the appropriate physical infrastructure, supporting the different types of transportation modes (Uniport, 2014).

Similar to the aforementioned terminals, the vessels, which daily visit the specific terminal are not hampered by locks, bridges or tidal differences. Moreover, the piers 5, 6 and 7 of Uniport are constructed far away from the coastal line, in the hinterland, which means that the vessels have a direct access through the port's canals into the country. As a result, transportation becomes more efficient and cheaper, because of the vast amounts of cargo, carried via sea, instead of road. Adjacent to Uniport's container terminal, there are many distribution centers, cold stores, auction facilities, as well as a great number of empty depots and repair shops. It is remarkable that Uniport's pier 6 includes one of the empty depots, while the rest are located at a short distance of 2 miles from the terminal (Uniport , 2014).

The terminal's expansion progress is impressive, because Uniport covered only 65000 m^2, when it was firstly constructed, in 1971, while nowadays, the terminal stretches out over 540000 m^2, including a yard with 28900 TEU of total ground slots capacity and 1248 electric reefer plugs and additional 400 temporary. In addition, the terminal's railway facilities contain two rail tracks of 600 m each, offering dedicated services to the trains. Regarding the quay equipment, Uniport is equipped with 9 STS container gantries, 1 mobile crane, 9 yard stacking cranes and 6 twinlifts for twenty foot containers (Uniport, 2014).

The PoR's Expansion Project - Maasvlackte 2

Within the framework of this report, it has been clearly stated that the port of Rotterdam is the most important port of Europe. Million tons of cargo pass through the specific port every year and numerous companies have expressed their interest to set up their facilities in order to constitute an active part of the port's industrial cluster. Nevertheless, the industrial area of the port was not able to house the increasingly larger number of businesses, due to the lack of necessary space. As a result, the port authority focused its endeavors on the elaboration of an innovative expansion project, which would give the port the opportunity to accommodate more businesses in order to increase its profitability and meet the future rising demand, maintaining its leading position against the neighboring ports. Therefore, the Maasvlackte 2 project typically constituted a direct extension of the already existing Maasvlackte, exploiting to a great extent all the existing connections with the European hinterland. According to this new project, 1000 ha of space will be available for deep-sea related container transshipment, distribution and chemical industry. In addition, this will be the first location, where the world's largest vessels will be able to moor and be handled for 24/7. Parallel to the port's expansion project,

the quality of life and the protection of the region's flora and fauna are also issues of augmented significance. Therefore, the Rotterdam Mainport Development Project (PMR) started in order to cope with the other important issues. Apart from the Maavlackte 2 project, PMR also consists of two other subprojects. The first one is the improvement of the Existing Rotterdam Area (BRG), while the second includes the construction of 750 ha of recreation area, dedicated to nature (Port of Rotterdam, 2014).

3.5 The Advantages of PoR as a Container Port

It is generally accepted that there are numerous reasons, which, nowadays, define the PoR as the leading port in the container market segment. The following subchapter provides the reader with an analytical description of the strengths of the PoR as a container port.

Hinterland Connections: It is considerable that the PoR is a non-detachable part of the European supply chain. The port provides a large variety of logistic solutions, because of its extensive hinterland network, which can easily support the carriage of goods by different transportation modes. For instance, over half of the imported cargo is transported to other destinations within Europe by barge or is delivered to the port by the same mean for transshipment. Moreover, road transportation is a very important option, which is usually preferred for the speed and the efficient provision of door to door services to the final customer. The PoR has the appropriate infrastructure, which directly connects the port with the national motorways, offering fast transportation without bottlenecks. Furthermore, the rail transportation is another significant alternative option, which is basically preferred in case of huge quantities of cargo that must be conveyed to distant destinations. Regarding this transportation mode, the port is connected with a large railway network, which stretches over the European continent and constitutes the main link of the port with most of Europe's industrial areas. Therefore, the port offers short transit times, which are less than 12 hours for close destinations like Germany and Belgium and not more than 48 hours for more distant destinations like Czech Republic, Poland and Italy (Port of Rotterdam, 2014).

Terminals and Depots: The port includes a unique cluster of technologically advanced container terminals, which, most of them, are directly accessible from the North Sea, while others have been strategically positioned closer to the hinterland. Rotterdam's container terminals offer their cargo handling services for 24/7. In addition, the fact that the deep-sea terminals have an unrestricted depth of approximately 19.65 m, make them capable of handling the largest new generation vessels (Port of Rotterdam, 2014). It should be also taken into consideration that the port is considered as one of the leading transshipment hubs, due to the fact that it constitutes the first or last choice as a port of call of the big liner shipping companies. The major determinant of this choice is the port's numerous connections with some of the most important economic zones, such as the UK, the Iberian/Peninsula, Ireland and the Scan/Baltic region (Port of Rotterdam, 2014). Thereafter, it is remarkable that the storage capacity and the storage possibilities are crucial factors for a container port, because they directly affect the port's efficiency and productivity, contributing to the effective exploitation of all the available space from the deep-sea terminals. In the PoR more than 120 hectares of space are dedicated to container storage. The container depots are scattered within the port area in 20 different locations and are being inspected frequently for safety reasons. In addition, the numerous terminal operators, which act within the port, offer a wide range of services and enhance the economy of the local community (Port of Rotterdam, 2014).

Shortsea: The PoR also tries to promote short sea shipping in order to fully exploit the numerous short sea connections and the inland waterway network. This type of

shipping is the most sustainable and stimulates the European shipbuilding industry. Additionally, it has the most favorable labor/capital ratio, which typically means that it decreases the unemployment rate. Another important reason of economic interest is that short sea shipping needs the less infrastructure in comparison with the other types of shipping (Haralambides, 2012). Hence, the port has focused its endeavors on constructing a huge shortsea network, which typically constitutes the link between the port and the distant destinations that are not accessible by the largest vessels. The UK, Ireland, Scandinavia, the Iberian/Peninsula, the Baltic States and Russia are some of the major connections of the port, which are daily served multiple times. As aforementioned in subchapter 3.4, the port's largest shortsea cluster is located at the Waalhaven/Eemhaven, including ECT City Terminal, Rotterdam Shortsea Terminal (RST) and Uniport (Uniport Multipurpose Terminals BV) (Port of Rotterdam, 2014).

Projects

It should be taken into consideration that innovation has a pivotal role for the PoR in order to maintain its leading position in the following years. The PoR has always been a port, where new ideas were adopted and implemented throughout the years.

Container Logistics Maasvlackte (CLM): The main goal of CLM project is the optimization of barge, rail and feeder product in order for the transport of containers to/from Rotterdam to be facilitated. The concept's realization constitutes of a joint effort of Rotterdam's port authority, stakeholders and market parties (Port of Rotterdam , 2014).

Inlandlinks: Inlandlinks is a program, which includes the charted hinterland network of Rotterdam, offering to the customers an overview of the most efficient intermodal route. Apart from the charted network the program also provides the customer with an overview of all the inland locations, where empty containers can be loaded or discharged. Therefore, this program is considered as a very useful tool for the better management of the empty containers, as it saves a huge amount of empty kilometers and increases sustainability (Port of Rotterdam , 2014).

Rail Incubator: This project includes the dedicated efforts of the port of Rotterdam authority to further develop a sustainable rail transportation. Within the framework of this concept, the port authority has focused its endeavors on extending the amount of rail shuttles, establishing new maritime rail connections or increasing the frequency of the already existing connections (Port of Rotterdam , 2014).

Nextlogic: The main objective of this concept is the achievement of more efficient handling of inland container shipping for the greater good of the entire logistic chain. In other words, Nextlogic is typically focused on the better use of the terminal's equipment. As a result, higher reliability and predictability, regarding the turnaround times can be achieved as well as fewer, small calls in the sea port. In addition, three pillars constitute the fundaments of Nextlogic solution, allocation of terminal and depot slots, call optimization and performance measurement (Port of Rotterdam , 2014).

(Peter De Langen, 2012), in his inquiry used different variables, such as the GDP growth and the trade growth, in order to prove the existing relationship between the port throughput and these variables. In addition, in another research (Fung, 2001) devised a three player oligopoly model in conjunction with a structural error correction model (SECM) in order to study the competitive interaction of the different operators. Moreover, through this research the author concludes that forecasts have to be based on realistic assumptions in order to gain optimum results.

Thereafter, (Peter De Langen, 2003) created a model in order to analyze and estimate the future demand of transport between two countries. Within the framework of his inquiry he stresses that the uncertainty of trade flows is very large and he tries to explain the great need of flexibility in economic interest decisions related to port investments. Additionally, the author uses seven variables in total. Four of them are relevant to the overall volume of trade and international transport flows. These are the GDP, the Export quote of economies, the direction of trade and the value density of trade. Furthermore, the other last three are variables, which are correlated with the containerized proportion of transport flows. These variables are the containerizable share of transport flows, the rate of containerization and the share of shipping in international trade.

According to (Francesco Russo, 2013) ,the specified and well calibrated demand models help us to obtain more accurate results, concerning the demand variables. The basic requirement is a given geographical area and a well-defined time frame. Moreover, another research, which were elaborated by (Wen-Yi Peng, 2009), focuses on forecasting the variation of demand in the short run for the container throughput of international ports. The author used a classical decomposition model and a trigonometric regression model with seasonal dummy variables. It is also remarkable that the author stresses through this inquiry the power of the classical decomposition model, in terms of short term demand predictions. Thereafter, (Lei Fan, 2012) used an intermodal network flow model in order to analyze congestion and its impact on container imports. According to the author's conclusions, the negative effects of congestion are the rise of costs and traffic diversion to other routes. In addition, the author stresses that a possible expansion of marginal capacity could have a positive effect on reduction of costs and waiting times.

Furthermore, (Zijian Guo, 2005) proves how important can be the implementation of the grey Verhulst model on the time series error corrected in order to obtain higher forecasting accuracy, regarding the results related to port throughput. To conclude, the author explains why the throughput forecasting can be the cornerstone of port development, planning and building. Subsequently, (Cullinane, 1999) in another research examines if the Baltic Freight Index behavior changed after the removal of handy size routes. The author elaborated the inquiry by using the ARIMA model, which is a very powerful tool for short term predictions. The main objective of this research was the comparison of the new results with the previous results in order to assess an impending loss in the validity of the latter.

Finally, another significant article about the financial crisis, which can be useful for our study, was written by (Meifeng Luo, 2009). In this report the author uses a dynamic economic model in order to examine the relationship between the demand of container transport services and the container fleet capacity. The author's

conclusions about the impact of financial crisis were that the container freight rate decreased, due to the reduction of the international trade. Hence, this situation had serious corollaries. Some of them were the decrease in new orders and the cancelation of existing orders.

Chapter 5: Hypothesis

It should be taken into consideration that the aforementioned literature review contributed to the identification of crucial variables, which definitely must be included in the model of this inquiry. Within the framework of the statistical analysis, the following hypothesis must be defined in order for the main research question to be answered.

Main Research Question

“How much do different types of economic and non-economic indicators influence the container throughput of the Port of Rotterdam and what is their value for future estimations?”

Hypothesis 1

The Gross Domestic Product (GDP) of the Netherlands and the Container Throughput of the PoR are positively correlated.

Hypothesis 2

The Consumer Price Index (CPI) of the Netherlands and the Container Throughput of the PoR are negatively correlated.

Hypothesis 3

The Economic Sentiment Indicator (ESI) of the Netherlands and the Container Throughput of the PoR are positively correlated.

Hypothesis 4

The New Order Manufacturing index (NOM) of the Netherlands and the Container Throughput of the PoR are positively correlated.

Hypothesis 5

The Retail Sales Indicator (RSI) of the Netherlands and the Container Throughput of the PoR are positively correlated.

Hypothesis 6

Germany’s Production Index for Manufacturing and the Container Throughput of the PoR are positively correlated.

Hypothesis 7

The Export of Goods and Services from China and the Container Throughput of the PoR are positively correlated.

Hypothesis 8

8000+ TEU container fleet development and the Container Throughput of the PoR are positively correlated.

Hypothesis 9

380 CTS bunker price at Rotterdam and the Container Throughput of the PoR are positively correlated.

Hypothesis 10

The China Europe Freight Index and the Container Throughput of the PoR are positively correlated.

To conclude, the validity of the above-mentioned hypothesis will be tested via a multiple regression model, showing which variables have an impact on the Container Throughput of the PoR. The following chapter will provide the reader with a more analytical description of the variables, while Chapter 8 includes the results, regarding the hypothesis.

Chapter 6: Variables

It is remarkable that the container throughput increased dramatically after the introduction of containerization in the nineteen sixties. Therefore, in order to understand the true drivers of this increasing trend, there must be identified certain variables, which can reflect the growth of the specific market segment. Nowadays, it is generally accepted that most of the products can be containerized and be transported in boxes. The main objective of this report is to identify and statistically test the major variables, which directly affect the container throughput of the PoR. For this reason, there has been carefully selected six economic variables and four non-economic variables, which will be tested and be measured in the report's statistical model.

Dependent Variable: Container Throughput of the PoR

This will be the dependent variable of the following model, as it is directly affected by other variables, which will be analytically described in the subsequent sections of this chapter. In addition, the data for the dependent variable were selected from 2003 to 2012 and have all been assessed in monthly values. It should be taken into account that the specific variable contains the imports, the exports and the transhipment of containers at the port of Rotterdam. Moreover, there has been observed a constant increase of the container throughput of the PoR, as the global container trade has grown.

According to (Hoffmann, 2010), the financial crisis's consequences were far worse for the trading sector in comparison with the production sector. Hence, the container shipping industry was strongly influenced when in 2009, the world's Gross Domestic Product (GDP) reduced by 2.2 percent, while trade decreased by 14.4 percent, as traders and factories used up their inventories.

Independent Variables

Macroeconomic indicators: The macroeconomic indicators are mainly statistics, which indicate the current state of a country's economy in accordance with a specific market segment e.g. industry, employment, trade etc. Furthermore, they are regularly published on a monthly, quarterly or yearly basis by governmental organizations and the private sector. Currently, the containers are globally used in order for a wide variety of goods to be conveyed. Therefore, the study of the macroeconomic indicators for the Netherlands and the neighbouring regions is of augmented significance for the elaboration of this report. Consequently, 10 indicators of this type have been selected and will be described as follows.

1. **Gross Domestic Product (GDP-Netherlands)**: The Gross Domestic Product is defined as the total value of all the finished goods and services, which are produced in the economy. Moreover, it should be taken into consideration that this indicator cannot be used in order to accurately estimate the national economic well-being, but expressed in volume, including inflation, it constitutes the best approach in order to obtain such a measure. The GDP represents the grand total of final expenditures, government consumption, private consumption, export of goods and services, imports of goods and services, gross fixed capital formation and

increases or decreases in stocks. Additionally, this indicator reflects the sum of value added in all branches throughout the economy and the total generated income in the Netherlands.

It is remarkable that the port of Rotterdam is characterized as a major commercial node, because it is the source of the largest amount of imports and exports throughout the Dutch economy. As a result, the GDP is considered as an indicator of fundamental interest, which provides the reader with a general view about how the country's economy influences the container throughput of the port. Furthermore, containers are not only used for the transportation of final goods, but also for the carriage of raw materials and semi manufactured commodities, which enter the supply chain and participate in the manufacturing or in the assembly procedure, respectively.

2. **Consumer Price Index (CPI-Netherlands)**: The CPI is the most widely used indicator of inflation. It is typically a measure of the overall prices of the goods and services bought by the average consumer. In addition, the specific index was firstly adopted as the main measure of inflation in the UK to bring it into line with the way of measuring inflation in the rest of Europe. Each month, a government bureau, the Office of National Statistics (ONS) in the UK and Eurostat in Europe, calculates and reports the CPI (N. Gregory Mankiw, 2011).

   It is considerable that CPI is a very useful tool in order for the changes in the cost of living to be measured. In other words, the main objective of this macroeconomic indicator is to estimate how much incomes must rise in order to maintain a constant standard of living (N. Gregory Mankiw, 2011). It is rational that the Consumer Price Index of the Netherlands is negatively correlated with the container throughput, because the higher the costs of living in a society the less goods and services the citizens will be able to consume. Therefore, there will be a reduction in the container throughput of the port, as it reflects the sum of commodities, which enter or leave the domestic market.

3. **Economic Sentiment Indicator (ESI-Netherlands)**: According to (Sarah Gelper, 2007), the European Economic Sentiment Indicator (ESI) is published every month by the European Commission. ESI relies on sentiment surveys, which aim to get insight into the beliefs of the various economic agents. In addition, the surveys are conducted in all member states of the European Union. This indicator consists of five surveys, in total, four business surveys, one for each of the industrial service, construction and retail sector, and one consumer survey. Each survey is assigned different weights, which depend on intuitive economic reasoning and contribute to the calculation of the overall index. Furthermore, the main idea behind the specific indicator is that if consumers and manufacturers feel confident, regarding the current and future general economic and own financial situation, then they are eager to increase their consumption and production respectively. In this sense, ESI is defined as an indicator of future economic activity in Europe and constitutes a benchmark for both businessman and policy makers.

It is generally accepted that the financial crisis had a huge impact on the global trade. Both consumers and producers focused their endeavours on risk averse actions, because of the highly volatile market. Therefore, the future uncertainty led the consumers to limit their expenditures in order to save more money and deal with unpredictability, while the producers stopped the construction of new inventories and tried to use only stocks, stored in their warehouses. Consequently, the specific indicator is expected to identify how much the container throughput of the port of Rotterdam is affected by changes in consumers' and producers' confidence level.

4. **New Order Manufacturing Index (NOM-Netherlands)**: The specific index is released on a monthly basis and relies on surveys, conducted in manufacturing firms by the Institute of Supply Management. Moreover, the NOM index, which is generally known as the ISM index, accrues from a wide range of data surveys in different sectors such as the employment, the supplier deliveries, the new orders as well as the production inventories. Hence, the index typically constitutes a composition of monitored compartments and is basically used for monitoring the national manufacturing conditions. Therefore, the investors can have a better understanding of the various economic conditions on a national level.

   It should be taken into consideration that containers are widely used for the transportation of high value commodities, manufactured in different production plants throughout the Netherlands. Additionally, these goods are equally important for the country's exports and imports, as the containers are also used for the carriage of Semi Knock Down (SKD) parts, which are necessary in order for the manufacture of the final products to be completed. Subsequently, the final products are exported to the global markets. To conclude, this indicator must be included in the report's model in order to examine whether and to what extent the changes in the New Order Manufacturing index can be used for the interpretation of the changes in the container throughput of the port.

5. **Retail Sales Indicator (RSI-excluding cars-Netherlands)**: The specific macroeconomic indicator is used for measuring the sales of retail commodities over a standard time period. The RSI is released on a monthly basis about two weeks before each month's end. In addition, it includes in-store sales and a wide variety of out-of-store sales. The monthly results of the specific report can be divided in two categories, total scale figures and ex-autos. This mostly happens due to the volatile nature of the automobile market segment, which can distort the survey's data. Finally, the RSI is considered as a very useful tool in order to understand the purchase patterns of the economy's different market segments.

6. **Production Index for Manufacturing (Germany)**: The specific macroeconomic indicator is basically used for measuring the real output of all manufacturing establishments, located in Germany. Distinguished producers, who are in the leading position of each industry are selected. It is remarkable that this index indicates the various changes in the production of the main German industries. Furthermore, manufacturing output reacts quickly to the fluctuations of the business cycle and is directly related to

consumer conditions such as the unemployment rates and earnings (Warraich, 2013).

As aforementioned, the Betuwe railway constitutes the major link, which directly connects the PoR with the German hinterland. Each month vast amounts of cargo are transported to the neighboring country via the specific route. Therefore, the Production Index for Manufacturing is considered as a crucial indicator in order to study the dominant trends in the container throughput of the port.

Subsequently, variables of non-economic type, which supposed to have an impact on the container throughput of the port of Rotterdam, will be also included in the model of this report. The specific variables will be described later in this chapter.

7. **Exports of Goods and Services (China)**: According to (Index Mundi, 2012), the specific indicator contains all transactions between residents of a country and the rest of the world involving a change of ownership from residents to nonresidents of general merchandise, net exports of goods under merchanting, nonmonetary gold, and services. Within the framework of this report, it has been clearly stated that the Far East/Europe trade route has contributed the most to the global trade, as it has been proved the most profitable trade lane for the liner shipping companies. Moreover, during the last decade, China has become a major power house, regarding the manufacturing sector. Hence, a vast amount of containers, imported in Rotterdam come from China. The specific macroeconomic indicator must be included in the model in order for the impact of China's exports on the container throughput of the PoR to be examined (Warraich, 2013).

8. **8000+ TEU Fleet Development**: It is considerable that one of the advantages of the PoR, in comparison with the other ports, is the unrestricted draught of its container terminals, which are directly located on the North Sea. Nowadays, the deep-sea terminals can handle the world's largest vessels. Nevertheless, the liner shipping companies have focused their endeavors on the utilization of bigger vessels in order to reap all the benefits from the economies of scale, concerning the operational costs. The specific indicator is included in the report's model in order for how the increasingly larger vessels, used by the liner shipping companies affect their choice of using the port of Rotterdam as their gateway to Europe to be identified (Warraich, 2013).

9. **380 CTS Bunker Price at the PoR**: The port of Rotterdam ranks in the third position on the list of the world's largest bunkering ports. In addition, the port's total annual bunker fuel throughput is 11 million tonnes, following Singapore and Fujairah with 40 million tonnes and 20 million tonnes respectively. Currently, approximately 2,000 bunker deliveries take place every month, which reflect a yearly value of more than € 6 billion (Port of Rotterdam, 2013). Furthermore, the port also includes one of the largest and most modern bunker barges, which are able to handle the bunker requirements of the new generation. It should be taken into account that Rotterdam is capable of selling bunker fuel oil at low competitive prices in comparison with the other bunkering ports, due to three major attributes. These are the harbor's unlimited depth, enabling the largest vessels to call at

the port, the favorable strategic location, which allows cheap heavy fuel oil imports from Russia and the Baltic States and last but not least, the bunker production at the local refineries. Moreover, it is remarkable that the largest part of the vessel's operational costs depends on the bunkering costs. Therefore, the port of Rotterdam can attract more container traffic, offering inexpensive fuels, which typically results in greater container throughput. Although there is a wide variety of different types of fuels, the data for 380 CTS prices was used, as it is the most common fuel used by containerships (Warraich, 2013).

10. **Freight Index (China-Europe)**: According to (Warraich, 2013), the specific freight rate index is mostly used for tracking the freight rate of one TEU, which is transported from China to Europe. It is also considered as a very useful tool in order to understand the cargo flows, as high cargo flows result in reduction of the available capacity, while the freight rates present an upward trend in accordance with basic economic principles of the consumer's theory. Nowadays, China has a pivotal role in the global trade, regarding the production of manufactured goods and semi manufactured goods, which are mainly conveyed in containers. Hence, the specific index must be also included in the report's model in order for the influence of this trade route on the container throughput of the PoR to be examined.

Data Sources

The following table depicts the aforementioned variables as well as the sources of data.

TYPE OF VARIABLES	*VARIABLES*	*DATA SOURCES*
DEPENDENT	CONTAINER THROUGHPUT (TONNES)	DATASTREAM
INDEPENDENT	GDP (NETHERLANDS)	DATASTREAM
INDEPENDENT	CPI (NETHERLANDS)	DATASTREAM
INDEPENDENT	ESI (NETHERLANDS)	DATASTREAM
INDEPENDENT	NOM (NETHERLANDS)	DATASTREAM
INDEPENDENT	RSI (NETHERLANDS)	DATASTREAM
INDEPENDENT	PRODUCTION INDEX FOR MANUFACTURING (GERMANY)	DATASTREAM
INDEPENDENT	EXPORT OF GOODS AND SERVICES (CHINA)	DATASTREAM
INDEPENDENT	8000+ TEU FLEET DEVELOPMENT	CLARKSON
INDEPENDENT	380 CTS BUNKER PRICE AT THE POR	CLARKSON
INDEPENDENT	FREIGHT INDEX (CHINA-EUROPE)	CLARKSON

Table 3: Data Sources

Chapter 7: Methodology

As aforementioned during the introduction, the main objective of this thesis is to elaborate an integrated report, monitoring the submarket of containers. More specifically, the report provides the reader with a qualitative analysis of the port's strategic position in line with the intense competition in the Hamburg-Le Havre range. In addition, it offers an overview of the cargo flows and the port's available infrastructure, regarding the cargo handling procedures. Last but not least, the specific report comprises a detailed quantitative analysis of the container market segment at the port of Rotterdam. Within the framework of the report, the first four chapters contain the qualitative part of the inquiry and contribute to build the foundation of the subsequent quantitative analysis of the container throughput. With respect to the quantitative part of the analysis, this report tries to identify and examine macroeconomic indicators and other important variables that directly or indirectly affect the total amount of containers, handled by the port. Furthermore, chapter 5 provides the reader with a more extensive description of the variables and the main reasons for including them in the report's statistical model. For the purposes of this research, a multiple regression model will constitute the basic statistical tool, containing the identified variables as the independent variables and the port's total container throughput as the dependent variable.

Moreover, reliable databases, such as Datastream and Clarksons, have been extensively researched in order for the appropriate datasets of the identified variables to be acquired. Additionally, the reader should take into consideration the following seven key spots during the reading of the research.

a) First and foremost, the dependent variable of our model (container throughput) is in x1000 tones. In general, the throughput's figures were preferably used in tons, instead of TEUs, because the specific inquiry constitutes part of a larger project in which the various goods, flowing through the PoR, have been examined in accordance with the same statistical model. As a result, the selection of tones, as the unit of measurement, makes the model comparable with the rest models of the project.
b) In addition, the sample's time period has been defined from January 2003 to December 2012. It should be taken into account that data, which were classified on quarterly or annually basis, have been converted on a monthly basis.
c) Data for the dependent variable of the model (container throughput of the PoR) has been acquired from Datastream database via the authorized subscription of the EUR (Erasmus University Rotterdam).
d) Regarding the macroeconomic indicators, the data have been also acquired from Datastream database.
e) Moreover, data for the non-economic indicators, such as 8000+ TEU Fleet Development, 380 CTS Bunker price at the PoR and Freight Index (China-Europe), has been acquired from Clarksons via the authorized subscription of the Maritime Economics and Logistics (MEL) office. It is also remarkable that the unit of measurement for 8000+ TEU Fleet Development is in x1000 TEUs, while 380 CTS Bunker price at the PoR is presented in US Dollars/Tone.

f) Additionally, the unit of measurement for Exports of Goods and Services from China is in Euros.
g) Finally, the data for Production Index for Manufacturing in Germany, which is generally known as Industrial Production Index (IPI), has been obtained from Datastream database and only the original rates of the specific variable included in the report's statistical model.

7.1 Multiple Regression Analysis

It is generally accepted that the multiple regression model is a statistical tool, which is mostly used in order for the impact of the independent variables on a defined dependent variable to be examined. Moreover, the specific technique simply constitutes an expansion of the linear regression model in order for more than one independent variables to be allowed. Although there is a great number of applications where there has purposely been developed a model with only one independent variable, in general it is preferable to include as many independent variables as are believed to affect the dependent variable. It should be also taken into account that arbitrarily limiting the number of the independent variables also limits the usefulness of the model (Keller, 2009).

Subsequently, the multiple regression model is represented by the following equation:

$$y = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \cdots + \beta_\kappa\chi_\kappa + \varepsilon$$

Where y represents the dependent variable, $\chi_1, \chi_2, \dots, \chi_\kappa$ are the independent variables, $\beta_0, \beta_1, \dots \beta_\kappa$ are the coefficients and ε is the error variable (Keller, 2009).

For the specific report, the multiple regression model's equation will be the following:

$$CONTAINER\ THROUGHPUT\ (PoR) = \beta_0 + \beta_1 * GDP(NL) + \beta_2 * CPI(NL) + \beta_3 * ESI(NL) + \beta_4 * NOM(NL) + \beta_5 * RSI(NL) + \beta_6 * PIM(GERMANY) + \beta_7 * EXPORTS\ OF\ GOODS\ AND\ SERVICES\ (CHINA) + \beta_8 * (8000 + TEU\ FLEET\ DEVELOPMENT) + \beta_9 * 380\ CTS\ BUNKER\ PRICE\ AT\ ROTTERDAM + \beta_{10} * FREIGHT\ INDEX(CHINA - EUROPE)$$

To conclude, for the purposes of the specific model the IBM SPSS dedicated statistical software will be used. The multiple regression model should be tested through multiple trials in order for the desirable outcome to be achieved.

7.2 Time Series Analysis

It is generally known that any variable, which is measured over time in sequential order is called a time series. Within the framework of this analysis, the main objective is to analyze time series in order to detect patterns, which will be useful in order to forecast future values of the time series. More specifically, the time series forecasting is forecasting that uses historical time series data to estimate future values of variables (Keller, 2009). For the forecasting needs of the specific report, lagged variables have been plugged in the aforementioned multiple regression equation. It should be taken into consideration that the lagged variables have a pivotal role in the forecasting part of the quantitative analysis, as they enable the

multiple regression model to make future predictions. For instance, predictions about a contingent period t are strictly based on the already acquired knowledge from the previous period$(t-1)$. More specifically, during the multiple regression model analysis, the Y variable had to be regressed on the X variable. Nevertheless, in this case, the Y variable has to be regressed on $LAG(X,1)$ and$LAG(Y,1)$.

Consequently, the new form of the multiple regression equation will be the following:

$$Y(t) = \beta_0 + \beta_1\chi_1 * (t-1) + \beta_2\chi_2 * (t-1) + \cdots + \beta_\kappa\chi_\kappa * (t-1) + \varepsilon$$

To conclude, the SPSS statistical software must be used again in order to run the new type of regression equation and identify the results, regarding the dependent variable and the lag variables.

Chapter 8: Analysis and Results

8.1 Multiple Regression Analysis Results

The specific subchapter comprises the interpretation of the results of the multiple regression model. Within the framework of chapter 6, several variables have been described. Therefore, all the aforementioned variables plugged in the multiple regression model in order for the impact of the independent variables on the dependent variable to be tested. It should be also taken into account that 2 out of 10 independent variables were excluded from the model, because after several trials they were considered as non-significant. The excluded variables are the Retail Sales Index (NL) and the China-Europe Freight Index. First of all, the following table is of fundamental interest, as it includes useful information, regarding the statistical significance of the model.

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2,315E8	8	28932646,093	519,365	,000[a]
	Residual	6183564,093	111	55707,785		
	Total	2,376E8	119			

a. Predictors: (Constant), GROSS DOMESTIC PRODUCT NETHERLANDS, ECONOMIC SENTIMENT INDICATOR NL, 380 CTS BUNKER PRICE ROTTERDAM, PRODUCTION INDEX FOR MANUFACTURING GERMANY, 8K+ TEU FLEET DEVELOPMENT, EXPORTS OF GOODS AND SERVICES CHINA, NEW ORDER MANUFACTURING NL, CONSUMER PRICE INDEX NL

b. Dependent Variable: CONTAINER THROUGHPUT PoR

Table 4: Multiple Regression ANOVA (2003-2012)

Generally, the Multiple Regression ANOVA table illustrates how well the model fits. The significance test ("Sig") is much less than 0.05, which typically means that is less than 5 percent of type 1 error rate or 5 percent false positive rate. Hence, the specific model is considered as a tight and statistically significant model, which is able to explain the deviations of the dependent variable.

Subsequently, another important table is the Multiple Regression Descriptive Statistics table, which provides the reader with useful information about the mean, the standard deviation and the number of observations (N) of the data used.

Descriptive Statistics

	Mean	Std. Deviation	N
CONTAINER THROUGHPUT PoR	8437,5250	1413,15766	120
380 CTS BUNKER PRICE ROTTERDAM	371,3724	176,29690	120
8K+ TEU FLEET DEVELOPMENT	1737,9809	1341,25103	120
EXPORTS OF GOODS AND SERVICES CHINA	1011,5273	450,36879	120
CONSUMER PRICE INDEX NL	34,3685	1,68306	120
ECONOMIC SENTIMENT INDICATOR NL	32,6147	3,79907	120
NEW ORDER MANUFACTURING NL	32,6598	1,71975	120
PRODUCTION INDEX FOR MANUFACTURING GERMANY	33,1088	2,66368	120
GROSS DOMESTIC PRODUCT NETHERLANDS	51121,4260	2442,58654	120

Table 5: Multiple Regression Descriptive Statistics (2003-2012)

According to the table, the mean of the dependent variable (Container Throughput PoR) from 2003 to 2012 is 8437.5250 (x1000 tonnes) per month. In addition, it is remarkable that the units of measurement are different for each of the variables. For instance, the Economic Sentiment Indicator (NL), the Consumer Price Index (NL), the New Order Manufacturing (NL) and the Production Index for Manufacturing (NL) are all macroeconomic indicators. The unit of measurement of 8K+ TEU Fleet Development is in 1000 TEUs, while the 380 CTS Bunker Price Rotterdam is measured in US $/Tonne. Moreover, the Exports of Goods and Services (CHINA) and the Gross Domestic Product (NL) are both measured in million Euros. Furthermore, the column of the standard deviation indicates the fluctuations of the variables. There has been observed high spreads for the dependent variable, because the container throughput passes through seasonal cycles. For the same reason, high spreads are also presented in the Exports of Goods and Services (CHINA) and the Gross Domestic Product (NL). Additionally, 8K+ TEU Fleet Development indicates relatively high spreads, because of the fact that the

construction of increasingly larger vessels is a recent trend. The last column of the table depicts the total number of observations, which are included in the model. For the purposes of this report, the data, which was selected, was modified on a monthly basis for 10 years. As a result, 10 years x 12 months (per year) = 120 observations.

Correlations

		CONTAINER THROUGHPUT PoR	380 CTS BUNKER PRICE ROTTERDAM	8K+ TEU FLEET DEVELOPMENT
Pearson Correlation	CONTAINER THROUGHPUT PoR	1,000	,927	,902
	380 CTS BUNKER PRICE ROTTERDAM	,927	1,000	,890
	8K+ TEU FLEET DEVELOPMENT	,902	,890	1,000
	EXPORTS OF GOODS AND SERVICES CHINA	,950	,912	,939
	CONSUMER PRICE INDEX NL	,926	,903	,989
	ECONOMIC SENTIMENT INDICATOR NL	,140	,035	-,211
	NEW ORDER MANUFACTURING NL	,852	,779	,650
	PRODUCTION INDEX FOR MANUFACTURING GERMANY	,788	,754	,591
	GROSS DOMESTIC PRODUCT NETHERLANDS	,868	,817	,755
Sig. (1-tailed)	CONTAINER THROUGHPUT PoR	.	,000	,000
	380 CTS BUNKER PRICE ROTTERDAM	,000	.	,000

	8K+ TEU FLEET DEVELOPMENT	,000	,000	.
	EXPORTS OF GOODS AND SERVICES CHINA	,000	,000	,000
	CONSUMER PRICE INDEX NL	,000	,000	,000
	ECONOMIC SENTIMENT INDICATOR NL	,063	,353	,010
	NEW ORDER MANUFACTURING NL	,000	,000	,000
	PRODUCTION INDEX FOR MANUFACTURING GERMANY	,000	,000	,000
	GROSS DOMESTIC PRODUCT NETHERLANDS	,000	,000	,000
N	CONTAINER THROUGHPUT PoR	120	120	120
	380 CTS BUNKER PRICE ROTTERDAM	120	120	120
	8K+ TEU FLEET DEVELOPMENT	120	120	120
	EXPORTS OF GOODS AND SERVICES CHINA	120	120	120
	CONSUMER PRICE INDEX NL	120	120	120
	ECONOMIC SENTIMENT INDICATOR NL	120	120	120
	NEW ORDER MANUFACTURING NL	120	120	120
	PRODUCTION INDEX FOR MANUFACTURING GERMANY	120	120	120

	GROSS DOMESTIC PRODUCT NETHERLANDS	120	120	120

Correlations

		EXPORTS OF GOODS AND SERVICES CHINA	CONSUMER PRICE INDEX NL	ECONOMIC SENTIMENT INDICATOR NL	NEW ORDER MANUFACTURING NL
Pearson Correlation	CONTAINER THROUGHPUT PoR	,950	,926	,140	,852
	380 CTS BUNKER PRICE ROTTERDAM	,912	,903	,035	,779
	8K+ TEU FLEET DEVELOPMENT	,939	,989	-,211	,650
	EXPORTS OF GOODS AND SERVICES CHINA	1,000	,946	,000	,784
	CONSUMER PRICE INDEX NL	,946	1,000	-,191	,675
	ECONOMIC SENTIMENT INDICATOR NL	,000	-,191	1,000	,528
	NEW ORDER MANUFACTURING NL	,784	,675	,528	1,000
	PRODUCTION INDEX FOR MANUFACTURING GERMANY	,740	,603	,548	,964
	GROSS DOMESTIC PRODUCT NETHERLANDS	,834	,809	,182	,864

Sig. (1-tailed)	CONTAINER THROUGHPUT PoR	,000	,000	,063	,000
	380 CTS BUNKER PRICE ROTTERDAM	,000	,000	,353	,000
	8K+ TEU FLEET DEVELOPMENT	,000	,000	,010	,000
	EXPORTS OF GOODS AND SERVICES CHINA	.	,000	,498	,000
	CONSUMER PRICE INDEX NL	,000	.	,018	,000
	ECONOMIC SENTIMENT INDICATOR NL	,498	,018	.	,000
	NEW ORDER MANUFACTURING NL	,000	,000	,000	.
	PRODUCTION INDEX FOR MANUFACTURING GERMANY	,000	,000	,000	,000
	GROSS DOMESTIC PRODUCT NETHERLANDS	,000	,000	,023	,000
N	CONTAINER THROUGHPUT PoR	120	120	120	120
	380 CTS BUNKER PRICE ROTTERDAM	120	120	120	120
	8K+ TEU FLEET DEVELOPMENT	120	120	120	120
	EXPORTS OF GOODS AND SERVICES CHINA	120	120	120	120
	CONSUMER PRICE INDEX NL	120	120	120	120

	ECONOMIC SENTIMENT INDICATOR NL	120	120	120	120
	NEW ORDER MANUFACTURING NL	120	120	120	120
	PRODUCTION INDEX FOR MANUFACTURING GERMANY	120	120	120	120
	GROSS DOMESTIC PRODUCT NETHERLANDS	120	120	120	120

Correlations

		PRODUCTION INDEX FOR MANUFACTURING GERMANY	GROSS DOMESTIC PRODUCT NETHERLANDS
Pearson Correlation	CONTAINER THROUGHPUT PoR	,788	,868
	380 CTS BUNKER PRICE ROTTERDAM	,754	,817
	8K+ TEU FLEET DEVELOPMENT	,591	,755
	EXPORTS OF GOODS AND SERVICES CHINA	,740	,834
	CONSUMER PRICE INDEX NL	,603	,809
	ECONOMIC SENTIMENT INDICATOR NL	,548	,182

	NEW ORDER MANUFACTURING NL	,964	,864
	PRODUCTION INDEX FOR MANUFACTURING GERMANY	1,000	,775
	GROSS DOMESTIC PRODUCT NETHERLANDS	,775	1,000
Sig. (1-tailed)	CONTAINER THROUGHPUT PoR	,000	,000
	380 CTS BUNKER PRICE ROTTERDAM	,000	,000
	8K+ TEU FLEET DEVELOPMENT	,000	,000
	EXPORTS OF GOODS AND SERVICES CHINA	,000	,000
	CONSUMER PRICE INDEX NL	,000	,000
	ECONOMIC SENTIMENT INDICATOR NL	,000	,023
	NEW ORDER MANUFACTURING NL	,000	,000
	PRODUCTION INDEX FOR MANUFACTURING GERMANY	.	,000
	GROSS DOMESTIC PRODUCT NETHERLANDS	,000	.
N	CONTAINER THROUGHPUT PoR	120	120
	380 CTS BUNKER PRICE ROTTERDAM	120	120
	8K+ TEU FLEET DEVELOPMENT	120	120

	EXPORTS OF GOODS AND SERVICES CHINA	120	120
	CONSUMER PRICE INDEX NL	120	120
	ECONOMIC SENTIMENT INDICATOR NL	120	120
	NEW ORDER MANUFACTURING NL	120	120
	PRODUCTION INDEX FOR MANUFACTURING GERMANY	120	120
	GROSS DOMESTIC PRODUCT NETHERLANDS	120	120

Table 6: Multiple Regression Correlations (2003-2012)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,987[a]	,974	,972	236,02497

Model Summary[b]

Model	Change Statistics				
	R Square Change	F Change	df1	df2	Sig. F Change
1	,974	519,365	8	111	,000

a. Predictors: (Constant), GROSS DOMESTIC PRODUCT NETHERLANDS, ECONOMIC SENTIMENT INDICATOR NL, 380 CTS BUNKER PRICE ROTTERDAM, PRODUCTION INDEX FOR MANUFACTURING GERMANY, 8K+ TEU FLEET DEVELOPMENT, EXPORTS OF GOODS AND SERVICES CHINA, NEW ORDER MANUFACTURING NL, CONSUMER PRICE INDEX NL

b. Dependent Variable: CONTAINER THROUGHPUT PoR

Table 7: Multiple Regression Model Summary (2003-2012)

According to the information of table 7, which illustrates the Multiple Regression Model Summary, there has been observed a very high multiple correlation coefficient (R=0.987), which typically means that the variables are highly correlated and can predict changes in the container throughput accurately. In addition, the interpretation of the value of "R Square" is that 97.4 percent of the variance in container throughput can be predicted by the combination of these 9 variables, which have already been used. Moreover, the "Adjusted R Square" takes into consideration the number of observations and the number of predictor variables and, in this case, indicates that 97.2 percent of the variation in the dependent variable is reflected by the variation in the independent variables. Furthermore, another important value is the "Standard Error of the Estimate", which is 236.02497 in this model. It is remarkable that this number indicates how much the dependent variable spreads around its mean. As aforementioned, the mean of the dependent variable is 8437.5250. Therefore, the "Standard Error of the Estimate" with a value of 236.02497 constitutes mere 2.8 percent of the total mean of the dependent variable. Since the value of the "Standard Error of the Estimate" is less than 10 percent, the model's credibility does not be affected.

Coefficients[a]

Model		Unstandardized Coefficients	
		B	Std. Error
1	(Constant)	-29028,034	3730,845
	380 CTS BUNKER PRICE ROTTERDAM	1,350	,369
	8K+ TEU FLEET DEVELOPMENT	-,594	,139
	EXPORTS OF GOODS AND SERVICES CHINA	,672	,199
	CONSUMER PRICE INDEX NL	986,609	128,913
	ECONOMIC SENTIMENT INDICATOR NL	69,975	15,184
	NEW ORDER MANUFACTURING NL	272,245	90,700

	PRODUCTION INDEX FOR MANUFACTURING GERMANY	-90,434	38,895
	GROSS DOMESTIC PRODUCT NETHERLANDS	-,093	,031

Coefficients[a]

Model		Standardized Coefficients		
		Beta	t	Sig.
1	(Constant)		-7,781	,000
	380 CTS BUNKER PRICE ROTTERDAM	,168	3,657	,000
	8K+ TEU FLEET DEVELOPMENT	-,564	-4,269	,000
	EXPORTS OF GOODS AND SERVICES CHINA	,214	3,376	,001
	CONSUMER PRICE INDEX NL	1,175	7,653	,000
	ECONOMIC SENTIMENT INDICATOR NL	,188	4,608	,000
	NEW ORDER MANUFACTURING NL	,331	3,002	,003
	PRODUCTION INDEX FOR MANUFACTURING GERMANY	-,170	-2,325	,022
	GROSS DOMESTIC PRODUCT NETHERLANDS	-,161	-3,026	,003

Table 8: Multiple Regression Coefficients (2003-2012)

According to table 8, the multiple regression equation will be as follows:

$$y = -29028.034 + 1.350\chi_1 - 0.594\chi_2 + 0.672\chi_3 + 986.609\chi_4 + 69.975\chi_5 + 272.245\chi_6 - 90.434\chi_7 - 0.093\chi_8 + \varepsilon$$

Where:

$\rightarrow \chi_1 = 380$ CTS BUNKER PRICE ROTTERDAM

$\rightarrow \chi_2 = 8\text{K} +$ TEU FLEET DEVELOPMENT

$\rightarrow \chi_3 =$ EXPORTS OF GOODS AND SERVICES (CHINA)

$\rightarrow \chi_4 =$ CONSUMER PRICE INDEX (NL)

$\rightarrow \chi_5 =$ ECONOMIC SENTIMENT INDICATOR (NL)

$\rightarrow \chi_6 =$ NEW ORDER MANUFACTURING (NL)

$\rightarrow \chi_7 =$ PRODUCTION INDEX FOR MANUFACTURING (GERMANY)

$\rightarrow \chi_8 =$ GROSS DOMESTIC PRODUCT (NL)

Subsequently, the hypothesis, stated in chapter 5 of this report, can be tested in accordance with the results of “t statistic”, which are included in table 8.

Hypothesis 1

The Gross Domestic Product (GDP) of the Netherlands and the Container Throughput of the PoR are positively correlated.

The hypothesis is not valid, as there has been observed a negative correlation between the Gross Domestic Product (GDP) of the Netherlands and the Container Throughput of the PoR. According to the initial hypothesis, the port of Rotterdam is characterized as a major commercial node, because it is the source of the largest amount of imports and exports throughout the Dutch economy. As a result, the GDP is considered as an indicator of major importance, which provides the reader with a general view about how the country’s economy influences the container throughput of the port. Furthermore, it has been clearly stated in chapter 6 that containers are not only used for the carriage of final goods, but also for the transportation of raw materials and semi manufactured commodities. Nevertheless, the initial hypothesis has been rejected, which typically means that a decrease in the value of GDP (NL) equals to higher container throughput. The basic reason for this trend is that the average GDP multiplier, which is the amount by which GDP growth is multiplied to equal container growth, for the last five years had fallen to 1.8, while, historically, it stood at a level between two and four. The rapid increase in trade protectionism contributed to the reduction of the GDP multiplier. There has also been observed that trade protectionism strongly affects trade among countries more than general economic growth. In addition, there are also other determinants, which could impact the multiplier, although to a lesser extent than the removal or introduction of trade barriers. For instance, the increased complexity of the supply chain as different areas of the world developed manufacturing specializations. Furthermore, nearshoring, as production moves closer to final market, could increase the need to directly convey raw materials to the point of production. Last but not least, infrastructure developments could facilitate growth, while a shift from air transport to ocean transport for certain kinds of products is also possible (Lloyd's list, 2014).

Hypothesis 2

The Consumer Price Index (CPI) of the Netherlands and the Container Throughput of the PoR are negatively correlated.

There has been observed a strong positive relationship between the Container Throughput of the PoR and the Consumer Price Index (NL). Hence, the specific hypothesis is not valid. The CPI basically measures the overall prices of the goods and services bought by the average consumer. Therefore, a high CPI indicates that

the prices of goods and services are relatively high in the economy. The initial hypothesis was based on the fact that the higher the costs of living in a society the less goods and services the citizens will be able to consume, which indirectly means less container throughput. Nevertheless, the model presents a positive relationship between the two variables due to the fact that most of the manufactured and semi manufactured commodities, nowadays, are globally transported via containers. As a result, countries with high CPI are more likely to have increased container throughput, because the products' prices are higher and producers make more marginal profit by selling their products in the specific economy.

Hypothesis 3

The Economic Sentiment Indicator (ESI) of the Netherlands and the Container Throughput of the PoR are positively correlated.

The hypothesis is confirmed, because table 8 depicts a positive relationship between the Economic Sentiment Indicator (ESI) and the Container Throughput of the PoR. According to the initial hypothesis, if consumers and manufacturers feel confident, regarding the current and future general economic and own financial situation, then they are eager to increase their consumption and production respectively. In this sense, ESI is defined as an indicator of future economic activity. Therefore, the positive relationship between the two variables indicates that consumers and producers feel more confident and this fact is the main driver, which rapidly increases the consumption and production respectively, resulting in higher container throughput.

Hypothesis 4

The New Order Manufacturing index (NOM) of the Netherlands and the Container Throughput of the PoR are positively correlated.

The hypothesis is confirmed, because there is a positive relationship between the New Order Manufacturing (NOM) index and the Container Throughput of the PoR. With respect to the initial hypothesis, containers are widely used for the transportation of high value commodities, manufactured in different production plants throughout the Netherlands. Moreover, these goods are equally important for the country's exports and imports, as the containers are also used for the carriage of Semi Knock Down (SKD) parts, which are necessary for the assembly stage, before the completion of the final product. Subsequently, the final products are exported to the global markets. Hence, higher NOM index results in higher container throughput.

Hypothesis 6

Germany's Production Index for Manufacturing and the Container Throughput of the PoR are positively correlated.

It is considerable that the specific hypothesis is not valid as there is a negative correlation between Germany's Production Index for Manufacturing and the Container Throughput of the PoR. According to the model's results, an increase/decrease in Germany's Production Index for Manufacturing results in lower/higher container throughput respectively. The possible interpretation of this outcome is that Germany's most imported and exported commodities cannot be containerized. It is generally accepted that the largest part of the country's economy relies on the heavy industry. The most important imported goods are crude oil, petroleum gas and cars, while the largest percent of the exported goods belongs to cars.

Hypothesis 7

The Export of Goods and Services from China and the Container Throughput of the PoR are positively correlated.

There has been observed a positive relationship between the Export of Goods and Services from China and the Container Throughput of the PoR. Therefore, the hypothesis is valid. As aforementioned, the Far East/Europe trade route has been proved the most profitable trade lane for the liner shipping companies. Moreover, during the last decade, China has become a major power house, regarding the manufacturing sector. This country is basically considered as a major exporter, who feeds the European market with finished goods and various compartments. Hence, a vast amount of containers, imported in Rotterdam come from China. As a result, increased amounts of exported products and services from China result in higher container throughput.

Hypothesis 8

8000+ TEU container fleet development and the Container Throughput of the PoR are positively correlated.

The specific hypothesis is not valid as there has been observed a negative relationship between the 8000+ TEU container fleet development and the Container Throughput of the PoR. In line with the initial hypothesis, it was expected a positive correlation between the two variables, because of the unrestricted draught of the port's container terminals, which are directly located on the North Sea. In addition, another important factor that enhanced this expectation is that, nowadays, the specific deep-sea terminals are equipped with state of the art facilities, offering cargo handling services to the world's largest vessels. Nevertheless, the initial hypothesis is not accepted and the basic reason is that the exploitation of larger ships by the liner shipping companies seems to be a relatively new trend. Therefore, it is expected that the correlation will become positive in the near future as increasingly more large vessels are constructed, which will successfully replace the already existing smaller vessels.

Hypothesis 9

380 CTS bunker price at Rotterdam and the Container Throughput of the PoR are positively correlated.

The hypothesis is confirmed, because there is a positive relationship between the 380 CTS bunker price at Rotterdam variable and the Container Throughput of the PoR. The main idea behind the initial hypothesis was that the port of Rotterdam is capable of selling bunker fuel oil at low prices in comparison with the other ports,

which act in the same region, due to three major attributes. As aforementioned, the main characteristics are the harbor's unlimited depth, enabling the largest vessels to call at the port, the favorable strategic location, which allows cheap heavy fuel oil imports from Russia and the Baltic States and the bunker production at the local refineries. Moreover, it is remarkable that the largest part of the vessel's operational costs depends on the bunkering costs. Therefore, the initial hypothesis is well-supported by the model's results. The port of Rotterdam is defined as an attractive commercial node, due to its special attributes, offering inexpensive fuels, which typically results in higher container traffic.

Thereafter, the following plots are typically used in order for the assumption of heteroscedasticity to be tested. It should be also taken into consideration that heteroscedasticity is present, when the variance associated with the residuals of the dependent variable are not homogenous across all levels of the independent variables. Hence, it is crucial that the strength of the prediction of the regression equation should be equally strong across all levels of the independent variables. Regarding the specific report, the histogram illustrates that the variables are normally distributed. On the contrary, the scatterplot stresses the existence of heteroscedasticity as there has been observed little homogeneity across all levels of the independent variables.

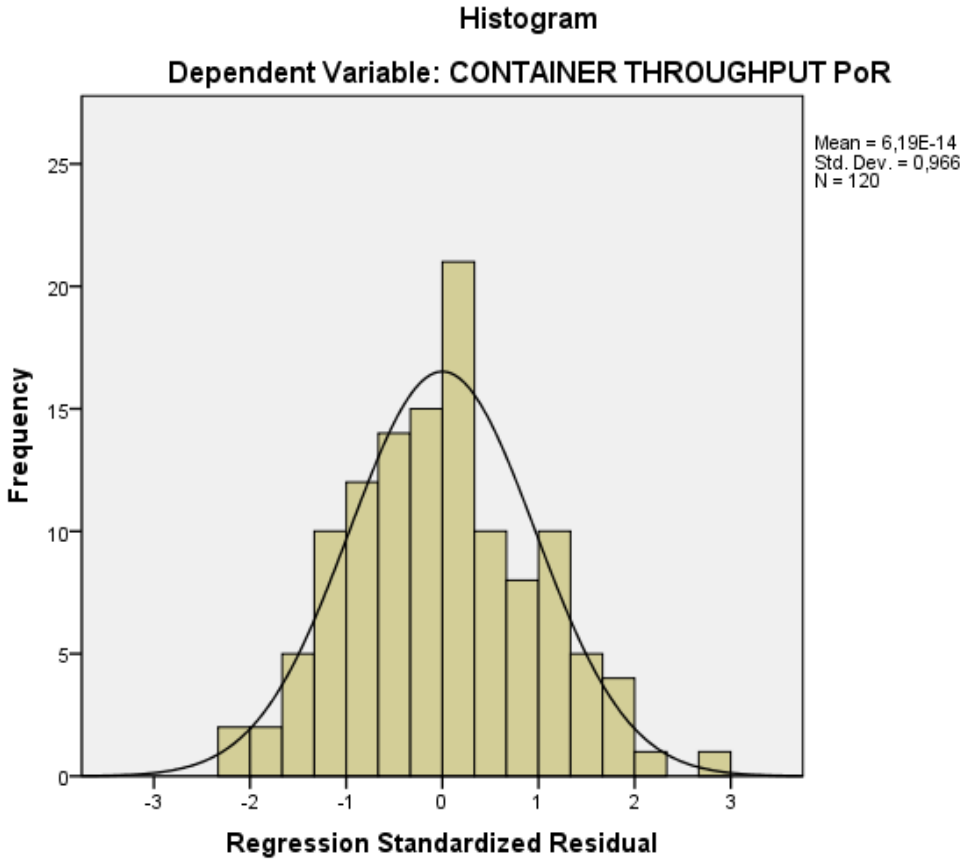

Figure 2: Histogram (Multiple Regression 2003-2012)

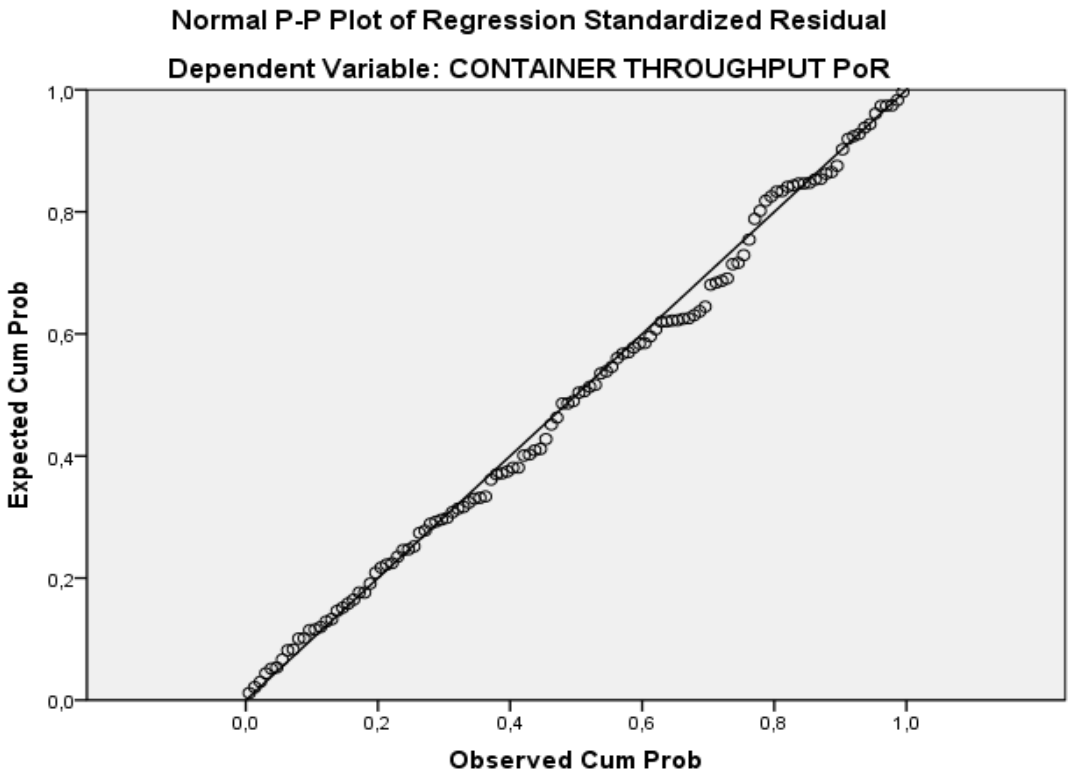

Figure 3: Normal P-P Plot of Regression Standardized Residual (Multiple Regression 2003-2012)

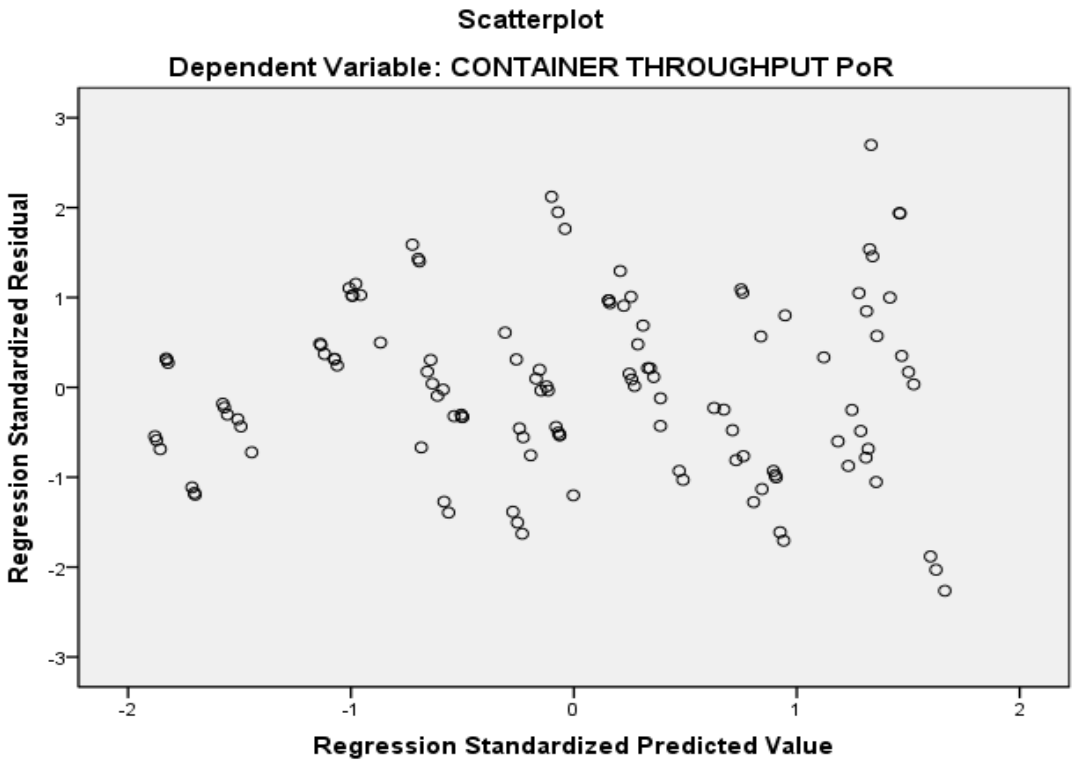

Figure 4: Scatterplot (Multiple Regression 2003-2012)

8.2 Multiple Regression Analysis Results - Economic Crisis

The main objective of the specific subchapter is to examine the impact of the economic crisis on the market segment of containers. Therefore, the initial sample must be divided into two subsets. The first one will include the time period 2003-2008, including the recession, while the second takes into consideration the time period 2009-2012, where the economic recovery started.

Time period: 2003-2008

Regarding the first time period, it should be taken into account that 4 out of 10 independent variables were excluded from the model after multiple trials. The non-significant variables are the 380 CTS Bunker Price at Rotterdam, the Retail Sales Indicator (NL), the Production Index for Manufacturing (Germany) and the Gross Domestic Product (NL). The following table depicts the statistical significance of the model for the specific time period.

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	82957125,331	6	13826187,555	623,942	,000[a]
	Residual	1440361,814	65	22159,413		
	Total	84397487,144	71			

a. Predictors: (Constant), CHINA-EUROPE FREIGHT INDEX, ECONOMIC SENTIMENT INDICATOR NL, 8K+ TEU FLEET DEVELOPMENT, EXPORTS OF GOODS AND SERVICES CHINA, CONSUMER PRICE INDEX NL, NEW ORDER MANUFACTURING NL

b. Dependent Variable: CONTAINER THROUGHPUT PoR

Table 9: Multiple Regression ANOVA (2003-2008)

According to the Multiple Regression ANOVA (2003-2008) table, the model presents augmented statistical significance as the value of the significance test ("Sig") is 0.00, which is much less than 0.05. Similar to the previous model, the new one is also able to explain the deviations of the dependent variable accurately.

Thereafter, more information about the mean, the standard deviation and the number of observations (N) are illustrated in the Multiple Regression Descriptive Statistics (2003-2008) table.

Descriptive Statistics

	Mean	Std. Deviation	N

CONTAINER THROUGHPUT PoR	7653,9721	1090,27382	72
8K+ TEU FLEET DEVELOPMENT	806,2649	588,95997	72
EXPORTS OF GOODS AND SERVICES CHINA	751,5582	307,90762	72
CONSUMER PRICE INDEX NL	33,2121	,92322	72
ECONOMIC SENTIMENT INDICATOR NL	33,9704	3,34640	72
NEW ORDER MANUFACTURING NL	32,2504	1,81895	72
CHINA-EUROPE FREIGHT INDEX	1475,5556	162,75367	72

Table 10: Multiple Regression Descriptive Statistics (2003-2008)

According to the new table, the mean of the dependent variable (Container Throughput PoR) from 2003 to 2008 is much lower than before. The new value is approximately 7654 (x1000 tonnes) per month. As aforementioned, the column of the standard deviation indicates the fluctuations of the variables. The dependent variable, the Exports of Goods and Services (CHINA) as well as a new additional variable, China-Europe Freight Index, present relatively high spreads, because of the seasonal cycles of the container market segment. Nevertheless, the independent variable of the Gross Domestic Product (NL), which also indicated high spreads in the previous analysis, has been defined as a non-significant variable from the beginning and therefore it is not included in the above table. Similar to the 10 year period analysis, 8K+ TEU Fleet Development indicates relatively high spreads, because of the fact that the construction of increasingly larger vessels is a recent trend. To conclude, the total number of observations is depicted in the last column. The selected data was modified on a monthly basis for 6 years. As a result, 6 years x 12 months (per year) = 72 observations.

Correlations

		CONTAINER THROUGHPUT PoR	8K+ TEU FLEET DEVELOPMENT	EXPORTS OF GOODS AND SERVICES CHINA
Pearson Correlation	CONTAINER THROUGHPUT PoR	1,000	,883	,931

	8K+ TEU FLEET DEVELOPMENT	,883	1,000	,959
	EXPORTS OF GOODS AND SERVICES CHINA	,931	,959	1,000
	CONSUMER PRICE INDEX NL	,931	,972	,969
	ECONOMIC SENTIMENT INDICATOR NL	,723	,488	,549
	NEW ORDER MANUFACTURING NL	,952	,894	,898
	CHINA-EUROPE FREIGHT INDEX	,152	,021	,075
Sig. (1-tailed)	CONTAINER THROUGHPUT PoR	.	,000	,000
	8K+ TEU FLEET DEVELOPMENT	,000	.	,000
	EXPORTS OF GOODS AND SERVICES CHINA	,000	,000	.
	CONSUMER PRICE INDEX NL	,000	,000	,000
	ECONOMIC SENTIMENT INDICATOR NL	,000	,000	,000
	NEW ORDER MANUFACTURING NL	,000	,000	,000
	CHINA-EUROPE FREIGHT INDEX	,101	,429	,266
N	CONTAINER THROUGHPUT PoR	72	72	72
	8K+ TEU FLEET DEVELOPMENT	72	72	72

	EXPORTS OF GOODS AND SERVICES CHINA	72	72	72
	CONSUMER PRICE INDEX NL	72	72	72
	ECONOMIC SENTIMENT INDICATOR NL	72	72	72
	NEW ORDER MANUFACTURING NL	72	72	72
	CHINA-EUROPE FREIGHT INDEX	72	72	72

Correlations

		CONSUMER PRICE INDEX NL	ECONOMIC SENTIMENT INDICATOR NL
Pearson Correlation	CONTAINER THROUGHPUT PoR	,931	,723
	8K+ TEU FLEET DEVELOPMENT	,972	,488
	EXPORTS OF GOODS AND SERVICES CHINA	,969	,549
	CONSUMER PRICE INDEX NL	1,000	,500
	ECONOMIC SENTIMENT INDICATOR NL	,500	1,000
	NEW ORDER MANUFACTURING NL	,885	,785
	CHINA-EUROPE FREIGHT INDEX	,041	-,008
Sig. (1-tailed)	CONTAINER THROUGHPUT PoR	,000	,000

	8K+ TEU FLEET DEVELOPMENT	,000	,000
	EXPORTS OF GOODS AND SERVICES CHINA	,000	,000
	CONSUMER PRICE INDEX NL	.	,000
	ECONOMIC SENTIMENT INDICATOR NL	,000	.
	NEW ORDER MANUFACTURING NL	,000	,000
	CHINA-EUROPE FREIGHT INDEX	,365	,475
N	CONTAINER THROUGHPUT PoR	72	72
	8K+ TEU FLEET DEVELOPMENT	72	72
	EXPORTS OF GOODS AND SERVICES CHINA	72	72
	CONSUMER PRICE INDEX NL	72	72
	ECONOMIC SENTIMENT INDICATOR NL	72	72
	NEW ORDER MANUFACTURING NL	72	72
	CHINA-EUROPE FREIGHT INDEX	72	72

Correlations

		NEW ORDER MANUFACTURING NL	CHINA-EUROPE FREIGHT INDEX
Pearson Correlation	CONTAINER THROUGHPUT PoR	,952	,152
	8K+ TEU FLEET DEVELOPMENT	,894	,021
	EXPORTS OF GOODS AND SERVICES CHINA	,898	,075
	CONSUMER PRICE INDEX NL	,885	,041
	ECONOMIC SENTIMENT INDICATOR NL	,785	-,008
	NEW ORDER MANUFACTURING NL	1,000	,146
	CHINA-EUROPE FREIGHT INDEX	,146	1,000
Sig. (1-tailed)	CONTAINER THROUGHPUT PoR	,000	,101
	8K+ TEU FLEET DEVELOPMENT	,000	,429
	EXPORTS OF GOODS AND SERVICES CHINA	,000	,266
	CONSUMER PRICE INDEX NL	,000	,365
	ECONOMIC SENTIMENT INDICATOR NL	,000	,475
	NEW ORDER MANUFACTURING NL	.	,110
	CHINA-EUROPE FREIGHT INDEX	,110	.

N	CONTAINER THROUGHPUT PoR	72	72
	8K+ TEU FLEET DEVELOPMENT	72	72
	EXPORTS OF GOODS AND SERVICES CHINA	72	72
	CONSUMER PRICE INDEX NL	72	72
	ECONOMIC SENTIMENT INDICATOR NL	72	72
	NEW ORDER MANUFACTURING NL	72	72
	CHINA-EUROPE FREIGHT INDEX	72	72

Table 11: Multiple Regression Correlations (2003-2008)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,991[a]	,983	,981	148,86038

Model Summary[b]

Model	Change Statistics				
	R Square Change	F Change	df1	df2	Sig. F Change
1	,983	623,942	6	65	,000

a. Predictors: (Constant), CHINA-EUROPE FREIGHT INDEX, ECONOMIC SENTIMENT INDICATOR NL, 8K+ TEU FLEET DEVELOPMENT, EXPORTS OF GOODS AND SERVICES CHINA, CONSUMER PRICE INDEX NL, NEW ORDER MANUFACTURING NL

b. Dependent Variable: CONTAINER THROUGHPUT PoR

Table 12: Multiple Regression Model Summary (2003-2008)

Table 12 illustrates the Multiple Regression Model Summary (2003-2008). Similar to the previous analysis, the multiple correlation coefficient (R=0.991) is very high, which means that accurate predictions, concerning the changes in container throughput can be achieved. Moreover, the value of “R Square” means that 98.3 percent of the variance in container throughput can be predicted by the combination of these 7 variables. Furthermore, the “Adjusted R Square” indicates that 98.1 percent of the variation in the dependent variable is reflected by the variation in the independent variables. According to table 10, the mean of the dependent variable is 7653.9721. Hence, the “Standard Error of the Estimate” with a value of 148.86038 constitutes approximately 1.9 percent of the total mean of the dependent variable. Since the value of the “Standard Error of the Estimate” does not exceed 10 percent, the model can be considered as reliable.

Coefficients[a]

Model		Unstandardized Coefficients	
		B	Std. Error
1	(Constant)	-39593,009	3258,718
	8K+ TEU FLEET DEVELOPMENT	-1,310	,193
	EXPORTS OF GOODS AND SERVICES CHINA	,797	,264
	CONSUMER PRICE INDEX NL	1131,033	98,812
	ECONOMIC SENTIMENT INDICATOR NL	44,182	18,096
	NEW ORDER MANUFACTURING NL	252,500	66,279
	CHINA-EUROPE FREIGHT INDEX	,336	,152

Coefficients[a]

Model		Standardized Coefficients		
		Beta	t	Sig.
1	(Constant)		-12,150	,000

8K+ TEU FLEET DEVELOPMENT	-,708	-6,780	,000
EXPORTS OF GOODS AND SERVICES CHINA	,225	3,017	,004
CONSUMER PRICE INDEX NL	,958	11,446	,000
ECONOMIC SENTIMENT INDICATOR NL	,136	2,442	,017
NEW ORDER MANUFACTURING NL	,421	3,810	,000
CHINA-EUROPE FREIGHT INDEX	,050	2,219	,030

Table 13: Multiple Regression Coefficients (2003-2008)

According to table 13, the new multiple regression equation for the time period 2003-2008 will be as follows:

$$y = -39593.009 - 1.310\chi_1 + 0.797\chi_2 + 1131.033\chi_3 + 44.182\chi_4 + 252.500\chi_5 + 0.336\chi_6 + \varepsilon$$

Where:

$\rightarrow \chi_1 = 8\text{K} + \text{ TEU FLEET DEVELOPMENT}$

$\rightarrow \chi_2 = \text{EXPORTS OF GOODS AND SERVICES (CHINA)}$

$\rightarrow \chi_3 = \text{CONSUMER PRICE INDEX (NL)}$

$\rightarrow \chi_4 = \text{ECONOMIC SENTIMENT INDICATOR (NL)}$

$\rightarrow \chi_5 = \text{NEW ORDER MANUFACTURING (NL)}$

$\rightarrow \chi_6 = \text{CHINA} - \text{EUROPE FREIGHT INDEX}$

Subsequently, the new charts depicts to a great extent that the phenomenon of heteroscedasticity is present, while the variables are not normally distributed.

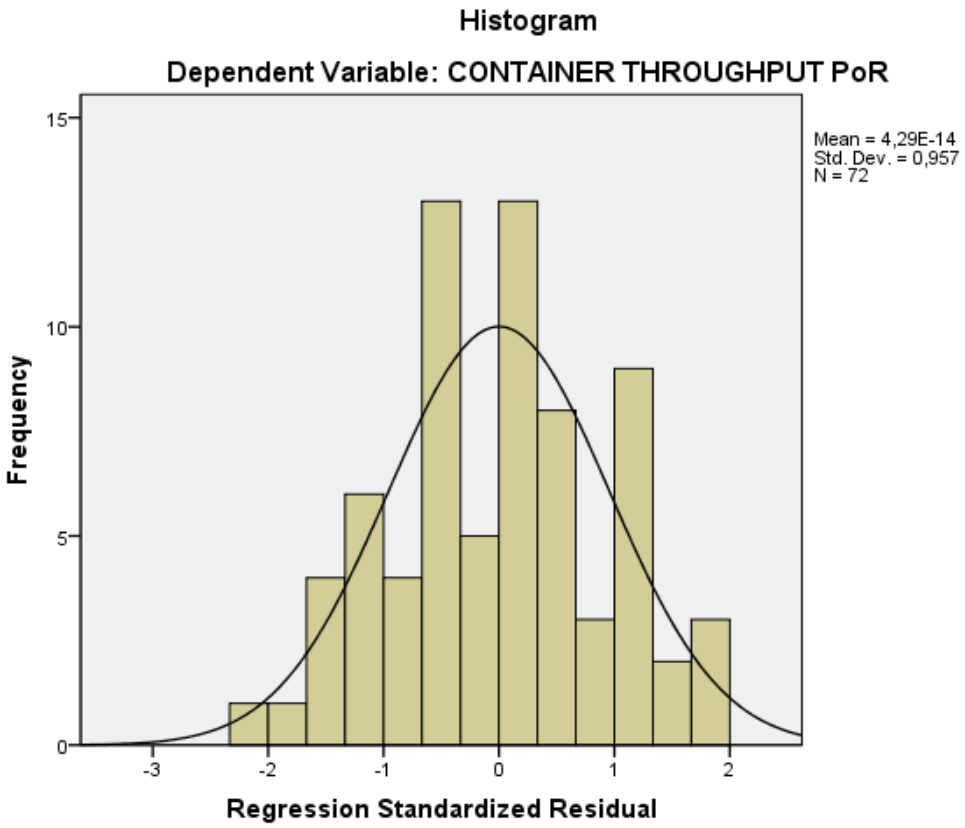

Figure 5: Histogram (Multiple Regression 2003-2008)

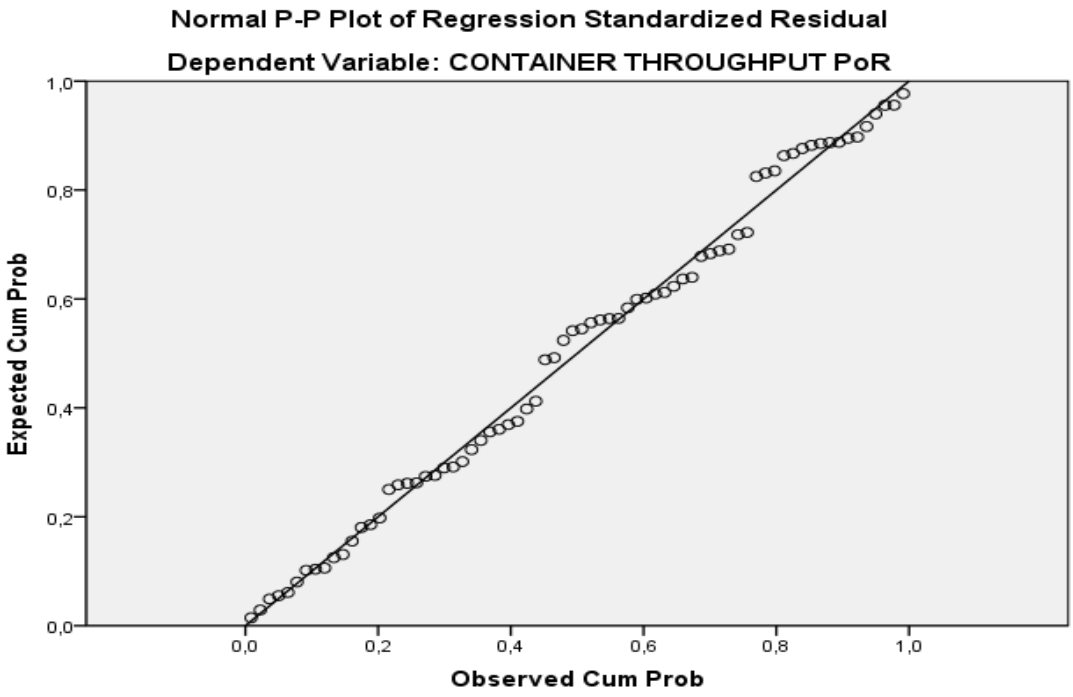

Figure 6: Normal P-P Plot of Regression Standardized Residual (Multiple Regression 2003-2008)

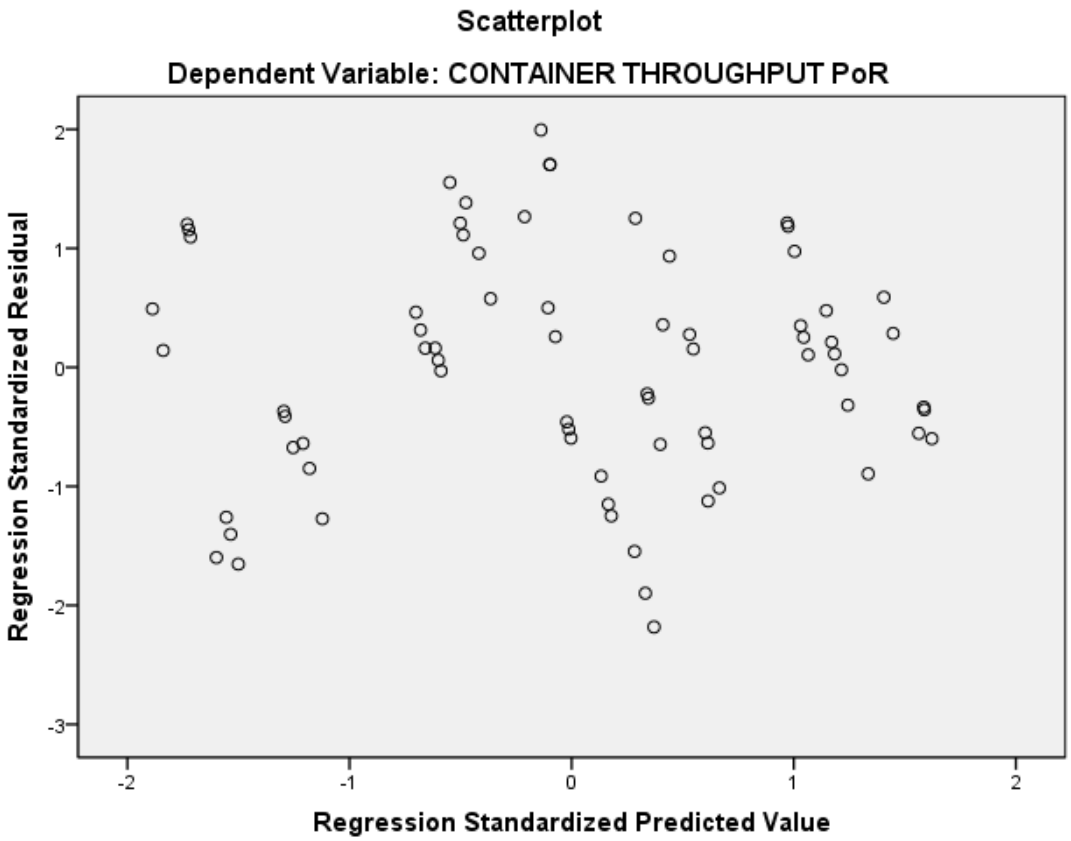

Figure 7: Scatterplot (Multiple Regression 2003-2008)

Time period: 2009-2012

The second time period, where the economic recovery started, has a total duration of four years. Within the framework of this inquiry, the following multiple regression analysis is dedicated to the four last years of the total 10 year period. First and foremost, for the purposes of the model, 8 out of 10 independent variables were excluded after multiple trials. The variables, which were characterized as non-significant in this case are the 8K+ TEU Fleet Development, the Exports of Goods and Services (CHINA), the Retail Sales Indicator (NL), the Economic Sentiment Indicator (NL), the New Order Manufacturing (NL), the Production Index for Manufacturing (Germany), the Gross Domestic Product (NL) as well as the China-Europe Freight Index. In addition, the statistical significance of the model for the time period 2009-2012 is illustrated in the Multiple Regression ANOVA (2009-2012) table.

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	36636499,637	2	18318249,818	135,161	,000[a]
	Residual	6098814,879	45	135529,220		

Total	42735314,516	47			

a. Predictors: (Constant), CONSUMER PRICE INDEX NL, 380 CTS BUNKER PRICE ROTTERDAM

b. Dependent Variable: CONTAINER THROUGHPUT PoR

Table 14: Multiple Regression ANOVA (2009-2012)

There has been observed that the model of this case is defined as statistically significant, due to the low "Sig" value, which is 0.00. Since the value is less than 0.05, the deviations of the dependent variable can be well explained by this model.

Subsequently, the Multiple Regression Descriptive Statistics (2009-2012) table provides the reader with more detailed information about the mean, the standard deviation and the number of the observations (N).

Descriptive Statistics

	Mean	Std. Deviation	N
CONTAINER THROUGHPUT PoR	9612,8544	953,55231	48
380 CTS BUNKER PRICE ROTTERDAM	515,4033	130,91144	48
CONSUMER PRICE INDEX NL	36,1031	,87351	48

Table 15: Multiple Regression Descriptive Statistics (2009-2012)

According to table 15, the mean of the dependent variable (Container Throughput PoR) from 2009 to 2012 is higher than the mean of the previous period (2003-2008), which is rational, because the sum of the two means of the periods 2003-2008 and 2009-2012 divided by two, approaches the mean of the dependent variable for the total 10 year period, which is depicted in table 5 of this report. Nevertheless, in this case, the value of mean is 9612.8544 (x1000 tonnes) per month. Regarding the second column, the dependent variable presents high fluctuations for the aforementioned reason, while it is also remarkable that the 380 CTS Bunker Price Rotterdam variable shows relatively high spreads, because of the corresponding fluctuations in the fuel prices over the years. Moreover, the total number of observations can be found in the last column of the table. The data, which was selected, was amended and recalculated on a monthly basis for 4 years. As a result, 4 years x 12 months (per year) = 48 observations.

Correlations

		CONTAINER THROUGHPUT PoR	380 CTS BUNKER PRICE ROTTERDAM	CONSUMER PRICE INDEX NL
Pearson Correlation	CONTAINER THROUGHPUT PoR	1,000	,917	,833
	380 CTS BUNKER PRICE ROTTERDAM	,917	1,000	,831
	CONSUMER PRICE INDEX NL	,833	,831	1,000
Sig. (1-tailed)	CONTAINER THROUGHPUT PoR	.	,000	,000
	380 CTS BUNKER PRICE ROTTERDAM	,000	.	,000
	CONSUMER PRICE INDEX NL	,000	,000	.
N	CONTAINER THROUGHPUT PoR	48	48	48
	380 CTS BUNKER PRICE ROTTERDAM	48	48	48
	CONSUMER PRICE INDEX NL	48	48	48

Table 16: Multiple Regression Correlations (2009-2012)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,926[a]	,857	,851	368,14293

Model Summary[b]

Model	Change Statistics

	R Square Change	F Change	df1	df2	Sig. F Change
1	,857	135,161	2	45	,000

a. Predictors: (Constant), CONSUMER PRICE INDEX NL, 380 CTS BUNKER PRICE ROTTERDAM

b. Dependent Variable: CONTAINER THROUGHPUT PoR

Table 17: Multiple Regression Model Summary (2009-2012)

According to table 17, the multiple correlation coefficient (R=0.926) is lower, in comparison with the previous models, but is still considered as a high number, which reflects the accuracy and the reliability of the predictions, concerning the changes of the dependent variable. The "R Square" means that 85.7 percent of the variance in container throughput can be predicted by the combination of these 2 variables, while the "Adjusted R Square" shows that 85.1 percent of the variation in the dependent variable is reflected by the variation in the independent variables. It has already been stated that the mean of the dependent variable is 9612.8544 with respect to the model's results. Therefore, the "Standard Error of the Estimate" with a value of 368.14293 represents approximately 3.8 percent of the total mean of the dependent variable. As a result, the model's results are trustworthy.

Coefficients[a]

Model		Unstandardized Coefficients	
		B	Std. Error
1	(Constant)	-2140,254	3679,541
	380 CTS BUNKER PRICE ROTTERDAM	5,294	,737
	CONSUMER PRICE INDEX NL	249,963	110,483

Coefficients[a]

Model		Standardized Coefficients	t	Sig.
		Beta		
1	(Constant)		-,582	,564
	380 CTS BUNKER PRICE ROTTERDAM	,727	7,181	,000

Coefficients[a]

Model		Standardized Coefficients	t	Sig.
		Beta		
1	(Constant)		-,582	,564
	380 CTS BUNKER PRICE ROTTERDAM	,727	7,181	,000
	CONSUMER PRICE INDEX NL	,229	2,262	,029

Table 18: Multiple Regression Coefficients (2009-2012)

According to table 18, the multiple regression equation for the time period 2009-2012 will be the following:

$$y = -2140.254 + 5.294\chi_1 + 249.963\chi_2 + \varepsilon$$

Where:

$\rightarrow \chi_1 = 380\ \text{CTS BUNKER PRICE ROTTERDAM}$

$\rightarrow \chi_2 = \text{CONSUMER PRICE INDEX (NL)}$

To conclude, the histogram, the normal p-p plot of regression standardized residual and the scatterplot show that the residuals of the dependent variable do not present homogeneity, while it is quite obvious that the variables are still not normally distributed.

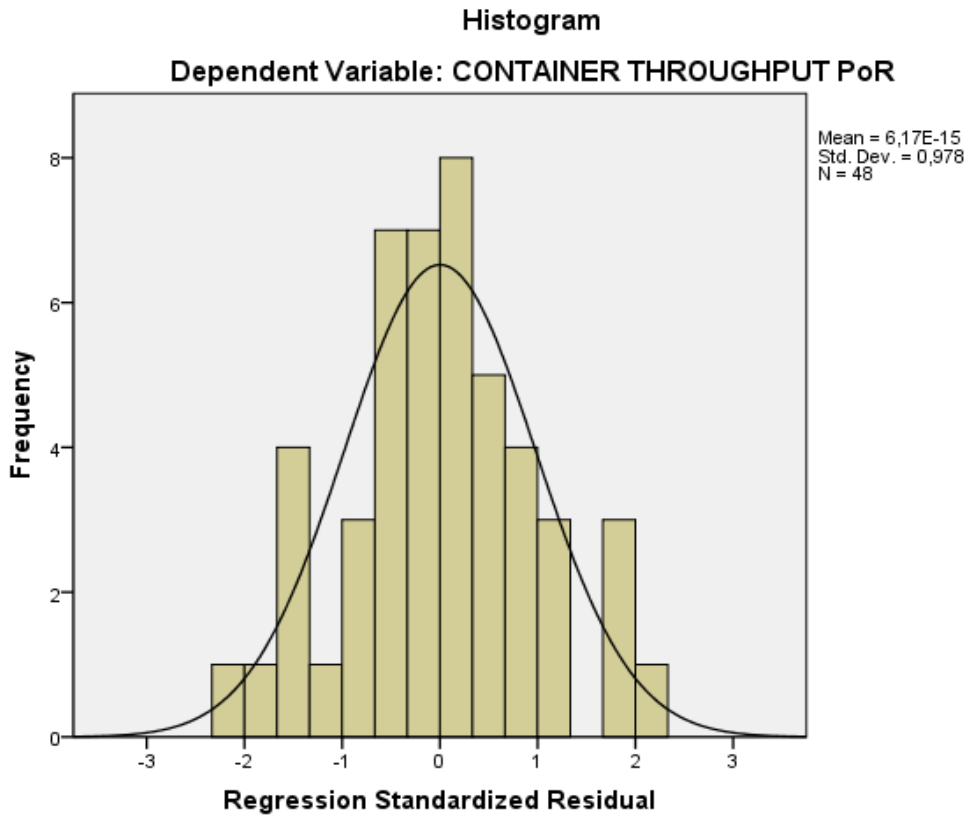

Figure 8: Histogram (Multiple Regression 2009-2012)

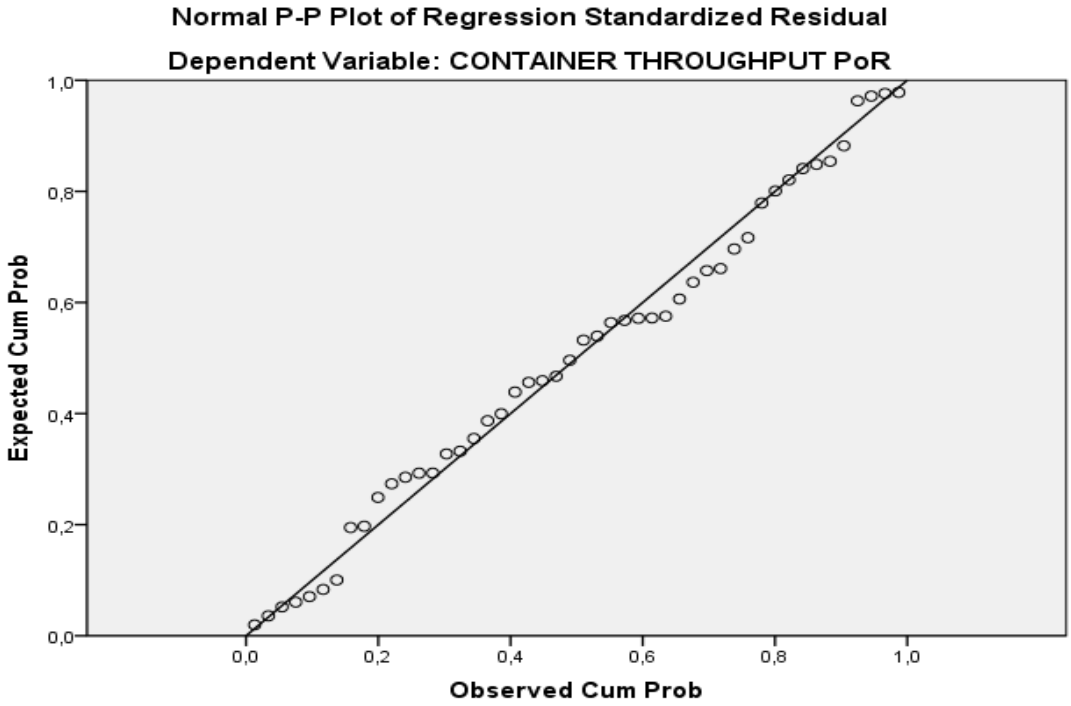

Figure 9: Normal P-P Plot of Regression Standardized Residual (Multiple Regression 2009-2012)

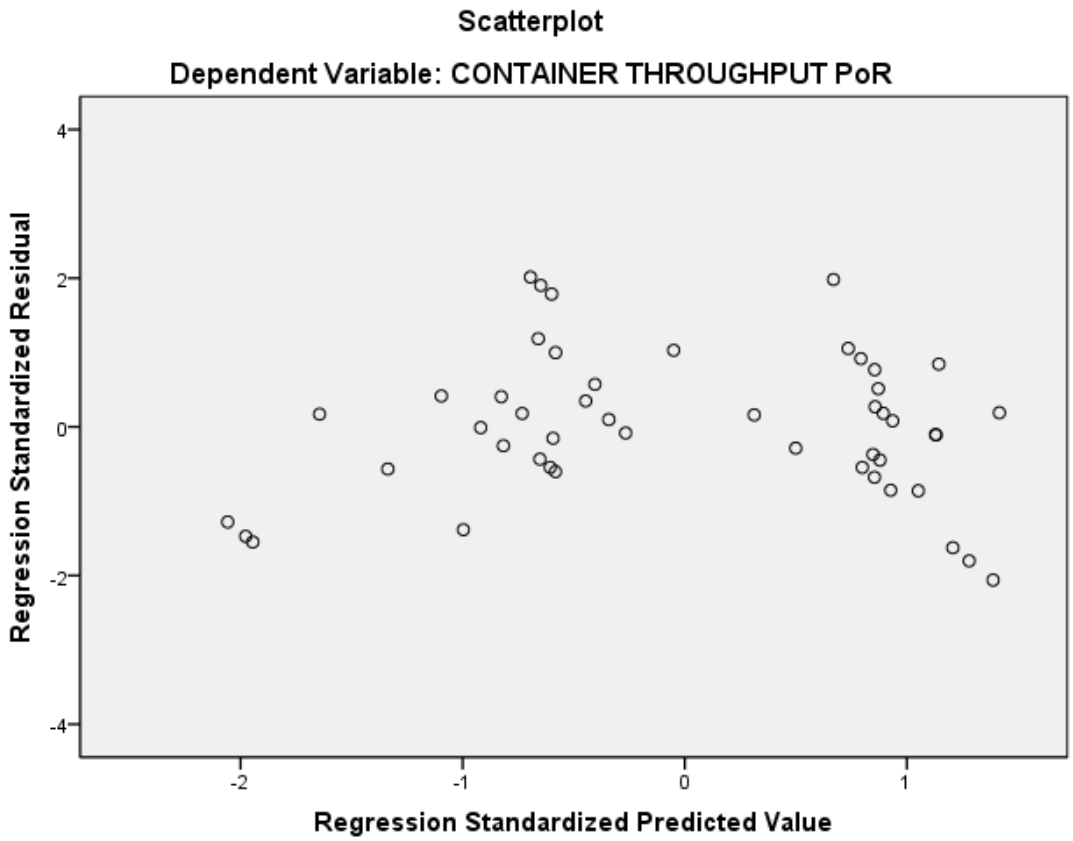

Figure 10: Scatterplot (Multiple Regression 2009-2012)

Conclusions on the Economic Crisis

From the results of the analysis, it is obvious that the global economic crisis had a great impact on the specific market segment. One of the bright spots of this research is that most of the economic and non-economic indicators, which were carefully selected in order for the deviations in container throughput over time to be examined, were totally different between the two time periods. For the first time period from 2003 to 2008, only six variables passed the exclusion procedure and were considered as statistically significant. These are the 8K+ TEU Fleet Development, the Exports of Goods and Services (CHINA), the Consumer Price Index (NL), the Economic Sentiment Indicator (NL), the New Order Manufacturing (NL) and the China-Europe Freight Index. On the other hand, for the second time period from 2009 to 2012, statistical significance was identified in only two variables, 380 CTS Bunker Price Rotterdam and Consumer Price Index (NL). Therefore, it should be taken into account that the Consumer Price Index of the Netherlands, was the only macroeconomic indicator, which was not rejected and maintained its statistical significance in both periods. In addition, the analysis indicated that the dependent variable is positively correlated with the Consumer Price Index (NL) in both periods, which typically confirms the results on hypothesis 2, presenting in subchapter 8.1 of the specific report.

8.3 Time Series Analysis Results

First of all, it should be taken into consideration that for the realization of an accurate forecast, the given independent variables must be modified into lag variables. Hence, the assistance of the IBM SPSS statistical software in performing that task, was of major importance. The necessary amendments were conducted and time series were created through the "transform" function of the software. In this case, where data, measured on a monthly basis, were used, a total lag of three periods attached to the independent variables. Subsequently, the dependent variable as well as the new converted lag variables plugged into the linear regression model in order for the new results on the future container throughput to be examined. In addition, it is remarkable that one of the independent variables was excluded from the model, as it was characterized as statistically insignificant in the first trial. The non-significant variable, in this case, was the 8K+ TEU Fleet Development. Similar to the previous analyses, the Time Series ANOVA (2003-2012) table provides the reader with useful information in order for the statistical significance of the new model to be tested.

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2,075E8	9	23051351,254	356,944	,000[a]
	Residual	6910040,667	107	64579,819		
	Total	2,144E8	116			

a. Predictors: (Constant), LAGS(CEFI,3), LAGS(EGS,3), LAGS(ESI,3), LAGS(RSI,3), LAGS(GDP,3), LAGS(CTS,3), LAGS(PIM,3), LAGS(CPI,3), LAGS(NOM,3)

b. Dependent Variable: CONTAINER THROUGHPUT PoR

Table 19: Time Series ANOVA (2003-2012)

According to table 19, the specific model presents a significance ("Sig") value of 0.00, which defines it as statistically significant, like the other aforementioned models.

Moreover, a closer look at the results of table 20 indicates that the value of the correlation of determination ("R Square") is approximately 0.968, which typically means that the deviations in the dependent variable can be well predicted. In this case, reliability is also ensured by the extremely high values of "R" and "Adjusted R Square", respectively.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,984[a]	,968	,965	254,12560

Model Summary[b]

Model	Change Statistics				
	R Square Change	F Change	df1	df2	Sig. F Change
1	,968	356,944	9	107	,000

a. Predictors: (Constant), LAGS(CEFI,3), LAGS(EGS,3), LAGS(ESI,3), LAGS(RSI,3), LAGS(GDP,3), LAGS(CTS,3), LAGS(PIM,3), LAGS(CPI,3), LAGS(NOM,3)

b. Dependent Variable: CONTAINER THROUGHPUT PoR

Table 20: Time Series Model Summary (2003-2012)

Thereafter, the Time Series Descriptive Statistics (2003-2012) table, as any other Descriptive Statistics table in this report, depicts more in depth information of statistical interest.

Descriptive Statistics

	Mean	Std. Deviation	N
CONTAINER THROUGHPUT PoR	8508,0428	1359,42496	117
LAGS(CTS,3)	365,6170	174,76332	117
LAGS(RSI,3)	105,9145	8,62292	117
LAGS(EGS,3)	990,0990	435,05628	117
LAGS(CPI,3)	34,2838	1,61767	117
LAGS(ESI,3)	32,7090	3,80106	117
LAGS(NOM,3)	32,6226	1,72576	117
LAGS(PIM,3)	33,0551	2,67632	117
LAGS(GDP,3)	51095,2787	2468,38916	117
LAGS(CEFI,3)	1428,5726	269,48586	117

Table 21: Time Series Descriptive Statistics (2003-2012)

In addition, the following table illustrates all the possible correlations of all the included variables in the model. Hence, there has been observed that the majority of the independent variables is positively correlated with the container throughput. The only variable, which indicates a negative relationship is the China-Europe Freight Index with a value of -0.029. At this point, it should be mentioned that the minus sign in front of the number typically symbolizes the aforementioned negative relationship between the two variables.

Correlations

		CONTAINER THROUGHPUT PoR	LAGS(CTS,3)	LAGS(RSI,3)
Pearson Correlation	CONTAINER THROUGHPUT PoR	1,000	,883	,322
	LAGS(CTS,3)	,883	1,000	,389
	LAGS(RSI,3)	,322	,389	1,000
	LAGS(EGS,3)	,886	,912	,534
	LAGS(CPI,3)	,913	,903	,397
	LAGS(ESI,3)	,169	,069	,092
	LAGS(NOM,3)	,815	,774	,447
	LAGS(PIM,3)	,717	,750	,416
	LAGS(GDP,3)	,848	,822	,516
	LAGS(CEFI,3)	-,029	-,009	-,059
Sig. (1-tailed)	CONTAINER THROUGHPUT PoR	.	,000	,000
	LAGS(CTS,3)	,000	.	,000
	LAGS(RSI,3)	,000	,000	.
	LAGS(EGS,3)	,000	,000	,000
	LAGS(CPI,3)	,000	,000	,000

	LAGS(ESI,3)	,035	,231	,162
	LAGS(NOM,3)	,000	,000	,000
	LAGS(PIM,3)	,000	,000	,000
	LAGS(GDP,3)	,000	,000	,000
	LAGS(CEFI,3)	,379	,460	,265
N	CONTAINER THROUGHPUT PoR	117	117	117
	LAGS(CTS,3)	117	117	117
	LAGS(RSI,3)	117	117	117
	LAGS(EGS,3)	117	117	117
	LAGS(CPI,3)	117	117	117
	LAGS(ESI,3)	117	117	117
	LAGS(NOM,3)	117	117	117
	LAGS(PIM,3)	117	117	117
	LAGS(GDP,3)	117	117	117
	LAGS(CEFI,3)	117	117	117

Correlations

		LAGS(EGS,3)	LAGS(CPI,3)	LAGS(ESI,3)
Pearson Correlation	CONTAINER THROUGHPUT PoR	,886	,913	,169
	LAGS(CTS,3)	,912	,903	,069
	LAGS(RSI,3)	,534	,397	,092
	LAGS(EGS,3)	1,000	,942	,049
	LAGS(CPI,3)	,942	1,000	-,152

	LAGS(ESI,3)	,049	-,152	1,000
	LAGS(NOM,3)	,787	,672	,561
	LAGS(PIM,3)	,742	,599	,580
	LAGS(GDP,3)	,856	,832	,195
	LAGS(CEFI,3)	-,005	-,125	,367
Sig. (1-tailed)	CONTAINER THROUGHPUT PoR	,000	,000	,035
	LAGS(CTS,3)	,000	,000	,231
	LAGS(RSI,3)	,000	,000	,162
	LAGS(EGS,3)	.	,000	,301
	LAGS(CPI,3)	,000	.	,051
	LAGS(ESI,3)	,301	,051	.
	LAGS(NOM,3)	,000	,000	,000
	LAGS(PIM,3)	,000	,000	,000
	LAGS(GDP,3)	,000	,000	,017
	LAGS(CEFI,3)	,479	,089	,000
N	CONTAINER THROUGHPUT PoR	117	117	117
	LAGS(CTS,3)	117	117	117
	LAGS(RSI,3)	117	117	117
	LAGS(EGS,3)	117	117	117
	LAGS(CPI,3)	117	117	117
	LAGS(ESI,3)	117	117	117
	LAGS(NOM,3)	117	117	117
	LAGS(PIM,3)	117	117	117
	LAGS(GDP,3)	117	117	117

LAGS(CEFI,3)	117	117	117

Correlations

		LAGS(NOM,3)	LAGS(PIM,3)
Pearson Correlation	CONTAINER THROUGHPUT PoR	,815	,717
	LAGS(CTS,3)	,774	,750
	LAGS(RSI,3)	,447	,416
	LAGS(EGS,3)	,787	,742
	LAGS(CPI,3)	,672	,599
	LAGS(ESI,3)	,561	,580
	LAGS(NOM,3)	1,000	,964
	LAGS(PIM,3)	,964	1,000
	LAGS(GDP,3)	,865	,774
	LAGS(CEFI,3)	,153	,160
Sig. (1-tailed)	CONTAINER THROUGHPUT PoR	,000	,000
	LAGS(CTS,3)	,000	,000
	LAGS(RSI,3)	,000	,000
	LAGS(EGS,3)	,000	,000
	LAGS(CPI,3)	,000	,000
	LAGS(ESI,3)	,000	,000
	LAGS(NOM,3)	.	,000
	LAGS(PIM,3)	,000	.
	LAGS(GDP,3)	,000	,000
	LAGS(CEFI,3)	,050	,043

N	CONTAINER THROUGHPUT PoR	117	117
	LAGS(CTS,3)	117	117
	LAGS(RSI,3)	117	117
	LAGS(EGS,3)	117	117
	LAGS(CPI,3)	117	117
	LAGS(ESI,3)	117	117
	LAGS(NOM,3)	117	117
	LAGS(PIM,3)	117	117
	LAGS(GDP,3)	117	117
	LAGS(CEFI,3)	117	117

Correlations

		LAGS(GDP,3)	LAGS(CEFI,3)
Pearson Correlation	CONTAINER THROUGHPUT PoR	,848	-,029
	LAGS(CTS,3)	,822	-,009
	LAGS(RSI,3)	,516	-,059
	LAGS(EGS,3)	,856	-,005
	LAGS(CPI,3)	,832	-,125
	LAGS(ESI,3)	,195	,367
	LAGS(NOM,3)	,865	,153
	LAGS(PIM,3)	,774	,160
	LAGS(GDP,3)	1,000	-,082
	LAGS(CEFI,3)	-,082	1,000

Sig. (1-tailed)	CONTAINER THROUGHPUT PoR	,000	,379
	LAGS(CTS,3)	,000	,460
	LAGS(RSI,3)	,000	,265
	LAGS(EGS,3)	,000	,479
	LAGS(CPI,3)	,000	,089
	LAGS(ESI,3)	,017	,000
	LAGS(NOM,3)	,000	,050
	LAGS(PIM,3)	,000	,043
	LAGS(GDP,3)	.	,191
	LAGS(CEFI,3)	,191	.
N	CONTAINER THROUGHPUT PoR	117	117
	LAGS(CTS,3)	117	117
	LAGS(RSI,3)	117	117
	LAGS(EGS,3)	117	117
	LAGS(CPI,3)	117	117
	LAGS(ESI,3)	117	117
	LAGS(NOM,3)	117	117
	LAGS(PIM,3)	117	117
	LAGS(GDP,3)	117	117
	LAGS(CEFI,3)	117	117

Table 22: Time Series Correlations (2003-2012)

Subsequently, the last column of the Time Series Coefficients (2003-2012) table shows the significance of the variables used. Therefore, in table 22, it is clearly stated that all the independent variables remain significant, except for the 8K+ TEU Fleet Development variable, which has already been excluded from the model. Moreover, the “B” column contains the coefficients of the independent variables, which are basically adjusted in the following prediction equation in order for the forecasting, regarding the total container throughput, to be achieved. The

interpretation for the specific coefficients is that for every single unit of change of each of the independent variables, the dependent variable proportionally changes in accordance with the rate of the corresponding coefficient. For instance, if the 380 CTS Bunker Price Rotterdam increases by 1 unit, the Container Throughput of the PoR will rise by 1.102. The same logic is also applied to the rest of the coefficients.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-27580,707	2491,343		-11,071	,000
	LAGS(CTS,3)	1,102	,408	,142	2,699	,008
	LAGS(RSI,3)	-10,211	3,885	-,065	-2,628	,010
	LAGS(EGS,3)	-,605	,265	-,194	-2,281	,025
	LAGS(CPI,3)	847,791	80,341	1,009	10,552	,000
	LAGS(ESI,3)	90,575	16,285	,253	5,562	,000
	LAGS(NOM,3)	766,839	101,683	,973	7,541	,000
	LAGS(PIM,3)	-347,510	43,362	-,684	-8,014	,000
	LAGS(GDP,3)	-,152	,032	-,276	-4,688	,000
	LAGS(CEFI,3)	-,304	,104	-,060	-2,941	,004

a. Dependent Variable: CONTAINER THROUGHPUT PoR

Table 23: Time Series Coefficients (2003-20012)

According to table 22, the prediction equation for the time period 2003-2012 will be as follows:

$$y = -27580.707 + 1.102\chi_1 - 10.211\chi_2 - 0.605\chi_3 + 847.791\chi_4 + 90.575\chi_5 + 766.839\chi_6 - 347.510\chi_7 - 0.152\chi_8 - 0.304\chi_9 + \varepsilon$$

Where:

$\rightarrow \chi_1 = 380$ CTS BUNKER PRICE ROTTERDAM (LAGGED)

$\rightarrow \chi_2 =$ RETAIL SALES INDICATOR (NL)(LAGGED)

$\rightarrow \chi_3 =$ EXPORTS OF GOODS AND SERVICES (CHINA)(LAGGED)

$\rightarrow \chi_4 =$ CONSUMER PRICE INDEX(NL)(LAGGED)

$\rightarrow \chi_5 =$ ECONOMIC SENTIMENT INDICATOR (NL)(LAGGED)

$\rightarrow \chi_6 =$ NEW ORDER MANUFACTURING (NL)(LAGGED)

$\rightarrow \chi_7 =$ PRODUCTION INDEX FOR MANUFACTURING (GERMANY)(LAGGED)

$\rightarrow \chi_8 =$ GROSS DOMESTIC PRODUCT (NL)(LAGGED)

$\rightarrow \chi_9 =$ CHINA $-$ EUROPE FREIGHT INDEX (LAGGED)

To conclude, the following figures seem to be slightly worse in comparison with the histogram and the scatterplot in the multiple regression analysis section for the corresponding time period, while the existence of heteroscedasticity is witnessed by the following scatterplot.

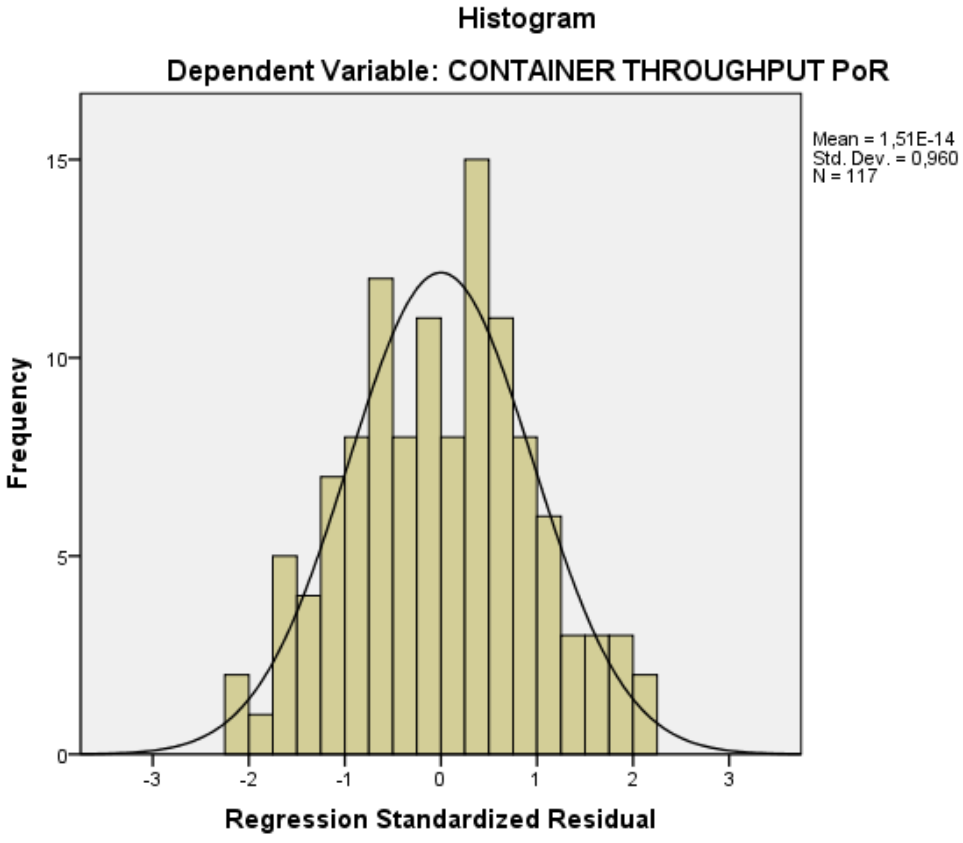

Figure 11: Histogram (Time Series 2003-2012)

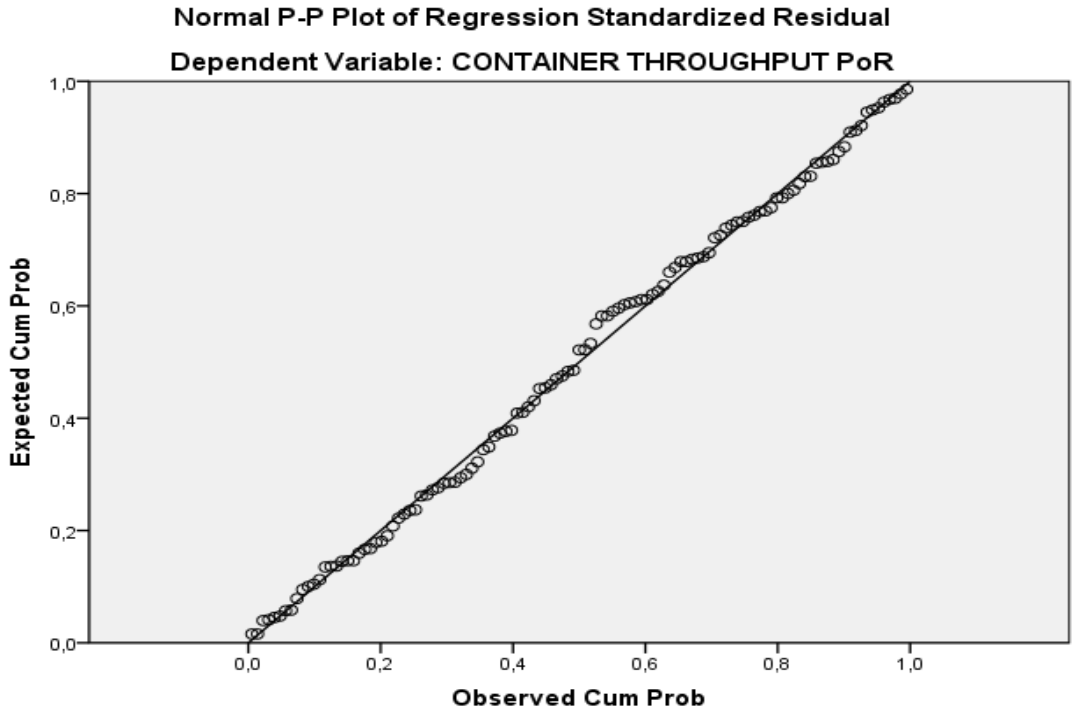

Figure 12: Normal P P-Plot of Regression Standardized Residual (Time Series 2003-2012)

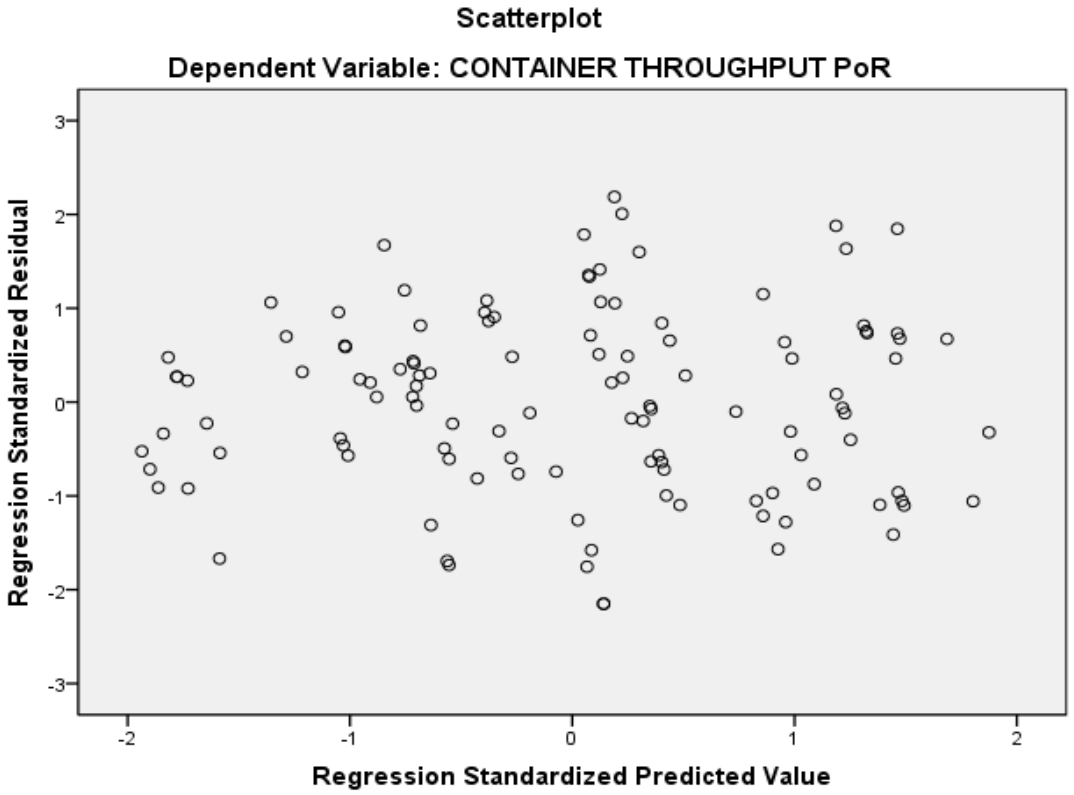

Figure 13: Scatterplot (Time Series 2003-2012)

Conclusions on non-significant hypothesis

At this point, it should be taken into consideration that 10 variables were carefully selected in accordance with the already existing literature review in order for the quantitative part of this thesis to be conducted. Nevertheless, it has been clearly stated in subchapter 8.1 that some of the variables were considered as statistically insignificant and therefore they were excluded from the model. The specific variables are the Retail Sales Indicator (NL) and the China-Europe Freight Index. As a result, hypothesis 5 and 10 did not constitute part of the analysis and cannot be explained within the framework of this research, as the aforementioned variables did not present the appropriate level of significance and direct correlation with the dependent variable.

Hypothesis 5

The Retail Sales Indicator (RSI) of the Netherlands and the Container Throughput of the PoR are positively correlated.

There was no correlation between the Retail Sales Indicator (NL) and the Container Throughput of the PoR. As a result, the variable was rejected.

Hypothesis 10

The China Europe Freight Index and the Container Throughput of the PoR are positively correlated.

There was no correlation between the China-Europe Freight Index and the Container Throughput of the PoR. Hence, the variable was rejected.

Chapter 9: Conclusions

9.1 Conclusions

In the specific report a wide variety of different indicators were used in order for the container throughput of the Port of Rotterdam to be analyzed. Within this framework, the answer to the main research question, stated in the introduction part, is provided through an extensive analysis on the different types of indicators and their identified significance. The main research question is:

"How much do different types of economic and non-economic indicators influence the container throughput of the Port of Rotterdam and what is their value for future estimations?"

Furthermore, this thesis examines the determinants, which directly affect the container throughput of the Port of Rotterdam from three different aspects. Firstly, the port is viewed with respect to its strategic location, as it deals with fierce competition, because of the other ports, which also act in the Hamburg-Le Havre range. At this point, the first generated sub-research question, which has to be answered is: "Why Port of Rotterdam is considered as the dominant port in the Hamburg-Le Havre range?"

Hence, the answer to the aforementioned sub-research question is a result of systematic study and analysis of the port's various attributes in physical and knowledge infrastructure. The specific task was completed after the inclusion of more academic information, based on the already existing literature review, concerning the inter-port competition in this trade route. In line with this literature review, various key factors of augmented significance were identified and their pivotal role added to the argumentation of this thesis in order for the leading position of the Port of Rotterdam in the European container market segment to be supported. At this point, some of the major identified determinants, which typically enhance the port's attractiveness, should be stressed. These are the available infrastructure, the wide range of multimodal hinterland connections, the provided services, which facilitate various activities in the port, the investments in additional capacity as well as the connectivity options, provided to the liner shipping companies. In addition, regardless the fact that the Port of Rotterdam is considered as the market leader in the Hamburg-Le Havre range, the port authority does not remain idle. On the contrary, it focuses its endeavours on maintaining and ensuring this achievement through new investments and a well-organized strategic planning.

Subsequently, the next sub-research question is: "Why Port of Rotterdam is considered as one of the most important logistical hubs for the liner shipping globally?" In this case, a descriptive view of the global container trade was considered as necessary in order for the second answer to be provided. There has been observed that the world container trade is expected to increase by 5.8 percent in 2014 and 6.7 percent in 2015 to 180.7 million TEU. Therefore, it should be taken into consideration that this upward trend indicates to a great extent the importance of the container ports, as the liner shipping companies choose increasingly more hub and spoke centres to call at and be served. Moreover, it should be stressed that the Port of Rotterdam is not only defined as an important transhipment hub for Europe, but also its value is globally recognized, as it constitutes a major

commercial node, which is typically served by the three main trade routes. (Transatlantic, Transpacific, Far East/Europe). Additionally, the port's direct accessibility from the North Sea as well as its capability to handle the world's largest vessels, supporting draughts over 19 meters are two major attributes, which define it as one of the most significant European logistical hubs.

Thereafter, the analytical description of the different parties involved in the container business provides the reader with an explicit picture of the port's vital role in the carriage of goods via containers. The Port of Rotterdam is straight away linked with the European hinterland through numerous connections, offering a wide range of reliable and daily services to various shippers and receivers.

In addition, Rotterdam is a distinguished container port, which has been historically developed in the largest container port of Europe. This can be easily witnessed by the tremendous scale of the port's activities in the container market segment over the years. Moreover, the port's leading position is increasingly enhanced with the construction of more state of the art facilities and the constant investments in Maasvlackte 2.

Subsequently, an econometric analysis was conducted in order for the variables, which have an impact on the main research question to be examined. Then, a set of variables measured or modified on a monthly basis were identified from the literature review. More specifically, the variables, which were carefully selected for this task are the Economic Sentiment Indicator (NL), the Gross Domestic Product (NL), the Retail Sales Indicator (NL), the New Order Manufacturing (NL), the Consumer Price Index (NL), the Production Index for Manufacturing (GERMANY), the Exports of Goods and Services (CHINA), the 380 CTS Bunker Price Rotterdam, the 8000+ TEU Fleet Development and the China-Europe Freight Index. Thereafter, with the assistance of the IBM SPSS statistical software, a multiple regression analysis for the time period 2003-2012 was carried out in order for the variables' significance, regarding the port, to be studied. It should be taken into account that after multiple trials some of the variables, which were characterized as non-significant and unable to explain the deviations in container throughput, had to be excluded from the model. The non-significant variables are the Retail Sales Indicator (NL) and the China-Europe Freight Index. Although, the aforementioned variables were rejected, it should be taken into consideration that in a different methodology the same variables could acquire statistical significance. Therefore, during the subsequent forecasting model all the variables had to be again included.

Furthermore, it should be mentioned that a separate analysis with respect to the impact of the economic crisis on the container throughput was conducted. As a result, the initial time period of 10 years had to be divided into two subsets, from 2003 to 2008 and from 2009 to 2012, respectively. The first period represents the recession, while the second signals the beginning of the economic recovery. The results of the analyses indicate that only one out of ten indicators maintained its statistical significance in both periods. Consequently, only the Consumer Price Index (NL) variable was found important in explaining the changes in container throughput between both periods and showed remarkable positive relationship with the dependent variable.

Finally, a forecasting model was created, where the aforementioned variables were used with a total lag of 3 periods. Hence, a prediction equation was generated in order for estimations for one quarter in container throughput to be made.

9.2 Recommendations

In this subchapter, some recommendations are stated with respect to the conduction of further research on the specific market segment. First of all, it should be taken into consideration that the robustness of the model could be easily enhanced with the utilization of larger datasets, which would basically cover a wider spectrum. In addition, the added value and the significance of the model's results could be improved with the inclusion of datasets for more trading countries. Furthermore, future inquiries could be based on different and more appropriate forecasting methods, so as explicitly described in the literature review of this thesis. It is remarkable that the predictions in container throughput are of fundamental interest as much for the ports as for the terminal operators, because the investment decisions rely on them. Therefore, various forecasting techniques must be employed in order for the validity of the results via different methodologies to be tested.

9.3 Limitations

The specific subchapter contains some of the major factors, which limited this research. Initially, the plan of this inquiry was that the analysis had to be conducted on a 12 year foreground, from 2000 to 2012. The main idea behind this plan was to increase the research's validity and contribution, breaking the sample in three subsets, instead of two, in order for the consequences of the global economic crisis to be accurately imprinted. Nevertheless, the specific task could not be accomplished, due to the lack of the available data. Moreover, it is generally accepted that the global container trade is considered as an exceptionally complicated market segment, because of the large amount of various goods that are conveyed in containers. Hence, on certain occasions, container throughput is difficult to be measured and is not absolutely representative, in comparison with corresponding throughputs of single commodities that are not containerized. For this reason, only economic indicators could be utilized in order for the impact on container throughput from an economic point of view to be examined.

Hypothesis	Thesis's Results
1	Negative Correlation (Contradicted)
2	Positive Correlation (Contradicted)
3	Positive Correlation (Supported)
4	Positive Correlation (Supported)
5	Rejected
6	Negative Correlation (Contradicted)
7	Positive Correlation (Supported)
8	Negative Correlation (Contradicted)
9	Positive Correlation (Supported)
10	Rejected

Table 24: Initial Hypothesis and Thesis's Results

Author	Dependent Variable/Issues examined	Independent Variable(s)	Sample	Time Period	Methodology	Results	Thesis's Results	Hypothesis
De Langen et al (2012)	Total throughput of all major commodities (16), handled in the Hambourg-Le Havre range	1. GDP growth 2. Transshipment Volumes 3. Maturity of the supply chains 4. Increasing Ship Size	Throughput data for 2008, which was used as the base year	Estimations up to 2030 - A total time period of 20 years	Freight transport model (TRANS TOOLS model), combined with expert judgement and commodity specific research - Flows are distributed spatially with a doubly constrained Gravity model taking account of trends in supply and demand, including changes in trade impediments between countries - 4 different scenarios were created	The results show that in all scenarios, total throughput is expected to increase, although in three scenarios not as fast as in the previous two decades. In addition, the results suggest relatively low growth rates or decline for raw materials and moderate growth rates for intermediates and container. Thus, the composition of throughput is likely to change substantially.	The specific report identifies GDP as an indicator of augmented statistical significance and also agrees with the fact that there is a need for using more complicated forecasting methods	Agree
De Langen (2003)	Demand for Maritime transport of Containers	1. The Value Density of Trade 2. The Direction of Trade 3. The GDP 4. The Containerizable Share of Transport Flows 5. The Export Quotes for Economies 6. The Share of Shipping in International Trade 7. The Containerisation Rate	x	x	x	Economic and non-economic indicators have an impact on container throughput	The inquiry presents that different types of economic and non-economic indicators can affect container throughput to a great extent	Agree

Fung (2001)	Demand for Hong Kong container handling services	1. The log of Container throughput handled at Kwai Chung Terminal (KWAI) 2. The log of total container throughput handled in midstream in Hong Kong (MID) 3. The log of Singapore's container throughput (SINGVOL) 4. The log of container throughput at the Shenzhen ports (SHENVOL) 5. The log of the total value of China's foreign trade (CHNTRD) 6. The log of the total value of South and Southeast Asia's foreign trade (ASIATRD) 7. The log of Hong Kong's container terminal tariff (HKTAR) 8. The log of Singapore's container terminal tariff (SINGTAR) 9. The log of Hong Kong's midstream tariff (MIDTAR)	x	From January 1986 to March 1997	Three-player oligopoly model (one for each operator, Hong Kong container terminals, Hong Kong midstream, Singapore container terminals) - Structural Error Correction Model (SECM)	Within the framework of this article, forecasts of demand for Hong Kong's container handling services are generated with certain realistic assumptions on the growths of trade volume and Shenzhen's container throughput. Moreover, the resulting forecasts are found to be more accurate than that reported by the government authority, and suggests an earlier construction of new terminals to meet future demand.	This thesis identifies the Exports of Goods and Services (CHINA) as a statistically significant variable, which directly affects the container throughput of the port of Rotterdam	Not Applicable
Wen-Yi Peng (2009)	Estimated container throughput	Container throughput of Keelung Port, Container throughput of Taichung port, Container throughput of Kaohsiung Port (Data measured on a monthly basis)	Time series data on container throughput volumes in three major ports in Taiwan - The initial sample was divided into two datasets: an in-sample data set for estimation and an out-of-sample data set for prediction	Initial sample: From January 2003 to December 2006 - in-sample data set: From January 2003 to December 2006 - out-of-sample dataset: From January 2006 to December 2006	Within the framework of this inquiry, six univariate models were conducted, the Classical Decomposition Model (multiplicative approach), the Trigonometric Regression Model, the Regression Model with Seasonal Dummy Variables, the Grey Model (GM), the Hybrid Grey Model (GM, combined with the ratio-to-moving-average deseasonalization method), and the SARIMA Model (an extended version of the ARIMA model, including seasonal factors	The research presents that a simple method like the classical decomposition model seems to perform extremely well. On the contrary, sophisticated or complex statistical methods do not necessarily provide more accurate forecasts than simpler ones. Furthermore, many forecasting methods with different strengths and weaknesses are available. A better method for one industry may not be a reliable one for another industry. Therefore, It is of major importance to find the right forecasting method for the particular industry in question	According to the thesis's results, the multiple regression analysis is not defined as the ideal forecasting approach. Nevertheless, future inquiries could be based on different and more appropriate forecasting methods	Agree

Anderson (2008)	Investment choices between the port of Busan and the port of Shanghai	Profits-Investment costs	Quantity of services demanded at each port based on the observed price differences (Shipping times-Transshipment volumes)	x	Game theoritic best response framework (The Nash equilibrium profits of a Bertrand pricing game) pricing game	The specific research stresses that, at least in the major submarket of northern Chinese transshipment services, the amount of revenue at stake is surprisingly small, within reasonable ranges of development and pricing opportunities, which typically means that the strategic game based on current activities in a large segment of the existing market does not support the high levels of investment being contemplated, and undertaken, throughout East Asia. In addition, the inclusion of strategic response of competitor ports suggests two determinants, which contribute the most to the evaluation of new investments. First and foremost, governments must rely primarily on estimates of multiplier effects when considering the benefits of being a hub port. Moreover, governments must be mindful of current and planned development by competitors, who have the potential to capture or defend market share a static or non-strategic analysis would predict use a new port	The thesis's qualitative analysis indicates the importance of investments and strategic planning for the PoR. Regarding the quantitative analysis, the study identifies a positive relationship between the Exports of Goods and Services (CHINA) and the dependent variable (container throughput of the PoR)	Agree
NG Adolf (2006)	The role of qualitative factors in the attractiveness of ports (as container transshipment hubs)	x	The world's top 30 liner shipping companies	x	A Likert-style questionnaire was distributed to the global top 30 liner shipping companies. According to Alphaliner (2005), with respect to the amount of TEUs carried. Additionally, the analysis of variance (ANOVA) statistical test was used in order for the initial hypothesis for the different geographical locations to be examined	Within the framework of this inquiry, the shipping lines indicate that monetary cost is not the only component in explaining port attractiveness. Other determinants such as time efficiency, geographical location and service quality, should also be taken into consideration. Moreover, it was found that Benelux and German ports possess decent service quality in time efficiency and qualitative factors, while Felixstowe and Le Havre should input better efforts. With respect to geographical location, respondent opinions suggest that Bremerhaven and Hamburg are ideal ports in serving Scandinavia-Baltic, although Rotterdam also possesses competitive edges in serving this market. For the UK and the Iberian Peninsula, Antwerp, Felixstowe, Le Havre and Rotterdam are all decent options to shipping lines and thus the competitive position of ports in these markets seem to be dependent on whether ports can provide decent service quality to their customers. Furthermore, the author stresses that attractiveness is usually only a pre-requisite to allow the port to achieve competitiveness and proves through a case study that two attractive options are not necessarily compete each other	The thesis supports the results of the specific article, as it explicitly describes the comparative advantages of the PoR. More specifically, large part of this inquiry is devoted to the unique, strategic geographical location of the port as well as the high quality of the numerous services provided	Agree

Francesco Russo (2013)	Demand variables of maritime container transport (throughput, transhipment and origin–destination flows)	x	This is an aggregate estimation of the aforementioned variables for countries facing the Mediterranean basin. This geographical area was defined to support a specific analysis of the transhipment hub ports of Gioia Tauro, Taranto and Cagliari	2006-2015	Freight demand models with recalibrated freight demand parameters by means of an aggregate procedure that allows spatial and temporal fitting operations to be performed from multiple heterogeneous data sources. The research supports an ex-post analysis for historical estimation of demand variables of the containerized maritime freight market as well as an ex-ante analysis for forecasting purposes, through the specification and calibration of relationships between throughput and origin–destination flow variables	The specific inquiry indicates that, at a worldwide level, the complete availability of data, despite the discrepancies between the available sources, enabled ex-post and ex-ante analysis respectively at 2006 and 2015 and the calibration of parameters expressing the relationship between throughput and OD flow variables. Nevertheless, at the Mediterranean level, the lack of data does not allow estimation of the same variables to be obtained. On the contrary, huge time and monetary resources are required to build a freight demand model in order to establish relationships between the throughput and OD flow variables. It is also remarkable that the implementation of the specific methodology allowed demand variables as at 2006 and 2015 to be estimated for the Mediterranean area, in accordance with expectations before the crisis and then to current developments in the container market	In the specific research, various types of economic and non-economic indicators were used in order for changes in container throughput of the PoR to be explained. Nevertheless, the sample had to be divided into two periods in order for the consequences of the economic crisis to be successfully studied. At this point, it should be mentioned that the lack of the available data hampered the author's initial attempt to select a larger time period and divide the sample into three subsets for the elaboration of a more accurate analysis	Agree
Lei fan (2012)	Port Capacity, Utilization, Imports and Congestion cost (as a function of throughput for import containers)	Variable 1: The number of container ship transits of different size serving trade routes or strings for containerized imports, including Transpacific-West Coast, Panama Canal-East/Gulf Coast, and Transatlantic-East/Gulf Coast. Furthermore, The origins of imports are specified as Northeast Asia and Europe Variable 2: The total TEUs shipped through ports imported from Northeast Asia and Europe. Variable 3: Includes different types of variables, which represent the number of TEUs shipped from US, Canadian, or Mexican ports to US BEAs (Bureau of Economic Areas). Variable 4: Defines the total TEUs shipped over US rail routes	Data on port throughput (imports) and rail flows in the United States	x	Intermodal network flow model based on cost minimization. In addition, queuing functions were also utilized in order for the average waiting times as well as congestion costs of the vessels to be estimated	According to the inquiry's results, congestion exists at most ports and its consequences are to raise costs at these nodes, and in some cases to divert traffic to other routes. To conclude, with a possible port expansion, the value of marginal capacity would converge to nil, and expansion would reduce congestion costs and waiting times. It is also remarkable that dual values for port capacity were highest for ports of Los Angeles/Long Beach. Additionally, the ports of Savannah, Norfolk, and Seattle/Tacoma also include higher dual values. Finally, the simultaneous expansion of ports reduced congestion costs and waiting time	There are no relevant results in this thesis about congestion	Not Applicable

Zijian Guo (2005)	Container throughput (forecasting)	x	Historical annual container throughput of a Chinese port (There are 16 observations, where 1989-2000 are used for model fitting and 2001-2004 are reserved for ex post testing)	From 1989 to 2004	Grey Verhulst model on time series error corrected for the port throughput forecasting	The results indicate that the Grey Verhulst model on time series corrected is applicable, especially, when the throughput increases according to the curve with S type, not only higher forecasting accuracy can be obtained, but also the superiority and the features of grey system model can be reserved	As aforementioned, the multiple regression analysis is not defined as the ideal forecasting approach. Nevertheless, future inquiries could be based on more accurate forecasting methods	Not Applicable
Meifeng Luo (2009)	Container shipping freight rate, Global container fleet capacity	Container throughput, Bunker price, Delivery, Scrap, New order	The world container shipping market statistics (annual data)	From 1980 to 2008	Three-stage least square method. Moreover, the stability of the regressed model was tested via two additional regression analyses, applied to data from different time periods, from 1980 to 2006 and from 1980 to 2007, respectively	According to the model's results, the estimated parameters showed high statistical significance, and the overall explanatory power of the model is above 90%. Moreover, the short-term in-sample prediction of the model can largely replicate the container shipping market fluctuation in terms of the fleet size dynamics and the freight rate fluctuation in the past 20 years. To conclude, the prediction of the future market trend reveals that the container freight rate should continue to decrease in the coming three years if the demand for container transportation services grows at less than 8%	No correlation can be identified, concerning the results. The study focuses its endeavors on explaining deviations in container throughput of the PoR. Therefore, the utilization of different dependent variables leads to different results	Not Applicable
Cullinane (1999)	Baltic Freight Index, which mainly represents freight rates (prices charged by the shipowners for the chartering)	x	Freight rates of the Baltic Freight Index (excluding handysize trades)	From 3 November 1993 to 29 March 1996	Box-Jenkins methodology, which is typically based on the development of ARMA (Autoregressive Moving Average) models	The results of the specific research showed that the behaviour of the Baltic Freight Index (BFI) has not been radically altered, in comparison with the results of the same author's forecasting attempt in 1992, even following this radical revision	No correlation can be identified, concerning the results	Not Applicable

Bart W. Wiegmans (2008)	The specific inquiry deals with the importance of port choice and container terminal selection for deep-sea container carriers, in accordance with three different dimensions, buying decision characteristics, port choice strategy and terminal selection	x	12 deep-sea container operators responded in detail to the three unstructured questions. Those companies were: APL, CMACGM, Cosco, Evergreen, Hanjin, Hyundai, Maersk, MSC, MOL, NYK, OOCL and Yang Ming	x	Literature review and interviews (30 minutes telephone surveys - 3 unstructured questions: 1. How important is port choice versus terminal choice? 2. What are the main criteria underlying port choice? 3. What are the main criteria underlying terminal choice?)	With respect to the results of the research, strategic considerations on company level are important. Furthermore, the most significant, identified criteria, concerning the port choice, are the following: The availability of hinterland connections, reasonable tariffs and immediacy of consumers (large hinterland). Morever, it is remarkable that the shipping lines attach great value to neglected factors, such as feeder connectivity, environmental issues and the total portfolio of the port. In addition, the study stresses the difference between the port selection and the terminal selection criteria. According to the results, the terminal selection criteria strictly depend on handling speed, handling costs, reliability and hinterland connections. To conclude, the inquiry reveals tha the decision making approach differs per container carrier, per trade and per port type, implying that a one size fits all approach is not relevant	The thesis also identifies the availability of hinterland connections, the feeder connectivity, the environmental issues, the total portfolio of the port as well as the immediacy of consumers as criteria of augmented significance with respect to port selection. In addition, the terminal selection criteria are analytically described and distinguished. Moreover, the general idea behind the decisions of the liner shipping companies is provided. It should be also taken into consideration that the description is mainly focused on the comparative advantages of the PoR against its competitors	Agree
Notteboom (2010)	Container throughput	x	78 container ports in Europe	From 1985 to 2008	A Shift - Share analysis was implemented, as an expansion of Notteboom's (1997) older study, taking into consideration a larger sample. Within the framework of this report, some mathematical expressions were used to calculate the net volume of the shift-effects between (inter) and within (intra) the different port ranges or multi-port gateway regions	The research aims at identifying key trends and issues underlying recent developments in the European container port system. More specifically, the trends include the formation of multi-port gateway regions, changes in the hinterland orientation of ports and port regionalization processes. While the local hinterland remains the backbone of ports' traffic positions, a growing demand for routing flexibility fuels competition for distant hinterlands between multi-port gateway regions. It is considerable that the dominant assumption that containerisation would lead to further port concentration is not a confirmed fact in Europe, as the European port system and most of its multi-port gateway regions witness a gradual cargo deconcentration process. Still, the container handling market remains far more concentrated in comparison with other market segments in the European port system, as there are strong market-related factors supporting a relatively high cargo concentration level in the container sector. To conclude, the specific paper does not include the consequences of the economic crisis, as it was elaborated at the beginning of the crisis. Hence, the structural ramifications on port hierarchy and competition in Europe are not imprinted	In comparison with the specific article, this thesis provides the reader with analytical information about the impact of the economic crisis on the container throughput of the PoR, where only the Consumer Price Index was typically identified as a statistically significant indicator. Moreover, the various hinterland connections and their significance in Rotterdam's development are also identified, while the report refers the special attributes of the port as the main gateway for millions of products to the European market	Agree

Jean-Claude Thill (2010)	Accessibility at location (The report's expected target was the estimation of the impact of intermodal networks on accessibility improvement)	1. The set of all potential destinations 2. The economic opportunities available at potential destination 3. The impedance function of shipping cost	The performance of the intermodal freight network is evaluated by comparing accessibility measures based on the highway network and on the intermodal network, respectively, for all North American container ports, as well as for subgroups of container ports on the Eastern Seaboard, the Western Seaboard, and the Gulf Coast of North America (37 ports)	2003	Accessibility analysis (Gravity type)	Within the framework of this research, it was identified that the implementation of intermodal networks reduces the gap of accessibility among regions by providing better connections to container ports. In addition, it is remarkable that Intermodal service to Eastern and Gulf Coast container ports brings about a more uniform improvement in accessibility over the contiguous United States. Therefore, the Western ports seem to be in a more favorable position to use intermodalism to their advantage and increase their business with customers in some geographically peripheral regions that otherwise may not export or may do so through other gateways, but fail to experience the broad base payoff that Eastern and Golf Coast ports are set to benefit from. Furthermore, one of the bright spots of this inquiry is that intermodalism can promote a decentralization of economic activities by evening out accessibilities to export gateways. Nevertheless, it should be stressed that it cannot be seen, as a silver bullet capable of erasing the logistical disadvantages of geographic peripherality	Within the framework of the qualitative part of this thesis, it has been clearly stated that the geographical location, the numerous intermodal connections as well as the accessibility are attributes of fundamental interest, which mainly define the PoR, as the main gateway of Europe and one of the most important global commercial nodes	Agree
Kenyon (1970)	The paper analyzes the shifting magnitudes and composition of general cargo freight among selected United States ports with respect to the extent and makeup of their domestic hinterlands, their overseas trade orientation, and the economic character of the port metropolis itself and review some of the changing conditions and practices of major importance, regarding the competitive struggle among American ports. Finally, the availability of developable space at the selected ports for the kind of terminal activity is examined	x	The ports selected for the analysis are New York, Boston, Philadelphia, Baltimore, New Orleans and Chicago	x	Qualitative analysis, based on previous literature	The specific research supports that there is great inertia among the ports of the United States. The ports' success is only partly determined by their regional location, the size of their local and nearby economy, and their proximity to overseas trading areas. In addition, it is also importantly predicated upon the extent of their commercial, financial, and organizational structure, and especially upon their ability and will to prepare for the future. Within the framework of this report, the port of New York demonstrates the will to retain its lead and great resilience in its ability to meet new situations. The port's comparative advantages seem to be strong and relatively stable. On the contrary, Boston and Philadelphia both lack such effective port organization, both suffer from proximity to New York, and both lack large tracts of nearby waterfront, well served by rail transportation, and otherwise suitable for development as containership terminals. Philadelphia is more strongly oriented to manufacturing, while Boston seems to be strong in wholesaling. Baltimore has a number of advantages, including adequate space for containerized freight-handling, strong port organization, and relative proximity to the Midwest, which new rates on containerized rail traffic seem to be taking into account. Nevertheless, New Orleans and Chicago, safely distant from New York, seem to have the best chances to grow disproportionately. Moreover, it is remarkable that New Orleans stands to benefit from expansion of its regional economy, and from probable enlargement of trade with northern Latin America and the Pacific, while it is also fortunate in having large tracts of land available for port expansion	In line with the results of the previous article, this study supports that the Port Authority of the PoR focuses its endeavors on investments, strategic plans and the issue of the port vision 2030 plan in order for the leading position of the port to be maintained. In addition, as aforementioned, the strategic position of the port, which facilitates commercial activities in the specific region as well as the port's huge industrial cluster, have a pivotal role in the port's expansion potentials and the general development of the regional economy	Agree

Wei Yim Yap (2006)	Annual slot capacity (TEU)	1. Container throughput 2. Data for shipping services deployed by shipping lines 3. Average vessel capacity	The ports of Hong Kong, Busan, Kaohsiung, Shanghai and Shenzhen	From 1995 to 2001	x	According to the inquiry's results, new services started by mainline operators calling at Mainland China are bypassing Japanese and Taiwanese ports. Nevertheless, these services continue to call at Hong Kong. Although the composition of containers handled at Mainland Chinese ports consists largely of gateway cargo, these ports are expected to handle a rising share of transhipment traffic	The only possible relationship between the two studies is that this report identifies the Exports of Goods and Services (CHINA) as a statistically significant variable, which directly affects the container throughput of the PoR. It should be also taken into account that the two variables present remarkable positive correlation, which means that they simultaneously increase or decrease, respectively	Not applicable
H. Arjen van Klink (1998)	1. The potential effects of intermodalism on a port's hinterland (Europe). 2. the impact of EU policies on intermodal transport in general, and intermodal transport of maritime flows. 3. The hypothesis that gateways are excellently positioned to stimulate intermodal transport, and that this can be deployed to enlarge the market scope of ports (Rotterdam-Italy)	x	x	x	Qualitative analysis, based on previous literature	According to the hypothesis of this article, the gateways are in an excellent position to stimulate intermodal transport, given the scale advantages they can generate in inland transport. It is remarkable that the supply of intermodal services can enable seaports to create new hinterlands and extend their hinterland potential. In the case of Rotterdam, it appears that intermodal transport can extend the port's hinterland. Furthermore, the introduction of shuttle trains to Italy, supported by the Rotterdam port authority, has added to the transshipment of containers to/from Italy in Rotterdam. Nevertheless, critics stress that bypassing Italian ports will stop when transport externalities are incorporated in continental transport tariffs. As a result, the hinterland potentials of ports in Western Europe will shrink to the advantage of the southern ports. However, that reasoning only holds for truck transport. As the external costs of train and barge are relatively low internalising externalities will not change their competitive position, which typically means that comparative advantages of the PoR, such as the high frequency of liner services and the first port of call status, will remain unchanged. To conclude, the various seaports manage to keep their share in the changing European market and to enlarge their hinterland towards new regions, adopting intermodalism. Therefore, stimulating intermodal transport from gateways automatically means higher efficiency of the transport system	According to the thesis's results, major determinants of the PoR, such as the high frequency of the liner services and the first port of call status, will remain unchanged and their importance seems to be enhanced. Furthermore, the study supports to a great extent the adoption of the theory of intermodalism and explicitly outlines the advantages of such application	Agree

Table 25: Key findings in comparison with previous literature

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Appendix A: Operated Fleets

GLOBAL FIGURES

Today, there are **5,961** ships active on liner trades, for **18,454,976** TEU and **233,636,169** TDW
Including **5,002** fully cellular ships for **17,994,631** TEU

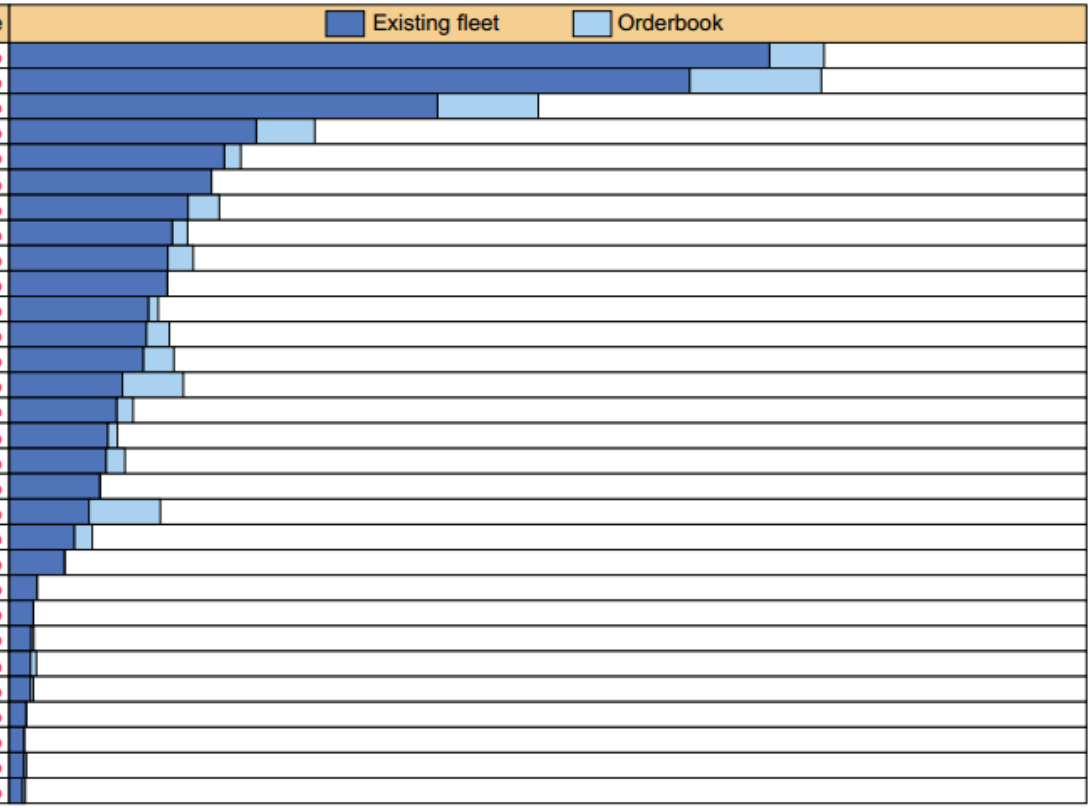
The total existing cellular fleet (all sizes / all positions) stands at **4,999** ships for **17,994,084** TEU

Idle ships - See ad hoc reports

THE TOP 100 LEAGUE

> The percentage shown on the left of each bar represents the operator's share of the world liner fleet in TEU terms.
> The light coloured bar on the right represents the current orderbook (firm orders).

Rnk	Operator	TEU	Share
1	APM-Maersk	2,801,768	15.2%
2	Mediterranean Shg Co	2,507,630	13.6%
3	CMA CGM Group	1,578,223	8.6%
4	Evergreen Line	910,329	4.9%
5	COSCO Container L.	792,697	4.3%
6	Hapag-Lloyd	744,587	4.0%
7	CSCL	658,708	3.6%
8	Hanjin Shipping	600,878	3.3%
9	MOL	584,103	3.2%
10	APL	582,760	3.2%
11	OOCL	513,434	2.8%
12	Hamburg Süd Group	505,394	2.7%
13	NYK Line	494,455	2.7%
14	Yang Ming Marine Transport Corp.	416,729	2.3%
15	Hyundai M.M.	396,346	2.1%
16	PIL (Pacific Int. Line)	363,421	2.0%
17	K Line	357,052	1.9%
18	Zim	334,136	1.8%
19	UASC	293,811	1.6%
20	CSAV Group	240,557	1.3%
21	Wan Hai Lines	204,074	1.1%
22	X-Press Feeders Group	102,610	0.6%
23	HDS Lines	88,608	0.5%
24	KMTC	80,668	0.4%
25	SITC	78,180	0.4%
26	NileDutch	77,869	0.4%
27	UniFeeder	62,597	0.3%
28	TS Lines	54,914	0.3%
29	Simatech	54,112	0.3%
30	Arkas Line / EMES	49,324	0.3%



		Total		Owned		Chartered			Orderbook		
Rnk	**Operator**	TEU	Ships	TEU	Ships	TEU	Ships	% Chart	TEU	Ships	% existing
1	APM-Maersk	2,801,768	598	1,542,933	251	1,258,835	347	44.9%	200,768	12	7.2%
2	Mediterranean Shg Co	2,507,630	500	1,057,735	193	1,449,895	307	57.8%	484,740	42	19.3%
3	CMA CGM Group	1,578,223	430	545,625	84	1,032,598	346	65.4%	371,036	39	23.5%
4	Evergreen Line	910,329	193	534,891	111	375,438	82	41.2%	215,456	17	23.7%
5	COSCO Container L.	792,697	161	473,493	99	319,204	62	40.3%	60,386	6	7.6%
6	Hapag-Lloyd	744,587	146	417,576	65	327,011	81	43.9%			
7	CSCL	658,708	138	469,654	75	189,054	63	28.7%	115,072	7	17.5%
8	Hanjin Shipping	600,878	96	272,800	37	328,078	59	54.6%	56,140	6	9.3%
9	MOL	584,103	112	207,558	33	376,545	79	64.5%	93,866	10	16.1%
10	APL	582,760	105	386,543	50	196,217	55	33.7%			
11	OOCL	513,434	95	338,481	48	174,953	47	34.1%	35,552	4	6.9%
12	Hamburg Süd Group	505,394	106	263,906	42	241,488	64	47.8%	84,368	9	16.7%
13	NYK Line	494,455	109	287,486	51	206,969	58	41.9%	112,000	8	22.7%
14	Yang Ming Marine Transport Corp.	416,729	91	228,891	45	187,838	46	45.1%	224,646	18	53.9%
15	Hyundai M.M.	396,346	60	159,326	21	237,020	39	59.8%	60,000	6	15.1%
16	PIL (Pacific Int. Line)	363,421	158	257,787	115	105,634	43	29.1%	35,001	9	9.6%
17	K Line	357,052	69	127,352	21	229,700	48	64.3%	69,350	5	19.4%
18	Zim	334,136	82	62,889	17	271,247	65	81.2%			
19	UASC	293,811	49	198,164	26	95,647	23	32.6%	262,726	17	89.4%
20	CSAV Group	240,557	48	84,850	15	155,707	33	64.7%	65,100	7	27.1%
21	Wan Hai Lines	204,074	84	169,327	70	34,747	14	17.0%			

22	X-Press Feeders Group	102,610	73	17,330	11	85,280	62	83.1%			
23	HDS Lines	88,608	22	6,864	3	81,744	19	92.3%			
24	KMTC	80,668	49	34,035	24	46,633	25	57.8%	9,696	5	12.0%
25	SITC	78,180	67	33,109	32	45,071	35	57.7%	21,600	12	27.6%
26	NileDutch	77,869	28	4,811	2	73,058	26	93.8%	10,530	3	13.5%
27	UniFeeder	62,597	58			62,597	58	100.0%			
28	TS Lines	54,914	32	3,156	2	51,758	30	94.3%			
29	Simatech	54,112	22	8,136	6	45,976	16	85.0%	8,700	2	16.1%
30	Arkas Line / EMES	49,324	34	42,349	29	6,975	5	14.1%	10,000	4	20.3%
31	Quanzhou An Sheng Shg Co	48,215	42	43,524	33	4,691	9	9.7%	13,088	6	27.1%
32	Sinotrans	47,510	33	20,631	16	26,879	17	56.6%			
33	CCNI	47,134	14			47,134	14	100.0%	36,120	4	76.6%
34	RCL (Regional Container L.)	44,836	30	21,773	20	23,063	10	51.4%			
35	Grimaldi (Napoli)	37,517	36	36,882	35	635	1	1.7%	24,400	11	65.0%
36	Schöller Group	36,484	21	6,042	3	30,442	18	83.4%			
37	Swire Shipping	35,434	27	31,378	22	4,056	5	11.4%	6,468	4	18.3%
38	OEL / Shreyas (Transworld Group)	34,941	23	19,387	14	15,554	9	44.5%			
39	Heung-A Shipping	34,428	30	8,095	13	26,333	17	76.5%	4,172	4	12.1%
40	Matson	32,666	20	31,118	17	1,548	3	4.7%	7,200	2	22.0%
41	Sinokor	31,089	30	16,149	16	14,940	14	48.1%			
42	Samudera	29,145	34	10,971	18	18,174	16	62.4%			
43	Salam Pasific	29,020	45	27,732	43	1,288	2	4.4%			
44	Seaboard Marine	28,962	24	1,444	2	27,518	22	95.0%			

45	Meratus	28,764	48	28,105	43	659	5	2.3%			
46	Tanto Intim Line	27,310	47	27,310	47						
47	Zhonggu Shipping	26,033	38	15,920	14	10,113	24	38.8%	25,000	10	96.0%
48	Linea Messina	24,959	12	17,028	7	7,931	5	31.8%	11,680	4	46.8%
49	Horizon Lines	24,840	12	19,836	9	5,004	3	20.1%			
50	S.C. India	24,491	7	14,407	5	10,084	2	41.2%			
51	FESCO	23,221	21	11,581	14	11,640	7	50.1%			
52	MACS	22,986	13	15,566	8	7,420	5	32.3%			
53	Nam Sung	22,692	26	18,965	22	3,727	4	16.4%	1,009	1	4.4%
54	Emirates Shipping Line	20,117	6			20,117	6	100.0%			
55	Crowley Liner Services	18,463	18	8,304	9	10,159	9	55.0%	4,800	2	26.0%
56	Mariana Express Lines	17,039	11			17,039	11	100.0%			
57	Log-In Logistica	17,024	7	8,964	4	8,060	3	47.3%	8,424	3	49.5%
58	Westwood	14,699	7			14,699	7	100.0%			
59	Dole Ocean Liner	14,427	19	9,178	10	5,249	9	36.4%	4,620	3	32.0%
60	Shanghai Hai Hua (Hasco)	13,660	18	8,336	12	5,324	6	39.0%	4,080	4	29.9%
61	Turkon Line	13,578	8	13,578	8						
62	DAL	13,556	6	1,684	1	11,872	5	87.6%			
63	Great White Fleet	13,423	20			13,423	20	100.0%			
64	Far Shipping	13,281	10			13,281	10	100.0%	3,610	2	27.2%
65	Temas Line	12,096	23	12,096	23						
66	Marfret	12,047	9	3,731	4	8,316	5	69.0%			
67	Containerships OY	11,181	13	966	1	10,215	12	91.4%	2,800	2	25.0%

68	Goto Shipping	11,120	8			11,120	8	100.0%			
69	Guangxi Hongxiang Shipping Co	10,984	23	10,984	23						
70	Peel Ports (BG Freight)	10,310	14			10,310	14	100.0%			
71	Shanghai Jin Jiang	9,990	11	9,278	10	712	1	7.1%	4,400	4	44.0%
72	King Ocean	9,961	13	158	1	9,803	12	98.4%			
73	Independent Container Line	9,573	4			9,573	4	100.0%			
74	Borchard Lines	9,550	10	5,254	5	4,296	5	45.0%			
75	Chun Kyung (CK Line)	8,967	13	3,244	8	5,723	5	63.8%	3,800	2	42.4%
76	Interworld Shipping Agency	8,847	5	8,402	3	445	2	5.0%			
77	Samskip	8,284	11	3,945	5	4,339	6	52.4%			
78	Eimskip	8,056	12	5,425	8	2,631	4	32.7%	875	1	10.9%
79	Melfi C.L.	8,040	5			8,040	5	100.0%			
80	MTT Shipping	8,010	7	4,552	4	3,458	3	43.2%			
81	Vinalines	7,281	12	7,281	12				1,794	1	24.6%
82	Boluda Lines	7,011	10	3,388	6	3,623	4	51.7%			
83	SASCO (Sakhalin Shipping Co)	6,888	16	5,224	13	1,664	3	24.2%			
84	Tropical Shg	6,789	14	4,188	11	2,601	3	38.3%			
85	Kambara Kisen	6,765	8	2,947	3	3,818	5	56.4%			
86	OPDR	6,754	10	4,490	7	2,264	3	33.5%			
87	Oceanic Cargo Lines	6,557	18	6,557	18						
88	Valfajre Eight Shg Co	6,297	9	6,297	9						
89	PSL Navegaçao	6,296	4			6,296	4	100.0%			
90	Shin Yang Shipping Sdn Bhd	6,219	17	5,506	16	713	1	11.5%			

91	Caraka Tirta Perkasa	6,103	9	5,873	8	230	1	3.8%			
92	Qatar Navigation (Milaha)	6,095	8	4,977	7	1,118	1	18.3%			
93	Ningbo Ocean Shg Co	6,021	8	5,436	7	585	1	9.7%	11,384	7	189.1%
94	Caribbean Feeder Services	5,826	8	4,162	6	1,664	2	28.6%			
95	SeaFreight	5,646	5			5,646	5	100.0%			
96	IACC	5,303	3			5,303	3	100.0%			
97	Tarros	5,211	4			5,211	4	100.0%			
98	Taicang Container Lines	5,186	8	664	2	4,522	6	87.2%			
99	Delphis NV / Team Lines	5,112	4	1,440	1	3,672	3	71.8%			
100	EAS Datong	4,764	4	2,914	3	1,850	1	38.8%			

Source: (Alphaliner, 2014)