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Analysis of the determinants of container throughput of the major ports in the Hamburg Le Havre range

by

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"The battle of life is, in most cases, fought uphill; and to win it without a struggle were perhaps to win it without honour. If there no difficulties there would be no success; if there was nothing to struggle for, there would be nothing to be achieved"
– Samuel Smiles

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Abstract

Port competition in the Hamburg Le Havre range is extremely competitive in the container segment because of the close proximity shared between these ports and overlapping hinterlands among other factors. In order to survive in this highly competitive environment, strategic planning is undertaken. Before strategic planning is undertaken, it is crucial for the ports to understand their unique determinants of their container throughput.

In this study four major container ports, one from each country in the Hamburg Le Havre range has been selected to analyze the determinants of their container throughput. In addition to other studies to port competition determinants, this study uses classical regression model to ascertain the determinants of container throughput of the selected ports and understand its significance and impact on the throughput.

Around 20 variables impacting container throughput were identified for the Port of Antwerp, Port of Hamburg, Port of Rotterdam and Port of Le Havre.

For the Port of Antwerp, 10 variables formed the determinants of its container throughput out of which 6 were found significant comprising of 4 positive determinants and 2 negative determinants. For the Port of Hamburg, 10 variables also formed the determinants of its container throughput out of which again 6 were found to be significant comprising of only 2 positive determinants and 4 negative determinants. The Port of Le Havre returned with only 5 variables that determine its container throughput out which 3 were found to be significant and 2 insignificant. Finally, for the Port of Rotterdam, 8 variables were found to determine its container throughput, 5 out which were significant and 3 insignificant.

Based on the results of the simple regression results and multi regression model of the selected ports, several long term strategies of each port were analyzed to determine to what extent they fit their unique determinants for container throughput.

This study is aimed to be useful for the port authorities of the selected ports and port stakeholders.

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List of Abbreviations

AUT	Austria
BEL	Belgium
CHE	Switzerland
CZK Rep	Czech Republic
DEU	Germany
EUR	Euro
FRA	France
GDP	Gross Domestic Product
Ha	Hectare
HUN	Hungary
M	Meter
MLN	Million
NLD	Netherlands
POL	Poland
SSS	Short Sea Shipping
SVK Rep	Slovak Republic
TEU	Twenty Feet Equivalent Unit
TT	Total Transport
Ttonne	Thousand tonne

1. Introduction

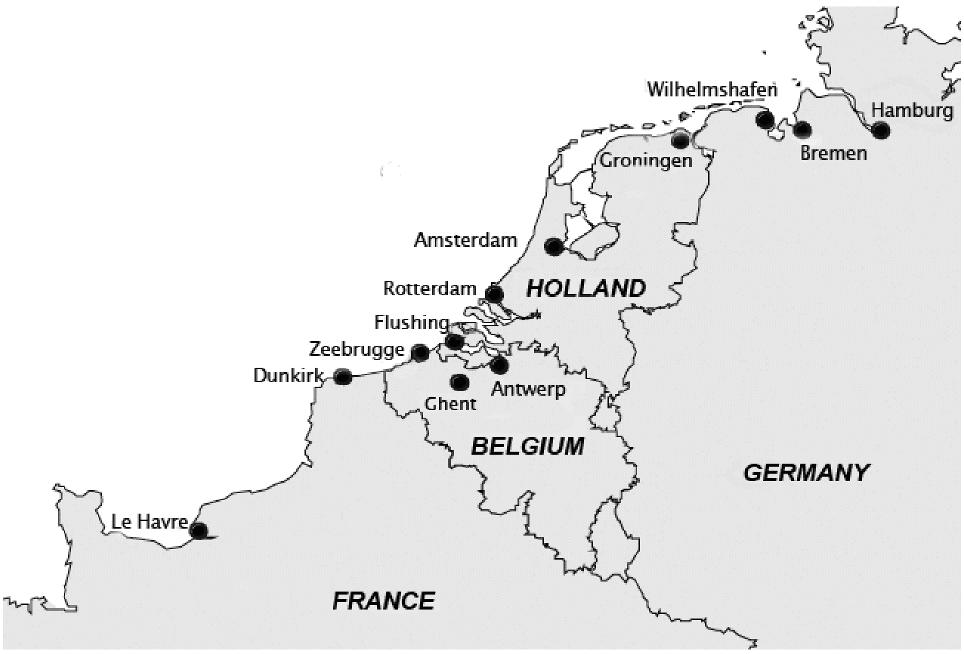
1.1 Importance of the Hamburg Le Havre Range

From Le Havre to Hamburg, the Northern Range is one of the main and most competitive port ranges in the world (Joly, 2006). Within a distance of about 850 kilometres, 11 ports are located with more than 1,224,300,000 tons throughput in 2015 (Port of Rotterdam Authority, 2016a).

The below figure 1 shows the Hamburg Le Havre range which helps in visualizing the proximity of the ports to each other.

Figure 1

Hamburg Le Havre Range



(Lasa-Epelde, n.d.)

Further, the figures of container throughput of these 11 ports are as per the below table 1 which show that the Port of Rotterdam is the most dominant container port followed by Port of Antwerp and Port of Hamburg.

(Table 1)

Container throughput in the Hamburg Le Havre Range

Sl.	Port	Country	TEU (2015)
1	Rotterdam	Netherlands	12,235,000
2	Antwerp	Belgium	9,654,000
3	Hamburg	Germany	8,821,000
4	Bremerhaven	Germany	5,547,000
5	Le Havre	France	2,559,000
6	Zeebrugge	Belgium	1,569,000
7	Wilhelmshaven	Germany	429,000
8	Dunkirk	France	317,000
9	Amsterdam	Netherlands	52,000
10	Zeeland Seaports	Netherlands	37,000
11	Ghent	Belgium	20,000

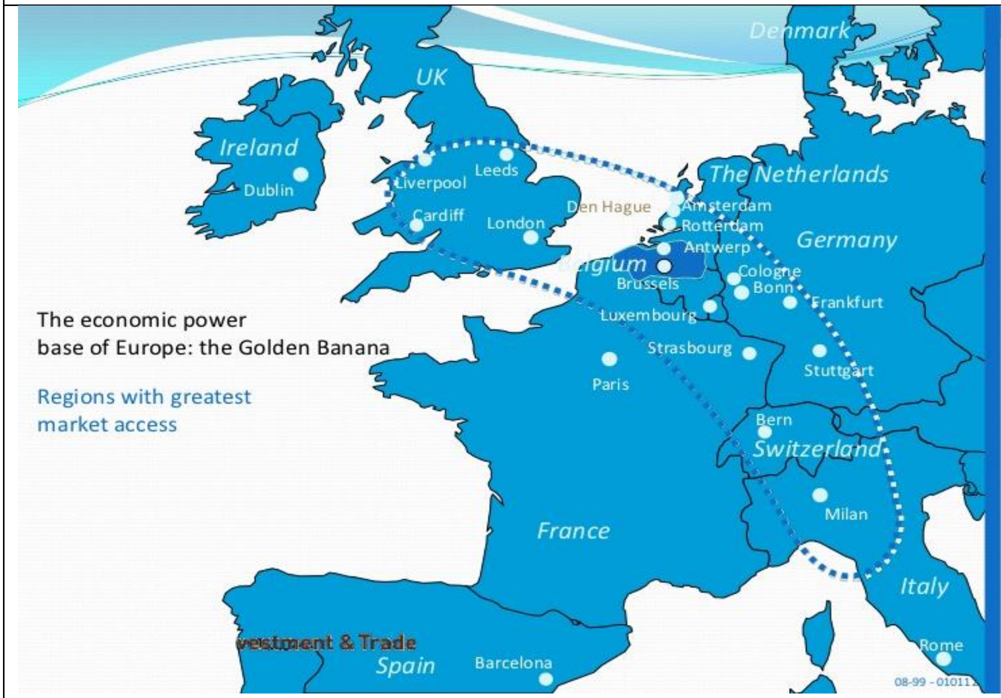
(Port Authorities & Port of Rotterdam, 2015)

The first major factor for the significance of the Hamburg Le Havre port range is that that two-thirds of the population and industry on the European continent lives in the hinterland of these ports. (Port of Rotterdam, 2011). That is a significant reason for the largescale of container handling in Northern Europe.

The industries in Europe are concentrated in a zone termed as the European Banana Zone. This zone contains a very high concentration of high value economic activity. It roughly encompasses the region from North-West England to Norther Italy. The zone is a cluster of regions that have a long history of high economic development like London, Manchester, Amsterdam, Brussels, Belgium, Venice, Cologne, Milan and Zurich (Cattoor, 2012). The below figure 2 shows the European Banana Zone.

Figure 2

European Banana Zone



(Anonymous, 2009)

The second major factor is the geography of the continent. The Alps in particular form a barrier to freight transport (Port of Rotterdam, 2011). At the same time, rivers such as the Rhine open up a large part of the continent for the highly competitive mode of transport; inland shipping (Port of Rotterdam, 2011). The same applies to railways and roads, which are easier to construct in the northern part of Europe (Port of Rotterdam, 2011).

The third factor is the size of the container vessels which transport cargo to/ from Europe. In terms of cost per container, it is more cost effective to send large ships from the Far East to Northern Europe than smaller ones to South European ports (Port of Rotterdam, 2011). It is not commercially viable to use very large ships there because of the smaller volumes.

1.2 Motivation and relevance of the study

Summarizing the above, there is a clear rationale for the Hamburg Le Havre range being the most competitive port range in Europe. However, how do each of the ports within this range compare with each other? What are their unique competitive advantages?

As the competition between sea ports is high in the Hamburg Le Havre range it is crucial to understand which are the unique determinants that impact throughput significantly and which do not. Such a study will help the port authorities of the ports and relevant stakeholders of these ports to formulate strategies on the significant determinants and investment in the related projects. Therefore, this study will help ports to have the quantitative rationale for their main competitive advantages in this range.

Furthermore, it is good tradition for ports to publish their long term strategies. The long term port strategies of the selected ports are:

a) Port of Antwerp: Sustainability Report 2015
b) Port of Hamburg: The Port Development Plan to 2025 *"Hamburg is staying on Course"*
c) Port of Le Havre: Overview of the Strategic Plan 2014-19
d) Port of Rotterdam: Port Vision 2030 - "Port Compass"

These port strategies are capital intensive and their gestation period are long. As such choosing to invest in the most significant areas which would impact its throughput positively is important and stakeholders would like to know these 'significant determinants'.

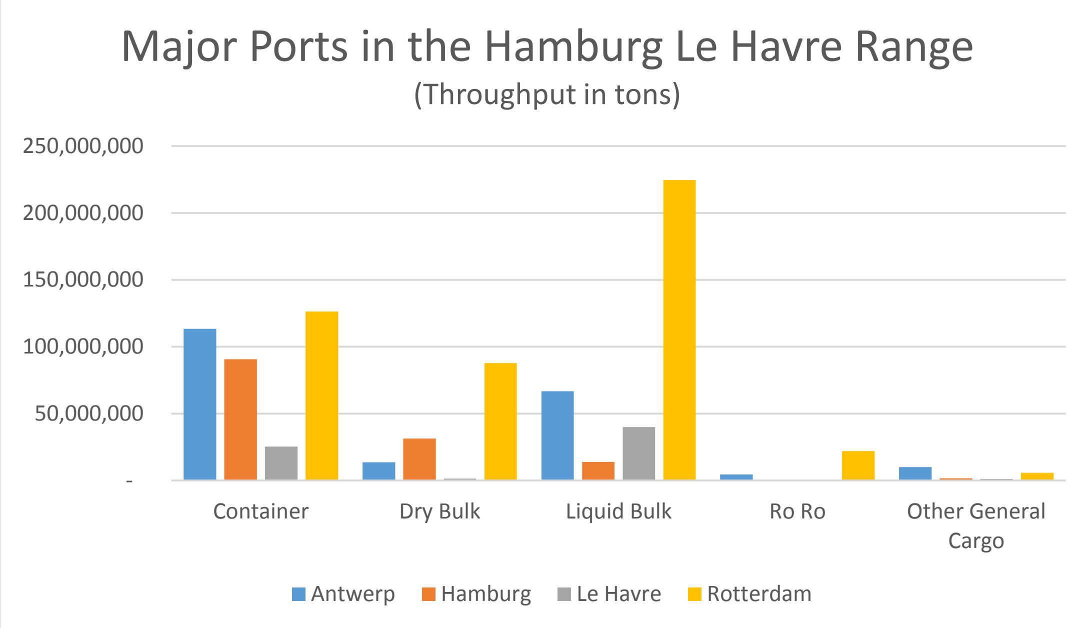
Finally, from the literature review it was observed that the regression model was successfully used in analyzing the determinants of container throughput of different ports. In their paper titled, "Empirical analysis of influence factors to container throughput in Korea and China ports" the authors used the regression model to analyze the strongest variables that impact the throughput of the port of Korea and China. They found that the strongest determinants of throughput of Korea container ports were transshipment (positive effect) and port tariff (negative effect) and for Chinese container ports it was hinterland's GDP (positive effect), hinterland's import/ export volume (positive effect) and investment made by the Government (positive effect) (Park, 2011).

However, based on the literature review, regression model has not been used by any distinguished authors for the Hamburg Le Havre range. As such this study is unique, as regression model is used to analyze the determinants of container throughput of the selected ports and its significance will be analyzed.

1.3 Scope of the research

As mentioned earlier, for the purpose of this study four ports are selected, each being the dominant container port of the particular country. As such the Port of Antwerp is selected from Belgium, Port of Hamburg is selected from Germany, Port of Rotterdam is selected from the Netherlands and Port of Le Havre is selected from France. The port throughput of these ports are depicted in figure 3 to help visualize each port's cargo segments.

Figure 3



(Port Authorities & Port of Rotterdam, 2015)

As can be seen from figure 3 above the two dominant cargo segment for all four ports are containers and liquid bulk. For the purpose of this study "container' segment is chosen. The reason for this selection is that it represents a substantial share of the selected ports. As such it becomes important to study the determinants of container throughput of these ports. Further, from the literature review undertaken, it is observed that all the selected ports want to stay competitive in the container segment.

The last motivation for studying solely the container segment is a matter of methodology. This study seeks to find the usefulness of a regression model in testing the determinants of container throughput of the ports. From the literature review undertaken it was observed that a regression model was very useful in understanding the variables that impacted the container throughput of several port/ port regions including China and Korea (Park, 2011).

1.4 Main Research Question and Sub Research Questions

The main question which the study seeks to address is, "What are the significant determinants of container throughput of the major container ports in the Hamburg Le Havre range?"

In order to answer the main research question, the study seeks to answer three sub-research questions which are critical.

First sub-research question: "What are determinants of container throughput?"

It would be imperative to first understand the commonly identified determinants of container throughput. This would be answered by the literature review that is covered by this study. There are general determinants such as GDP of a country, draft of the port, terminal efficiency, labour, etc which are common to all sea ports. Further, there are determinants identified during the literature review that apply to particular ports. In this study one of the unique variables is the hinterland as it differs from port to port. Also, the multi regression model will help identify the determinants of container throughput of the selected ports from the pool of general determinants of throughput.

Second sub-research question: "What is the significance of these determinants on the container throughput of the selected ports?

After identifying the general determinants of container port throughput it is important to understand its significance per port. i.e. how strong is the linear relationship of the determinant on the specific port's container throughput and whether it is significant or not. The strength of the linear relationship will be analysed using the simple regression method, while the significance will be determined using the multi regression model.

Third sub-research question: "How do port strategies compare with the results from the regression analysis of this study?

The selected ports in the Hamburg Le Havre range for this study have plans and vision documents for the next 10-15 years. They have outlined in these documents various areas and avenues they would be investing in. As such based on the analysis and observations from this study, the strategies of these ports will be analysed and conclusions drawn whether they have the right focus in case they want to maximize port throughput.

2. Literature review: the determinants of port throughput

Measuring port performance

To help analyze the determinants of port throughput, its impact on the performance of the port would need to be measured. Port performance can be measured in a number of ways.

The most widely used indicator is the throughput volume of goods (the number of containers in TEU or tons of cargo) (Peter de Langen, 2007). Growth of throughput is regarded as evidence of the performance of ports (Peter de Langen, 2007).

However, throughput does not provide information on the economic impact of the port and the attraction value of the port as a location for port connected industries. As such port-related employment and value added are also used as port performance indicators (Peter de Langen, 2007).

Financial indicators are also used to measure port performance as a port authority should be aware of the costs generated by its operations and the revenue resulting from them (United Nations, 1976). It is opined that port operational indicators such as service time, gang idle time & tons per ship hour at berth are more significant to port managers as through the control of these operational indicators, financial performance of the port could be controlled as well (United Nations, 1976).

As per the PPRISM report of the UNCTAD Ad Hoc Expert Meeting on Assessing Port Performance, port performance indicators include, (a) Socio Economic Indicators: employment & added value, (b) Market Trend indicators: maritime traffic & call size and (c) Logistical Indicators: maritime container connectivity & intermodal container connectivity (Fontanet, 2012)

Other performance indicators include (a) market dynamics & logistics performance indicators: i.e. maritime & intermodal connectivity and quality of customs procedures, (b) environment indicators: carbon footprint recycling measures, (c) governance indicators: autonomous management & corporate social responsibility measures sustainability and governance (Thomas, 2012).

To conclude, as the most common port performance is ‘throughput’, the same is used in this study as the common performance indicator for the four selected ports. It is also noted that in the port strategy reports of the selected ports, throughput in TEU’s is commonly used to measure the performance of the port.

In the regression model, container port throughput measured in TEU’s (Twenty-foot Equivalent Unit) has been used. TEU is an inexact unit of cargo capacity often used to describe the capacity of container ships and container terminals.

Determinants of Port Throughput

There is a lot of academic literature on determinants of port throughput and port choice. Based on the literature review, there appears to be consensus on three main areas that are of prime importance for the port throughput (1) maritime connections, (2) port efficiency and (3) the ports hinterland.

Based on the literature review, the following have been identified as the determinants of container port throughput.

2.1 Economy of the port's country

The usage of a sea port arises only when there is existence of export, imports and transshipment activities in a country. As such the sea port depends on these actors for its operationalization or in other words transport is a derived factor of the economy.

Therefore, important macroeconomic components such as a country's GDP, export and import value should be taken into account as a determinant for the port performance. Research has showed that these factors indeed has a significant influence on the port performance (Tongzon, 1994).

In their research the value of imports into a country was found to be the most significant determinant of throughput volumes (William Seabrooke et al, 2003).

It was also found that the economic development of a country has a significant influence on its sea ports performance as it is largely responsible for the ports expansion (Victor R Caldeirinha, 2009).

2.2 Geographical Location

The geographical location plays an important factor in the throughput of a sea port and therefore determines port throughput. This factor is related to the geographical location of the ports in relation to main sailing routes and to main industrial zones (Herrera, 1999). This is logical as if the port is situated close to an industrial complex it would be chosen as the center for exports and imports to the hinterland.

In the case of the ports in the Hamburg Le Havre range, the distance of the ports to important economic centers in Europe would be a crucial determinant of throughput. In this case the proximity or inclusiveness in the European Banana zone would be critical.

2.3 Accessibility

Accessibility of a port includes important factors such as pilots, draft and sea locks which determine the competitiveness of sea port. The deeper the draft of the port, the larger the container vessels would be able to access the port. Average container vessel sizes have increased continually, from 400 to 1000 TEU's in 1960's to 7000 to 9000 TEUs in 2000 and 18000 to 20000 TEU's in 2015 (Hook, 2002) (Shen, 2015). There is evidence that the draft of the sea port is critical in attracting the large vessels thereby impacting port performance (Heng, 2005), (Peter W. de Langen, 2012), (Victor R Caldeirinha, 2009). Further, insufficient water depth results in less economical vessels calling and lower efficiency of terminals (Victor R Caldeirinha, 2009). Draft is mainly a constraint on ship maneuverability and speed, and vessels with draught bigger than the lower draft will have to wait in some cases for the tide (Herrera, 1999).

Number of pilots used is an economic and nautical constraint because vessels have to reduce speed despite new techniques when pilots are boarding (Herrera, 1999). In addition, locks are important to take into consideration because they consume considerable maneuvering time. (Herrera, 1999).

2.4 Seaport Charges

Another influential factor is the amount of the port charges which are the charges that port users must pay for the services and facilities in the port. There are several costs which are incurred for a shipping company when its vessel calls at a particular port. Such charges include pilot fees, tug boat charges, gauger, port & quay dues, communication expenses, administration charges, terminal handling expenses, storage and bunkering charges, commission fees, agency fees and waste processing charges (AVV, Transport Research Centre Dutch Ministry of Transport - Public Works and Water Management, 2007).

While this has been historically an important factor, Tongzon in his paper observes that shippers (and more significantly shipping companies) are more concerned with indirect costs associated with delays, loss of markets/market share, loss of customer confidence, and opportunities foregone due to inefficient service (Tongzon, 1994).

Further, the total cost of the supply chain would be important, sea port charges only forming a part of it (Tongzon, 1994). In their paper, (Park, 2011) tested the effect of port tariff on port performance, but found a negative effect in the case of Korean and Chinese ports.

2.5 Port and terminal efficiency

It would be logical to say the port which has more number of container gantry cranes available and dedicated container berth length would be in a situation to load/ unload container vessels more efficiently than its peers. Tongzon and Heng also took in consideration the quay length of the terminal as an independent variable for the total throughput in a container port. The same was found to have a positive effect (Heng, 2005).

Further, Tongzon in his paper published in 1994 mentioned that terminal efficiency is determined by the following factors also:

a) "Container mix: composition of trade in relation to the proportions of 40 foot and 20 foot containers
b) Work practices: Delays in commencing and during stevedoring which result in inefficiency. Delays occur on account of meal breaks, equipment break down, weather etc
c) Crane efficiency: This depends on the 'number of cranes' and 'crane operations'. 3 cranes per vessel are used by highly productive ports while in others 2 cranes are used. Crane operations implies number of lifts per crane hour"

(Tongzon, 1994)

Tongzon further observed that terminal efficiency has a significant, positive impact on port performance (Tongzon, 1994).

In other instances, the container throughput in Hong Kong grew at an annual rate of 9.8%, inspite of the adverse impact of the Asian financial crisis on (Hook, 2002). High productivity and operational efficiency of container moves per crane was a reason behind it (Hook, 2002).

Other important aspects in terminal is the capacity, i.e. the maximum number of TEU's it can handle and the area of the terminal depicted in hectares. The larger the terminal area, the more number of TEU's it can manage (Carruthers, 2014).

2.6 Labour

The quality and quantity of labour available in a country can be a determinant of the performance of a port. In their paper the authors showed that labour is the most flexible component of transportation in terms of cost, time and risk (Turnbull, 2002). They argued that operating costs consists for 60-70% of labour costs (Turnbull, 2002). Labour demand and labour costs fluctuate daily, because of the variable activities in a port (Turnbull, 2002).

In the past the number of labourers was important as operations were less automated and machine dependent. However, the level of automation and mechanization has reduced the requirement of labour in areas such as loading and unloading (Lloyd's, n.d.).

2.7 Hinterland

2.7.1 Economy of hinterland

While many authors have observed that the economy of the port's country plays an important role for the port's performance, the economy of its hinterland is equally important. This is because not all countries have their own sea ports on account of them being landlocked or in case they do not have the required quality of port infrastructure. As such these countries depend on the sea ports of neighboring countries.

The findings of the authors while studying the ports of China and Korea confirm that the economic development of their hinterland had a significant influence on their port performance (Park, 2011).

2.7.2 Hinterland access

Along with the economy of the hinterland, access to the hinterland also plays a crucial role in achieving a high port performance. Several authors have opined that hinterland access is important for the competitiveness of seaports (Notteboom, 1997) and (Wever, 1998).

Ports have become parts of the supply chains. As such it would have to ensure that it has good capacity and quality of inland transport systems that can handle large volumes of goods quickly.

Hinterland access is important for seaports that have a high throughput volume where a large part of the cargo is transported to the hinterland (Chouly, 2004).

2.8 Container Traffic (choice of shipping companies)

Another important determinant for the throughput of a sea port is the ability to attract maximum container vessel traffic, i.e. container vessels that call at its port.

The choice for a port is increasingly often taken by shipowners (Huybrechts, 2002). When making the choice, competition between logistic chains takes a more important position, than competition between seaports (AVV, Transport Research Centre Dutch Ministry of Transport - Public Works and Water Management, 2007). Other factors such as hinterland connections, partnerships between shipowners and shippers / logistics service providers in hinterland transport, and the geographic and economic position of the ports play a more important role for the shipowners than just the seaport's own performance (AVV, Transport Research Centre Dutch Ministry of Transport - Public Works and Water Management, 2007).

Hence ports are often in a difficult position in this respect. On the one hand, they are no longer the most powerful partners in logistics chains; that balance has shifted in favour of shipping companies and large forwarders and shippers (Hilde Meersman, 2016).

A port's total traffic volume no longer solely depends on ‘local’ traffic, but also on the hubbing strategies of container shipping lines (Hilde Meersman, 2016). As such the ability to attract container vessels is a determinant of throughput of sea ports. It may be noted that container vessel traffic also represents the container shipping companies as ultimately the company decides on the choice of port for calling of its vessels.

2.9 Port infrastructure investment

Another important determinant that impacts the throughput of sea ports is the amount of money that is being invested in port infrastructure annually by the respective ports. Logically, investment made in port infrastructure should improve its efficiency and productivity and thereby increasing its throughput. However, it may be noted here that if investments are not being made in right areas or is not at an optimal level it would not impact the port’s performance. This is an important aspect as investment in any port infrastructure (eg. sea lock, quay areas, land reclamation) is an expensive affair and if the respective port is not able to manage its budget well, would lose out on several areas to its competitors.

This study analyses the investment decisions of the selected ports based on the results of the regression model read with the strategy documents of the selected ports. It may also be noted that such type of analysis has not yet been done by any other author based on the literature review that was undertaken making this study unique in this respect.

2.10 Short Sea Shipping

Various inland modes such as road, rail, inland waterways and pipeline are used to access the hinterland (Chouly, 2004). Short sea shipping is also one such mode that is used to access the hinterland region of the concerned port. As such this mode of transport plays an important role in transporting containers from ports to hinterland regions. This segment is particularly important in the Hamburg Le Havre range due to the fact that Europe has a respectable large coastline and as such the ports can access hinterland regions by short sea shipping efficiently.

2.11 Other factors

There are many other factors that would determine the throughput and competitiveness of a port. These include the presence of organized labour forces, i.e. trade unions, customs procedures, port policy, domestic legislations and regulations, enforcement level, political stability and environmental aspects. While these factors are important, a thorough qualitative review would need to be done and quantified to gauge its impact on throughput which is beyond the scope of this thesis. As such only those determinants that are quantified and available from public databases are used in this study.

Hypotheses

Given the literature review, the following hypotheses are presented which are necessary to prove/ disprove in order to ascertain the set of determinants of container throughput of the selected ports. It is observed from the literature review above that while each of the below variables were found to be determinants of container throughput of the concerned ports by the relevant authors, the same may/ may not be for the selected ports forming part of this study. Further, it would need to be observed if the same set of variables form the determinants of the selected ports or if it differs between each port:

Table 2

Hypotheses

No.	**Category**	**Hypotheses**
H1	Economy	The GDP of the country of a port is a determinant of its container port throughput
H2	Economy	The exports of the country of a port is a determinant of its container port throughput
H3	Economy	The imports of the country of a port is a determinant of its

		container port throughput
H4	Hinterland	The exports of the hinterland(s) of a port is/ are a determinant of its container port throughput
H5	Hinterland	The imports of the hinterland(s) of a port is/ are a determinant of its container port throughput
H6	Terminals	The total quay length of the container terminals in the port is a determinant of its container port throughput
H7	Terminals	The total terminal area of the container terminals in the port is a determinant of its container port throughput
H8	Terminals	The total number of dedicated container cranes in a port is a determinant of its container port throughput
H9	Terminals	The total container capacity in the port is a determinant of its container port throughput
H10	Inland Transport	The length of inland motorways of the country where the port is situated is a determinant of its container port throughput
H11	Inland Transport	The length of inland railways of the country where the port is situated is a determinant of its container port throughput
H12	Inland Transport	The length of inland rivers of the country where the port is situated is a determinant of its container port throughput
H13	Inland Transport	The length of inland canals of the country where the port is situated is a determinant of its container port throughput
H14	Inland Transport	The freight carried by motorways of the country where the port is situated is a determinant of its container port throughput
H15	Inland Transport	The freight carried by railways of the country where the port is situated is a determinant of its container port throughput
H16	Inland Transport	The freight carried by inland waterways (rivers & canals) of the country where the port is situated is a determinant of its container port throughput
H17	Short Sea Shipping	The freight carried through short sea shipping is a determinant of its container port throughput
H18	Labour	The labour productivity index of the country where the port is situated is a determinant of its container port throughput

H19	Choice of Shipping Companies	The number of container vessels calling at the port is a determinant of its container port throughput
H20	Investment	The amount of investment made in port infrastructure is a determinant of its container port throughput

The hypotheses have been proved/ dis-proved in the analysis section of this study

3. Profiles of the ports

On the basis of the literature review it was shown that there are various possible determinants for container throughput. In order to identify the relevant determinants for the specific ports, their profiles and characteristics first needs to be analyzed. Further, it would also be useful to observe how each of the selected ports compare in certain common determinants such as GDP, terminals and inland transport system.

The profiles and characteristics of the selected ports are presented below.

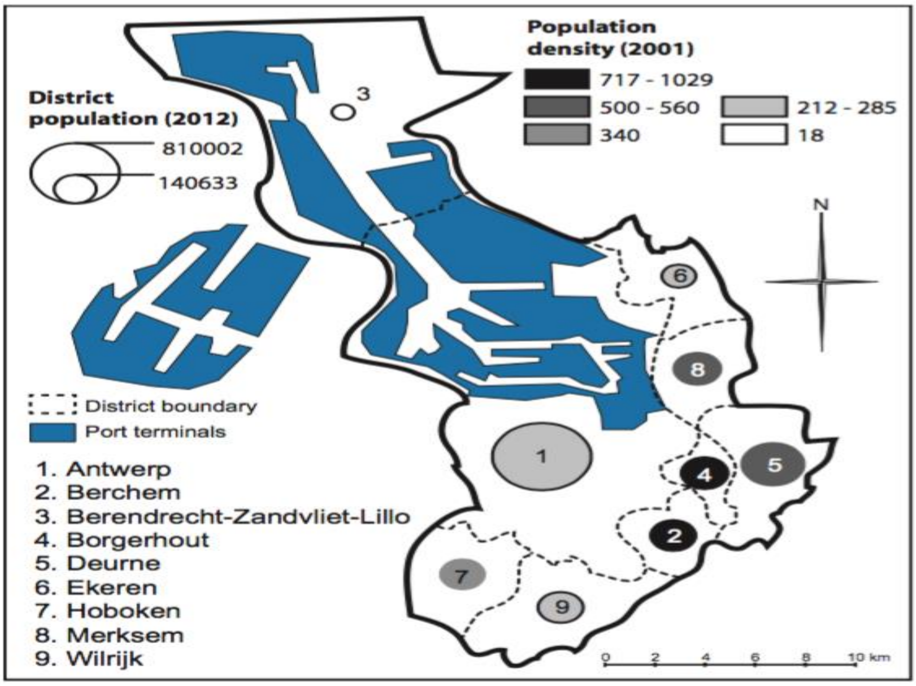
3.1 Port of Antwerp

The Port of Antwerp is an estuary port, connected via the River Scheldt to the North Sea, and is one of the largest ports in the world in terms of area (130 square kilometres), covering more than a third of the city (OECD , 2014(a)). Further, it is one of the fastest growing container ports of the Hamburg - Le Havre range (Port of Antwerp, 2016).

The port map is given below in figure 4 to get a graphical view of its layout:

Figure 4

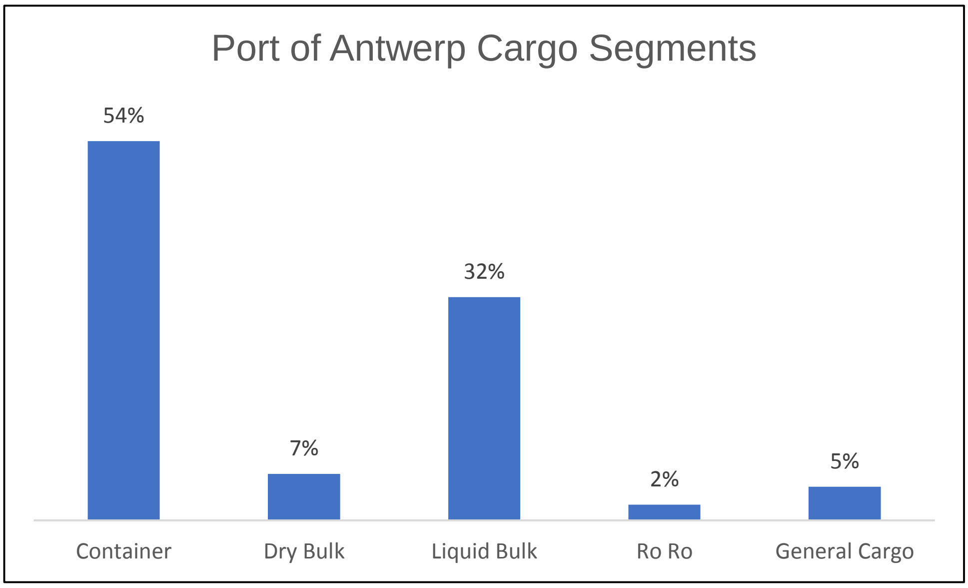
Port of Antwerp



(OECD , 2014(a))

As can been seen from figure 5 below the main cargo segment of the port of Antwerp is its container segment which contributes to more than half other total port throughput (tons) and liquid bulk cargo segment which contributes to almost 1/3rd of the port's throughput. Dry bulk contributes around 7% and such is relatively less significant.

Figure 5



(Port Authorities & Port of Rotterdam, 2015)

<u>Terminals</u>

The port of Antwerp has 6 dedicated container terminals which are given below in table 3:

Table 3

Container terminals in Port of Antwerp

	Operators Full Container Terminals	**Quay Length (meter)**	**Terminal Area (ha)**	**No Quayside Cranes**	**Total Cont. Capacity**	**Depth Alonside (meter)**
1	Independent Maritime Terminal (IMT)	700	16.7	2	200,000	12
2	PSA Europa Terminal	1180	72	9	1,800,000	14.5
3	PSA Noordzee Terminal	1125	79	10	2,100,000	17

4	MSC PSA European Right Bank Terminal (MPET)	2300	145	19	4,200,000	16
5	Antwerp Gateway Terminal	2470	126	9	1,800,000	16
6	MSC PSA European Left Bank Terminal (MPET)	2600	200	21	4,600,000	15.5
(Authors own work based on information available on website of the terminal operators)						

The port of Antwerp faces several challenges also. One of the main challenges it faces is with respect to road congestion. The roads and highways in and around Antwerp are heavily used, with considerable congestion costs resulting from. (OECD , 2014(a)).

<u>Hinterland</u>

The main hinterland regions for the Port of Antwerp are Belgium itself, the Netherlands, Germany, Switzerland and France (OECD , 2014(a)).

<u>Inland Transport</u>

In 2014, around 55% of containers was carried by road, 38% by inland waterways and 7% by railways (Port of Antwerp, 2015). The port aims to make the modal split even more sustainable by 2030, with 42% of containers carried by barge, 15% by rail and only 43% by road (Port of Antwerp, 2015).

The Port of Antwerp has access to 1,763 kms (2015 figure) of roadways, around 3,582 kms (2010 figure) of railways, 875 kms of navigable canals (2008 figure) and 641 kms of navigable rivers (2008 figure) (European Commission, 2016). Further, in 2015, roadways carried 20,769 thousand tonnes of containers and 21,655 thousnad tonnes of containers in 2014 (European Commission, 2016).

Short sea shipping carried 43,464 thousand tonnes of containers from/ to the Port of Antwerp in 2014 (European Commission, 2016).

3.2 Port of Hamburg

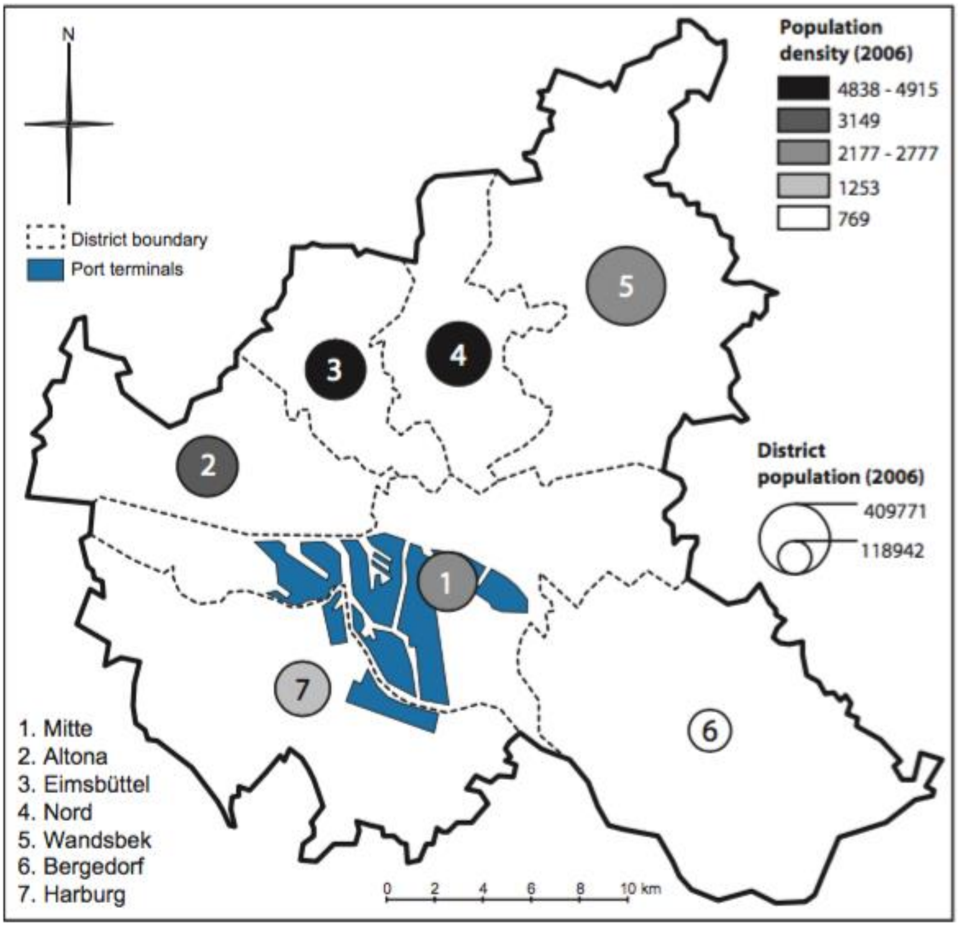
Located right in the centre of the city, the Port of Hamburg is the main hub for traffic from and to the Baltic Sea and a gateway for cargo to Central Europe (OECD , 2014(a)).

Hamburg is an estuary port, and has a disadvantage that the largest ships can only call at the port if they respect restrictive tidal conditions (OECD , 2014(a)). Another challenge the Port of Hamburg faces is with respect to the relative lack of competition in container terminal operators. The majority of container handling services is conducted by only two terminal operators, both being German companies (OECD , 2014(a)).

The following figure 6 give a graphical view of the port.

Figure 6

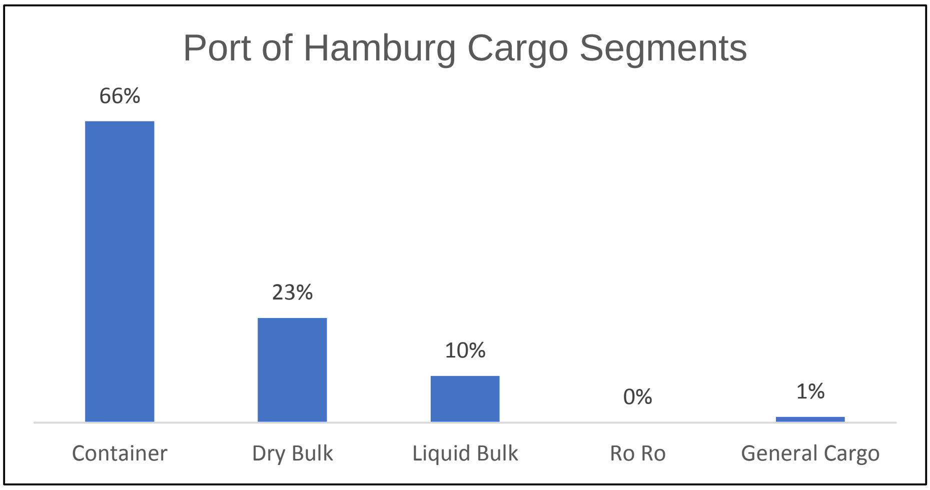
Port of Hamburg



(OECD , 2014(a))

As can be seen from figure 7, the container segment is critical for the Port of Hamburg as it determines 2/3rd of the port throughput (tons). Another important segment is the dry bulk throughput followed by the liquid bulk which is comparatively less significant.

Figure 7



(Port Authorities & Port of Rotterdam, 2015)

Terminals

The port of Hamburg has four terminals which are depicted below in table 4 along with key details:

Table 4

Container terminals of Port of Hamburg

Sl.	**Operators Full Container Terminals**	**Quay Length (meter)**	**Terminal Area (ha)**	**No Quayside Cranes**	**Total Cont. Capacity**	**Depth Alonside (meter)**
1	HHLA-Container Terminal Burchardkai CTB	2850	160	30	5,200,000	16.5
2	Tollerort Container Terminal GmbH TCT	1240	34.5	12	950,000	15.2
3	HHLA-Container Terminal Altenwerder CTA	1400	80	15	3,000,000	16.7

4	Eurogate Container Terminal Hamburg CTH	2100	140	23	4,100,000	15.5
[(Port of Hamburg, 2016) and website of terminal operators]						

Hinterland

As per OECD's report, "The Competitiveness of Global Port-Cities: The Case of Hamburg – Germany", it is noted that the German market is Hamburg's most important hinterland. Further, it is also noted that the Port of Hamburg is the first port for Hungary and Czech Republic. Other important hinterland regions for Port of Hamburg include, Poland, Switzerland, Austria and Slovak Republic (Merk, 2012).

Inland Transport

In 2010, around, 63% of containers was carried by roadways, 35% of containers was carried by railways and 2% by inland waterways (Merk, 2012).

Further, the Port of Hamburg has access to 12,949 kms of roadways, 37,775 kms of railway lines, 2,163 kms of navigable canals and 5,565 of navigable rivers in Germany as per 2014 figures (European Commission, 2016).

In 2014, roadways carried 272,822 thousand tonnes of container by roadways, 66,458 thousand tonnes by railways and 20,078 thousand tonnes by inland waterways (European Commission, 2016).

Further, short sea shipping from/ to the Port of Hamburg carried 27,619 thousand tonnes of containers in 2014 (European Commission, 2016).

3.3 Port of Le Havre

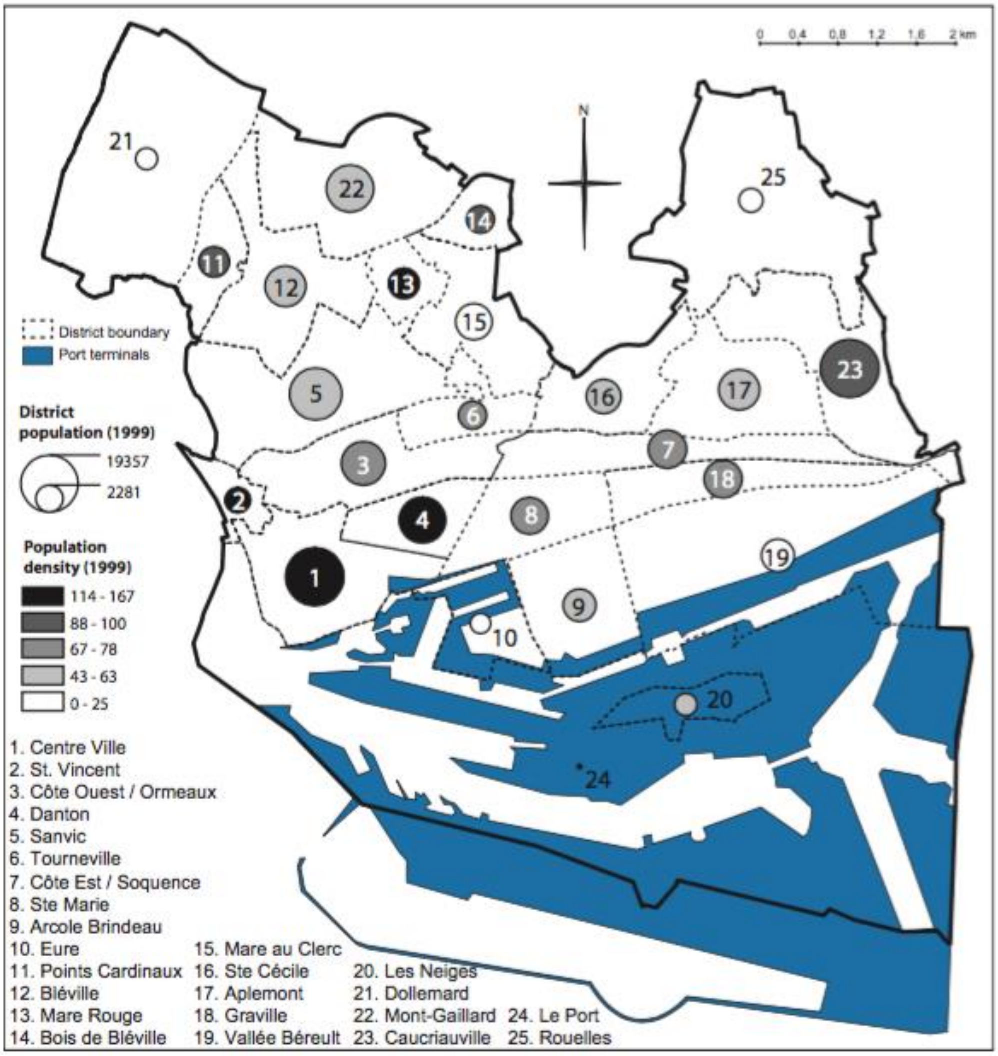
Le Havre is a small city of approximately 250 000 inhabitants with a large port, serving the greater Paris area and a large part of France (OECD , 2014(a)).

The Port of Le Havre is the largest container port in France. (World Port Source, 2016). It is France's second busiest port and the fifth biggest port in Northern Europe (World Port Source, 2016). It is a multi-purpose commercial port with a wide range of terminals that can process all types of cargo (World Port Source, 2016).

The following figure 8 gives a graphical view of the port.

Figure 8

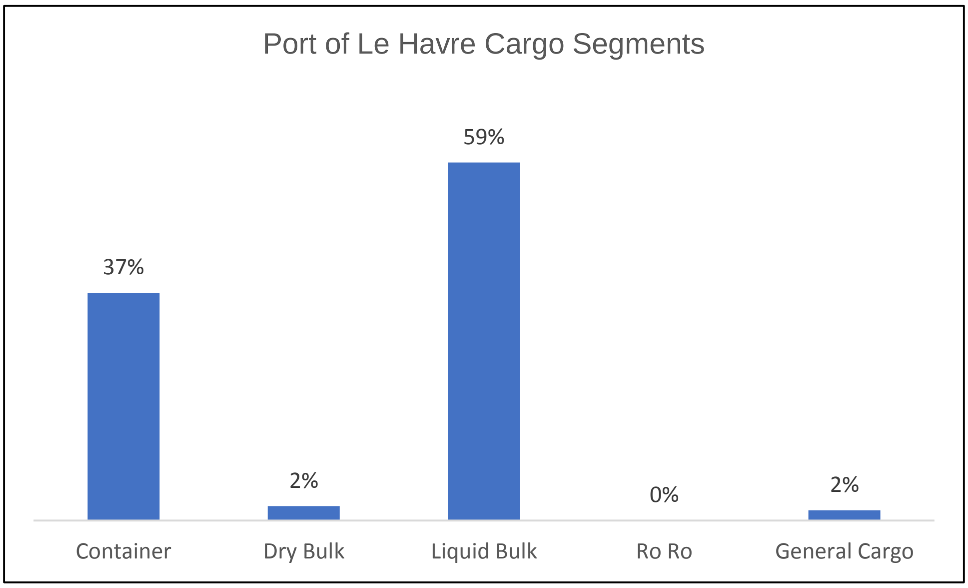
Port of Le Havre



(OECD , 2014(a))

As can be seen from the figure 9 below, the main cargo for the Port of Le Havre is Liquid Bulk which constitutes 59% of total throughput (tons) and container which constitutes 37%. The other segments are relatively less significant.

Figure 9



(Port Authorities & Port of Rotterdam, 2015)

The port faces many challenges as well. Most of the industrial development on the port site is not linked to port activities or Le Havre's local economic structure (OECD , 2014(a)). Further, hinterland modes other than road traffic remain a problem (OECD , 2014(a)).

Terminals

The Port of Le Havre has two container terminals which are given in table 5 below:

Table 5

Container terminals of Port of Le Havre

	Operators Full Container Terminals	**Quay Length (meter)**	**Terminal Area (ha)**	**No Quayside Cranes**	**Total Cont. Capacity**	**Depth Alonside (meter)**
1	Terminal Atlantic (NTB)	1308	115	8	1,645,973	14.3
2	Terminal Nord – North terminals (GMP)	1076	95	6	1,354,027	14.3

(Authors own work based on information available from website of terminal operators)

Hinterland

The Port of Le Havre has lost most of its natural hinterland to competing ports such Port of Rotterdam and Port of Antwerp (Merk, 2011). As such this is a weakness that it faces compared to other ports.

Inland Transport

At present around 85% of containers are transported by road, 10% by inland waterways and 5% by railways (Grand Port Maritime Du Havre, 2015). The target of the Port of Le Havre is to have around 75% of containers carried by roadways, 14% by inland waterways and 11% by railways by 2020 (Grand Port Maritime Du Havre, 2015).

The Port of Le Havre has access to 11,469 kms of roads, 29,386 kms of railway lines, 5,607 kms of navigable canals and 2,894 kms of navigable rivers (European Commission, 2016). In 2014, roadways carried 21,219 thousand tonnes of containers, railways carried 13,036 thousand tonnes and inland waterways carried 4,268 thousand tonnes of containers (European Commission, 2016).

The figures for short sea shipping were not available hence the same could not be ascertained and mentioned in this part of the study.

3.4 The Port of Rotterdam

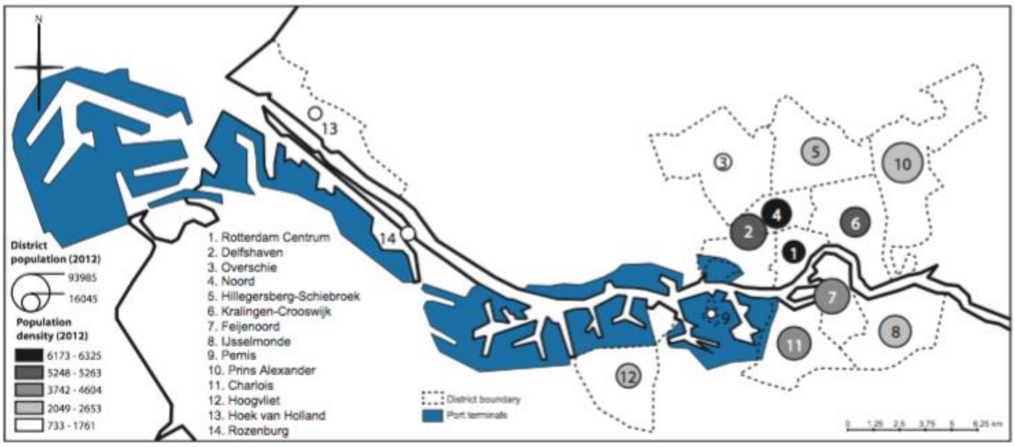
The port of Rotterdam’s annual throughput amounts to over 465 million tonnes (Port of Rotterdam, 2016d). This makes the port of Rotterdam the largest port in Europe. With respect the segment of containers, it is the largest container port in Europe. The port area includes 12,500 ha i.e. land and water (Port of Rotterdam, 2016d). Approximately 30,000 seagoing vessels and 110,000 inland vessels visit the port of Rotterdam every year. (Port of Rotterdam, 2016d). Further, it is a coastal port with the best nautical accessibility profile in north Europe (Merk, 2013).

The Port of Rotterdam, has an advantage over other ports as it has a deep draft of around 23 metres and open access to sea as there are no locks.

The following figure 10 gives a graphical view of the Port of Rotterdam.

Figure 10

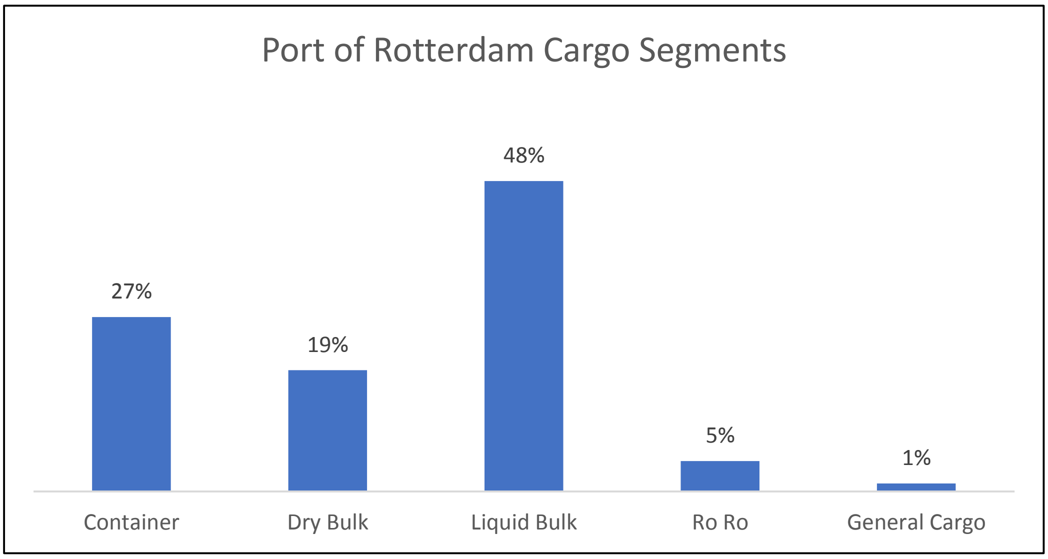
Port of Rotterdam



(OECD , 2014(a))

As can be seen from figure 11 below, the two main segments for the Port of Rotterdam are its liquid bulk segment and container segment. Other important businesses for the port of Rotterdam are its petrochemical industry and general cargo transshipment handlings.

Figure 11



(Port Authorities & Port of Rotterdam, 2015)

Terminals

Following is the summary of the certain key features of container terminals of the Port of Rotterdam in table 6:

Table 6

Container Terminals of Port of Rotterdam

	Operators Full Container Terminals	**Quay Length (meter)**	**Terminal Area (ha)**	**No Quayside Cranes**	**Total Cont. Capacity**	**Depth Alonside (meter)**
1	Rotterdam Short Sea Terminals	1800	46	14	1,440,000	11.65
2	ECT Delta Terminal	3600	272	38	5,000,000	16.65
3	Uniport Multipurpose Terminals	2400	54	9	1,200,000	14.5
4	Barge Center Waalhaven	225	6.4	2	200,000	9.65
5	APM Terminals Rotterdam	1600	100	14	3,350,000	16.65
6	Delta Container Services	260	2.5	1	150,000	12
7	Container Terminal Twente (CTT)	150	5.5	1	150,000	8
8	Rotterdam Container Terminal	400	17	3	500,000	10
9	ECT Delta Barge Feeder Terminal (barge)	890	7.5	3	880,000	10.5
10	Waalhaven Botlek Terminal (barge)	300	10.1	2	200,000	6.5
11	Euromax Terminal Rotterdam	1500	84	16	5,000,000	16.8
12	Rotterdam World Gateway	1700	108	14	2,350,000	20

13	APM Terminals Maasvlakte II	1500	86	12	2,700,000	20
(Port of Rotterdam Authority, 2016)						

Hinterland regions

As per the OECD report "The Competitiveness of Global Port-Cities: The Case of Rotterdam/Amsterdam – the Netherlands" it is observed that Germany is the most important foreign hinterland for Rotterdam. Further, Rotterdam is the largest port for Switzerland and the second largest for Austria. Other important hinterland regions include Slovak Republic, Hungary and the Czech Republic.

Inland Transport

One the reasons for its high competitiveness in Europe is because of its hinterland connections. The port of Rotterdam has an extensive intermodal network of rail, road and inland waterways that ensures that the cargo is efficiently transported from and to the rest of Europe. The main industrial and economic centres of Western Europe can be reached from Rotterdam within as less as 24 hours (Port of Rotterdam, 2016e).

The Port of Rotterdam has access to around 2600 kms of Dutch road network, 3000 kms of Dutch railways, 4700 kms of navigable canals and around 1400 kms of navigable rivers (European Commission, 2016).

In 2014, the above transport network carried 44,390 thousand tonnes of containers by road, 14,857 thousand tonnes by railway and 43,161 thousand tonnes by inland waterways (European Commission, 2016). Further, 33,943 thousand tonnes of containers was transported by short sea shipping to/ form the Port of Rotterdam (European Commission, 2016).

The modal split of inland transportation of containers of the Port of Rotterdam in 2009 was around 47% by road, 40% by inland waterways and 13% by railways. The plan is to have a shift in these modes whereby in 2035 road would carry around 35% of containers, inland waterways around 45% and railways 20%

4. Methodology

4.1 Reviewing different models

Several authors have used different models to analyse determinants of port throughput. From a literature review on the methodologies used by such authors few important ones are presented below.

4.1.1 TRANS-TOOLS model

In the paper "Combining Models and Commodity Chain Research for Making Long-Term Projections of Port Throughput: an Application to the Hamburg- Le Havre Range" the authors used the TRANS-TOOLS model to predict the port throughput of the ports in the Hamburg Le-Havre Range. The TRANS-TOOLS is an European network model that covers transport in Europe by mode of transport (road, rail, inland waterways and maritime transport) and by commodity (Peter W. de Langen, 2012). The main input of the TRANS-TOOLS model consists of socio-economic data which includes economic structure and population on a regional level and transport data on network level (Peter W. de Langen, 2012). The model translates the macro- economic scenarios into developments of freight flows in terms of projected annual growth rates for different commodities (Peter W. de Langen, 2012). For the projections of the throughput in the Hamburg – Le Havre range, the sub-model dealing with regional freight generation and interregional distribution of flows was applied since the projections focus on maritime transport flows (Peter W. de Langen, 2012).

While this model is very useful in comparing the port throughput between the ports in the Hamburge Le Havre range, it is not commonly used as it requires expert knowledge to use the same (European Commission, 2008). Further the focus of this thesis is to under the determinants of the competitiveness of the selected ports in the Hamburg Le Havre range. As such a model that gives the correlation between each variable and port throughput and significance of the determinant was required.

4.1.2 Time series and trend extrapolation

Another commonly used method for comparing the competitiveness of ports are the time series and trend extrapolation techniques that rely on historic data (Jansen, 2014). The forecasted port throughput figures of the selected ports are compared with each other to understand its competitiveness. However, the time series and trend extrapolation model does not give any correlation or insight into the variables that determine cargo throughput in ports. As such this method is not useful in understand the determinants of competitiveness.

4.1.3 Data Envelopment Analysis

Data Envelopment Analysis (DEA) is another method that has been used to analyze port competitiveness. Data envelopment analysis (DEA) is a linear programming methodology that measures the efficiency of multiple decision-making variables where the process presents a structure of multiple inputs and outputs. The technique is useful in resolving the measurement of port efficiency because the calculations are nonparametric and do not require specification or knowledge of a priori weights for the inputs or outputs, as is required for estimation of efficiency using production functions (Geoffrey Poitras, 1996). The concept of DEA is developed around the basic idea that the efficiency of a Decision Making Unit (DMU) is determined by its ability to transform inputs into desired outputs (Geoffrey Poitras, 1996). In addition to providing relative efficiency rankings, DEA also provides results on the sources of input and output inefficiency, as well as the ports which were used for the efficiency comparison (Geoffrey Poitras, 1996). The ability to identify the sources of inefficiency would be useful to port authority managers in inefficient ports, acting as a guide to focusing efforts at improving port performance (Geoffrey Poitras, 1996).

The model was used in determining the efficiency of ports and impact on competitiveness of short sea shipping versus road transport in Europe (Tovar, 2007), determining the impact of improving port infrastructure on cargo volumes in two Spanish ports (Martin-Bofarull, 2007; H.W.H. Welters, 2002), determining the efficiency of six West African ports competing for regional hub status (van Dyck, 2015), identifying factors influencing routing decisions through Rotterdam compared to other ports in Western Europe (Bückmann, 2003).

4.1.4 Classical Regression Model

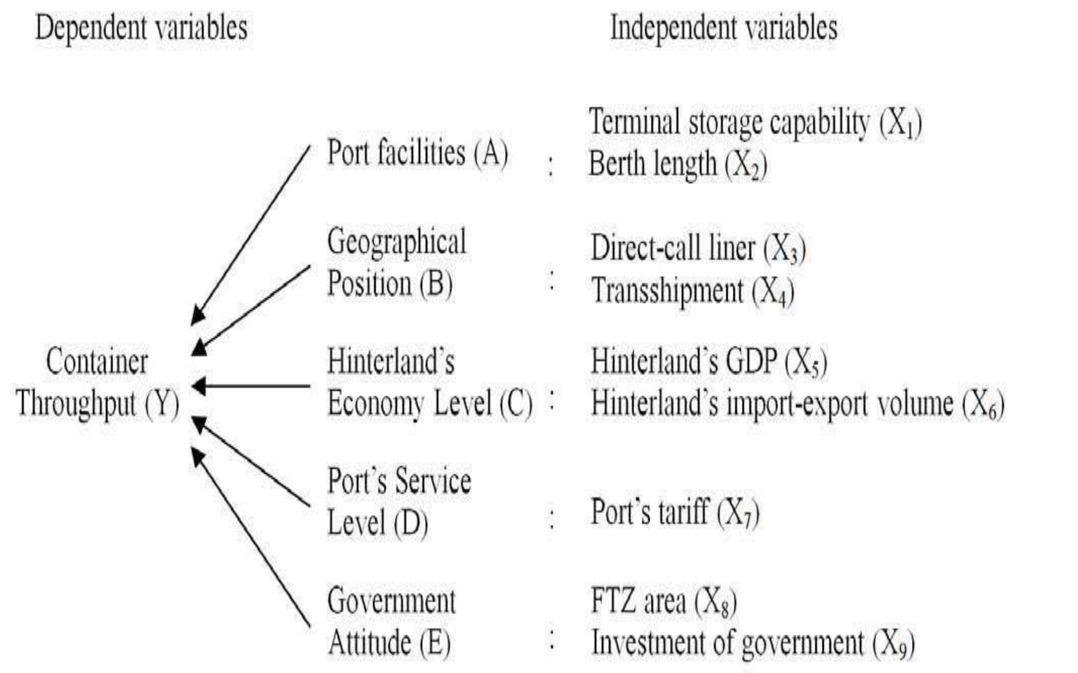
The classical regression model is another model used in practice. Regression analysis is not only used widely for prediction and forecasting, but also used to understand which independent variables are related to the dependent variable and to explore the forms of these relationships (Park, 2011). By measuring the co-movement of variables, this model detects causal relationships (Jansen, 2014). A regression analysis helps to describe data, estimate parameters and verify relations that arise from economic logic (Jansen, 2014).

It is important to mention here that regression proves if there is a linear relationship between the dependent and independent variables. It does not prove ‘causation’ of the relationship. As such ‘causation’ is proved using qualitative literature review which has been duly followed in the study.

In their paper, “Empirical Analysis of Influence Factors to Container Throughput in Korea and China Ports, the authors used the regression model to examine the relationship among container throughputs of China and Korea ports, and identify factors which determine container throughputs for China and Korea ports based on empirical data collected from 2001-2007 (Park, 2011). The authors also compared differences of port industry between China and Korea. The following variables were selected by them for their analysis:

Figure 12

Regression Model: Empirical Analysis of Influence Factors to Container Throughput in Korea and China Ports



Regression equation:

$$Y = \partial_0 + \partial_1 X_1 + \partial_2 X_2 + \partial_3 X_3 + \partial_4 X_4 + \partial_5 X_5 + \partial_6 X_6 + \partial_7 X_7 + \partial_8 X_8 + \partial_9 X_9$$

(Park, 2011)

The regression model is relatively simple to use with the help of statistical packages such as Minitab, Data Analysis Tool in Microsoft Excel and others. As such this method has been adopted to test the strength of linear relationship between the independent variables that determine container port throughput to the container port throughput measure in TEU (Twenty Foot Equivalent Unit).

4.2 Selection of variables in the regression model

Based on the literature review the following variables have been selected/ excluded from the regression model:

4.2.1 Economy of the port's country

Macroeconomic components such as the country's GDP where the selected port is situated, its exports and imports value has been used as a variable in the regression model to test if it results as a determinant of the particular port.

4.2.2 Geographical Location

This determinant has been excluded for the regression analysis. There are two reasons for this. The first reason is that all four sea ports are located in the same zone, i.e the Hamburg Le Havre range. As such this factor, though an important one would not show any useful results in the analysis of this thesis. Secondly the distance of the selected ports to the economic centers in the Blue Banana Zone is constant and as such cannot be used in the regression model. The regression model can be used only if there is more than one value of the variable.

4.2.3 Accessibility

As there was no increase in depth of the draft for any of the ports during the period of the data that has been used in the study, the same has been excluded from the regression model.

4.2.4 Seaport Charges

This factor has been excluded from the regression model and analysis of this thesis as based on the literature review that was done, it was observed that the total cost of supply chain was more important and not seaport charges alone. Total cost of supply chain is beyond the scope of this study.

4.2.5 Port and terminal efficiency

For the study, the total berth length of container terminals, the number of dedicated container cranes, the capacity of the terminal and the area of the terminal will be tested in the regression model. Other components such as berth productivity and crane moves per hour is being excluded as the same are not available in public databases and further to access them from private databases is extremely expensive.

4.2.6 Labour

For the regression model the Labour Productivity growth of the country of the port has been used to test the productivity of labour on the container throughput. The Labour Productivity growth is being used in this model as firstly, a port has varied operations and utilizes different types of skills from it labour force. As such a general labour index is being used viz. the labour productivity growth rate of the country where the port is situated. Secondly, availing port specific labour productivity related data is not available in public domain and would be a cumbersome exercise to calculate the same. Thirdly, even the if the data of each port is availed it would not be standardized between ports and hence meaningful comparision would not be easily possible. As such a standardized benchmark, i.e. the Labour Productivity growth is being used which is extracted from the OECD database and hence is credible.

4.2.7 Hinterland

4.2.7.1 Economy of hinterland

For the regression model used in this paper the hinterlands export and import value has been used for each of the hinterland region of the selected ports.

4.2.7.2 Hinterland access

The length of motorways, railway tracks and rivers & canal of the country where the port is situated is selected for the regression analysis.

Further, the volume of goods (tonnes) carried in containers over the road, railway and inland waterways has also been included in the regression model. The tonnage of goods in container will give an indication on the capacity and importance of the particular mode of transport to the port.

4.2.8 Container Traffic (choice of shipping companies)

The regression model uses container vessel traffic that calls at the selected seas port as the variable that will be tested against the container throughput. It may be noted that container vessel traffic also represents the container shipping companies as ultimately the company decides on the choice of port for calling of its vessels.

4.2.9 Port infrastructure investment

In the regression model investment in port infrastructure by the country has been used to test its impact on the throughput of the container port except the Port of Rotterdam whose previous years annual reports were referred to and investment amounts recorded. This was done as the details of investment made by Dutch stakeholders in port infrastructure projects was not available from the OECD database.

4.2.10 Short Sea Shipping

Short sea shipping volumes has been included in the regression model to test its relationship with container throughput.

4.2.11 Other factors

Other factors that determine throughput include the presence of organized labour forces, i.e. trade unions, customs procedures, port policy, domestic legislations and regulations, enforcement level, political stability and environmental aspects. As a thorough qualitative review would need to be done and quantified first, which is beyond the scope of the thesis these variables are being excluded from the regression model.

4.3 Data

For the purposes of the study the data sets were prepared using the following data sources as mentioned in table 7:

Table 7

Sources of Data used in the Study

Category	Data	Unit	Time period	Source
Economy	GDP	Million Euros	Port of Antwerp: 1999-2015 Port of Hamburg: 2000-2015 Port of Rotterdam: 1997-2015 Port of Le Havre: 1995-2014	OECD Data (OECD, 2016a)
	Exports	Million Euros	Port of Antwerp: 1999-2015 Port of Hamburg: 2000-2015 Port of Rotterdam: 1997-2015 Port of Le Havre: 1995-2014	UN Comtrade Database (United Nations, 2016)
	Imports	Million Euros	Port of Antwerp: 1999-2015	UN Comtrade

			Port of Hamburg: 2000-2015 Port of Rotterdam: 1997-2015 Port of Le Havre: 1995-2014	Database (United Nations, 2016)
Hinterland	Exports	Million Euros	Port of Antwerp: 1999-2015 Port of Hamburg: 2000-2015 Port of Rotterdam: 1997-2015 Port of Le Havre: 1995-2014	UN Comtrade Database (United Nations, 2016)
	Imports	Million Euros	Port of Antwerp: 1999-2015 Port of Hamburg: 2000-2015 Port of Rotterdam: 1997-2015 Port of Le Havre: 1995-2014	UN Comtrade Database (United Nations, 2016)
Terminals	Quay length	Meters	Port of Antwerp: 1999-2015 Port of Hamburg: 2000-2015 Port of Rotterdam: 1997-2015 Port of Le Havre: 1995-2014	Website of the selected ports
	Total terminal area	Hectares	Port of Antwerp: 1999-2015 Port of Hamburg: 2000-2015 Port of Rotterdam: 1997-2015 Port of Le Havre: 1995-2014	Website of the selected ports
	Total number of dedicated container cranes	Number	Port of Antwerp: 1999-2015 Port of Hamburg: 2000-2015 Port of Rotterdam: 1997-2015 Port of Le Havre: 1995-2014	Website of the selected ports

	Total container capacity	TEU	Port of Antwerp: 1999-2015 Port of Hamburg: 2000-2015 Port of Rotterdam: 1997-2015 Port of Le Havre: 1995-2014	Website of the selected ports
Inland Transport	Length of inland motorways	Kilometer	Port of Antwerp: 2006-2014 Port of Hamburg: 2006-2014 Port of Rotterdam: 2006-2014 Port of Le Havre: 2006-2014	Eurostat – 'Transport' (European Commission, 2016)
	Length of inland railways	Kilometer	Port of Antwerp: 2006-2014 Port of Hamburg: Not Available Port of Rotterdam: 2006-2014 Port of Le Havre: 2006-2014	Eurostat – 'Transport' (European Commission, 2016)
	Length of inland rivers	Kilometer	Port of Antwerp: 2006-2014 Port of Hamburg: Not Available Port of Rotterdam: 2006-2014 Port of Le Havre: 2006-2014	Eurostat – 'Transport' (European Commission, 2016)
	Length of inland canals	Kilometer	Port of Antwerp: 2006-2014 Port of Hamburg: Not Available Port of Rotterdam: 2006-2014 Port of Le Havre: 2006-2014	Eurostat – 'Transport' (European Commission, 2016)
	Freight carried by motorways	Thousand Tonne	Port of Antwerp: 2006-2014 Port of Hamburg: 2006-2014	Eurostat – 'Transport' (European

			Port of Rotterdam: 2006-2014 Port of Le Havre: 2006-2014	Commission, 2016)
	The freight carried by railways	Thousand Tonne	Port of Antwerp: 2006-2014 Port of Hamburg: Not Available Port of Rotterdam: 2006-2014 Port of Le Havre: 2006-2014	Eurostat – 'Transport' (European Commission, 2016)
	The freight carried by inland waterways (rivers & canals)	Thousand Tonne	Port of Antwerp: 2006-2014 Port of Hamburg: 2006-2014 Port of Rotterdam: 2006-2014 Port of Le Havre: 2006-2014	Eurostat – 'Transport' (European Commission, 2016)
Short Sea Shipping	The freight carried through short sea shipping	Thousand Tonne	Port of Antwerp: 2006-2014 Port of Hamburg: 2006-2014 Port of Rotterdam: 2006-2014 Port of Le Havre: Not Available	Eurostat – 'Transport' (European Commission, 2016)
Labour	The labour productivity index	Percentage	Port of Antwerp: 1999-2015 Port of Hamburg: 2000-2015 Port of Rotterdam: 1997-2015 Port of Le Havre: 1995-2014	OECD – 'Labour Productivity' (OECD, 2016d)
Choice of Shipping Companies	The number of container vessels calling at the port	Number	Port of Antwerp: 1999-2015 Port of Hamburg: 2000-2015 Port of Rotterdam: 1997-2015 Port of Le Havre: 2000-2008	Eurostat – 'Transport' (European Commission, 2016)

Investment	The amount of investment made in sea infrastructure	Euro	Port of Antwerp: 1999-2015 Port of Hamburg: 2000-2015 Port of Rotterdam: 2002-2015 Port of Le Havre: 1995-2014	OECD – 'Sea Infrastructure Investment' (OECD, 2016c) [For Port of Rotterdam, its annual previous year's annual reports]

From the above table 7, it is observed that the data for inland transport are for fewer years (2006 onwards) when compared to the other variables (1995 onwards). As such the multi regression model is being run twice to determine throughput, i.e. once for all the variables except inland transport & short sea shipping and the second time where only inland transport & short sea shipping variables will be used.

5. Results

Based on the regression model performed using Minitab statistical tool, the following results for each port are presented. The results include the significance of the determinants of container throughput for each of the selected ports.

5.1 Port of Antwerp

<u>Analysis of the simple regression results and multi regression model</u>

The simple regression results of the Port of Antwerp are as follows:

Table 8

Simple regression results of the Port of Antwerp

		Model					**Co-Efficient**		
Variable	**Category**	**Standard Error**	**R square**	**F Value**	**F Test**	**P Value**	**T Value**	**P Value**	**Strength of Linear Relationship**
FRA Exports (MLN EUR)	Hinterland	397900	96.14	373.52	4.54	0.0001	19.33	0.0001	Strong
FRA Imports (MLN EUR)	Hinterland	442094	95.23	299.73	4.54	0.0001	17.31	0.0001	Strong
DEU Rep Export (MLN EUR)	Hinterland	447663	95.11	291.95	4.54	0.0001	17.09	0.0001	Strong
NLD Export (MLN EUR)	Hinterland	538971	92.92	196.75	4.54	0.0001	14.03	0.0001	Strong
DEU Rep Import (MLN EUR)	Hinterland	542831	92.81	193.75	4.54	0.0001	13.92	0.0001	Strong
NLD Import (MLN EUR)	Hinterland	580149	91.79	167.76	4.54	0.0001	12.95	0.0001	Strong
BEL GDP (MLN EUR)	Economy	611008	90.90	149.77	4.54	0.0001	12.24	0.0001	Strong
BEL Export (MLN EUR)	Economy	618626	90.67	145.73	4.54	0.0001	12.07	0.0001	Strong
BEL Import (MLN EUR)	Economy	659965	89.38	126.23	4.54	0.0001	11.24	0.0001	Strong
Container Capacity (TEU)	Terminal	852916	82.26	69.56	4.54	0.0001	8.34	0.0001	Strong
Quay Side Cranes (Nos)	Terminal	853719	82.23	69.40	4.54	0.0001	8.33	0.0001	Strong
Terminal Area (Hectares)	Terminal	854325	82.20	69.28	4.54	0.0001	8.32	0.0001	Strong
Quay length (meters)	Terminal	868185	81.62	66.61	4.54	0.0001	8.16	0.0001	Strong
CHE Exports (MLN EUR)	Hinterland	996314	75.79	46.97	4.54	0.0001	6.85	0.0001	Strong

CHE Imports (MLN EUR)	Hinterland	1038566	73.70	42.03	4.54	0.0001	6.48	0.0001	Medium
Container Traffic (Nos)	Shipping Companies	1049198	73.16	40.88	4.54	0.0001	6.39	0.0001	Medium
Port of Antwerp Short Sea Shipping TT Ttonnes	Short Sea Shipping	452385	59.91	10.46	5.59	0.0144	3.23	0.0144	Medium
BEL Motorways (TT Ttonnes)	Inland Transport	619949	24.70	2.30	5.59	0.1734	1.52	0.1734	NIL
BEL Inland Waterways (TT Ttonnes)	Inland Transport	627135	22.95	2.08	5.59	0.1920	1.44	0.1920	NIL
Labour Producivity Index	Labour	1889148	12.97	2.24	4.54	0.1556	-1.50	0.1556	NIL
Investment in Sea Infrastructure (Euro)	Investment	1921919	9.93	1.65	4.54	0.2180	1.29	0.2180	NIL
BEL* Motorways (Kms)	Inland Transport	-	-	-	-	-	-	-	-
BEL* Railway lines (Kms)	Inland Transport	-	-	-	-	-	-	-	-
BEL* Railway lines (TT Ttonees)	Inland Transport	-	-	-	-	-	-	-	-
BEL* Navigable canals (Kms)	Inland Transport	-	-	-	-	-	-	-	-
BEL* Navigable rivers (Kms)	Inland Transport	-	-	-	-	-	-	-	-
Data unavailable or is constant									

As can be observed from the results of the simple regression above in Table 8, the variables that have a strong linear relationship with the throughput of the Port of Antwerp are its hinterland, local economy i.e. Belgium GDP, exports and imports and its terminals.

In its hinterland the exports and imports of France, Germany, The Netherlands and Switzerland exports are strongly linearly related to container throughput.

Further, Swiss imports, container shipping companies, and short sea shipping to/from the Port of Antwerp have a medium linear relationship to its throughput.

However, motor and inland waterways transport, labour productivity and investment in sea infrastructure did not show a linear relationship to its container throughput.

Multi Regression Model

From the below table 9 it is observed that the multi regression model of the Port of Antwerp comprises of quay length & total area of terminals, labour productivity index of Belgium, Belgium GDP, Switzerland and France exports & imports, container vessels called at the Port of Antwerp and investment made in port infrastructure.

Table 9

Multi Regression Model of Port of Antwerp

TEU = −6972662 − 399.2 Quay length (meter) + 6569 Terminal Area (ha) + 112344 Labour Productivity Index + 20.204 BEL GDP (MLN EUR) − 16.288 CHE Export (MLN EUR) + 11.919 CHE Import (MLN EUR) + 33.455 FRA Export (MLN EUR) − 18.884 FRA Import (MLN EUR) + 614.7 Container Traffic (calling) + 0.001572 Sea Infra Invest (EUR)

As can be observed from table 10 below the multi regression model of the Port of Antwerp is valid with a high R square of 99.90%.

Table 10

Model Summary of Port of Antwerp

R Square	**F-Value**	**F-Test**	**P-Value**	**Result**
99.90%	625.02	4.06	<0.0001	Valid

From the below table 11 it is observed that the total terminal area, labour productivity index, the Belgium GDP, Swiss imports, French exports, container vessels called at the Port of Antwerp and investment made in port infrastructure have a positive impact on the throughput of the Port of Antwerp. The most significant variables among these are the Belgium labour productivity index, Belgium GDP, French Exports and container traffic called at the Port of Antwerp.

On the other hand, total quay length of terminals, Swiss exports and French imports have a negative impact on the throughput of the Port of Antwerp. Amongst these, Swiss exports and French imports are the most significant variables.

Table 11 Significance of the Determinants of Port of Antwerp				
Determinant	**T Value**	**P Value**	**Relationship**	**Result**
France Exports	7.83	0.0002	Positive	Significant
Belgium GDP	7.16	0.0004	Positive	Significant
France Imports	-5.15	0.0021	Negative	Significant
Container Traffic Calling	3.62	0.0111	Positive	Significant
Labour Productivity Index	3.28	0.0167	Positive	Significant
CHE Exports	-2.01	0.0911	Negative	Significant
Terminal Area	1.63	0.1534	Positive	Insignificant
Quay Length	-1.55	0.1725	Negative	Insignificant
CHE Imports	1.54	0.1749	Positive	Insignificant
Port Infrastructure Investment	1.48	0.1898	Positive	Insignificant

Using the data recorded in 2015 of the variables in the multi regression model, the throughput is calculated:

Table 12 Calculation of container throughput of Port of Antwerp using the multi regression model			
Variable	**Coefficient [A]**	**Variable Value (2015 figures) [B]**	**Product [A] * [B]**
Constant	-6972662		-6972662
Quay length (meter)	-399	10375	-4141700
Terminal Area (ha)	6569	639	4195620
Labour productivity index	112344	0.82	92432
BEL GDP (MLN EUR)	20	446830	9027747
CHE Export (MLN EUR)	-16	262763	-4279888
CHE Import (MLN EUR)	12	227837	2715592
FRA Export (MLN EUR)	33	515750	17254416
FRA Import (MLN EUR)	-19	586346	-11072559

Container Traffic (calling)	615	4182	2570675
Sea Infra Invest (EUR)	0.0016	198447631	311960
Total as per Multi Regression Model			**9,701,633**
Total as per Recorded throughput (2015)			*9,654,000*
Difference			*47,633*

As can be observed from the above table 12 the multi regression model for the Port of Antwerp fits well and its independent variables can be used to determine and its container port throughput.

The multi regression model for inland transport for the Port of Antwerp is given below in table 13 below.

Table 13

Multi Regression Model for Inland Transport & Short Sea Shipping

BEL TEU = −456490 + 252.95 BEL Road TT - Ttonne + 7.96 BEL IW TT - Ttonne + 78.62 PoAtwp SSS TT-Ttonne

As can be observed from table 14 the multi regression model (Inland Transport and Short Sea Shipping) of the Port of Antwerp is valid with a relatively high R square of 87.91%.

Table 14

Model Summary Port of Antwerp
(Inland Transport & Short Sea Shipping)

R Square	**F-Value**	**F-Test**	**P-Value**	**Result**
87.91	12.12	5.41	0.0099	Valid

The above below table 15 shows that the short sea shipping and road transport segment is significant and has a positive impact on the throughput of the Port of Antwerp. However, inland waterways though having a positive impact is insignificant.

Table 15 Significance of the Determinants of Port of Antwerp (Inland Transport & Short Sea Shipping)				
Determinant	**T Value**	**P Value**	**Relationship**	**Result**
Port of Antwerp Short Sea Shipping (Ttonne)	4.05	0.0098	Positive	Significant
BEL Road Transport (Ttonne)	3.36	0.0201	Positive	Significant
BEL Inland Waterways (Ttonne)	0.52	0.6271	Positive	Insignificant

The below table 16 is helpful in visualizing the impact of increase of the significant determinants on the container throughput of the Port of Antwerp. It is observed that an increase of one million euro of Belgium GDP increases throughput by 20 TEU's. Further, French exports are important also as an increase of 1 million euro of it, increases throughput by 33 TEU's. Swiss exports and French imports on the other hand show a decrease of 16 and 19 TEU's respectively for every increase of 1 million euro amount.

It is observed that labour is a significant determinant, where a single percent increase in labour productivity index results in healthy increase of 112,344 TEU's.

Further for every 1 vessel that calls at the Port of Antwerp, the throughput increases by 615 TEU's.

From the inland transport & short sea shipping category it is observed that an increase of one thousand tonne volume of containers carried by short sea shipping and road transport, increases the throughput by 79 and 253 TEU's respectively.

Table 16 Significant Coefficients of the Multi Regression Model for the Port of Antwerp			
Determinant	**Category**	**Unit Increase**	**TEU increases/ (decreases) by**
Belgium GDP	Economy	1 Million Euro	20
French Exports	Hinterland	1 Million Euro	33
Swiss Exports	Hinterland	1 Million Euro	(16)
French Imports	Hinterland	1 Million Euro	(19)

Labour Productivity Index	Labour	1 Percent	112,344
Container vessels calling at port	Shipping Companies	1 vessel	615
Port of Antwerp Short Sea Shipping	Short Sea Shipping	Thousand Tonne	79
BEL Road Transport	Inland Transport	Thousand Tonne	253

Analysis of simple regression results and multi regression model with port strategy of the Port of Antwerp

In the review of the literature used in this thesis, the Sustainability Report 2015 of the Port of Antwerp was referred to, as this document contains latest information and exhaustive measures with respect to the planning and development of the port for future years.

Economy

The results of the simple and multiple regression model confirm the analysis of various authors such as that GDP of the home country plays a significant role in the port throughput of its ports (Tongzon, 1994) (Victor R Caldeirinha, 2009). Table 8 shows a strong linear relationship between GDP and the container port throughput of the Port of Antwerp. Further, as per table 16 it is observed that an increase in the GDP of Belgium by 1 million euro increases the TEU by 20 units.

Shipping Companies (Container vessels calling at port)

The Port of Antwerp, being a leading port in Europe and world, attracts well established container shipping companies. The combination of efficient, high-quality freight handling with an extensive logistics network and a strong supply of cargoes from manufacturing industry makes the port very attractive to shipping companies (Port of Antwerp, 2015). As such a large number of shipping companies, prefer to call their ships at the Port of Antwerp. The results of the simple and multi regression model also bears testament to this. Simple regression results shows a correlation of 73% between the container traffic calling at the port of Antwerp and its container port throughput. Further, the multi regression model shows that for every vessel that calls at the Port of Antwerp, the throughput increase by 615 TEU’s.

Hinterland

From the literature review it was observed that the most significant hinterlands of the Port of Antwerp are the countries of the Netherlands, Germany, Switzerland and France. In this context while the simple regression results showed a strong correlation between each of the hinterland regions and the container port throughput of the Port of Antwerp, the multi regression model identified French exports & imports and Swiss exports as the most significant determinants.

These results would imply that the Port of Antwerp is an important port for French exports along with the Port of Le Havre.

Further, French imports and Swiss exports reduce the throughput of the Port of Antwerp. A reason for this could be that these two cargos seem to be attracted by another port in Europe thereby adversely impacting the throughput of Port of Antwerp. An analysis of the competing ports would help the Port of Antwerp to formulate strategies to gain a share of this cargo thereby improving its throughput.

It is also interesting to observe from the simple regression results that the linear relationship between the container throughput of the Port of Antwerp and exports & imports of France, Germany and the Netherlands are equally strong when compared to the linear relationship between the exports & imports of its home country, i.e. Belgium and the container port throughput of the Port of Antwerp.

One of the reasons why these three countries show such strong linear relationship to the throughput of the Port of Antwerp could be that they share their territorial borders with Belgium and hence the exports and imports of these countries can be routed through the Port of Antwerp. Further, this also indicates the high competition that exists in the Hamburg Le Havre range. All ports being relatively close to one another, exporters/ importers can route their exports/ imports through any of the ports in the Hamburg Le Havre range, without being obliged to choose the port of the home country.

Labour

Labour is a significant determinant of the container port throughput of the Port of Antwerp as depicted by the multi regression model. As per the model, a one percent increase in labour productivity amounts to an increase of 112,344 TEU’s.

It may however be noted that the simple linear regression model did not show a correlation between container port throughput and labour productivity. A reason for this could be that, this variable gains significance in the multi regression model when it is used together with other variables to determine the container port throughput of the Port of Antwerp.

The Port of Antwerp acknowledges that it benefits from the high labour productivity that is characteristic of Belgium and also found in the port of Antwerp (Port of Antwerp, 2015). As such the result of the multi regression model is in coherence with the statement of the Port of Antwerp.

Port infrastructure investment

The ‘investment in port infrastructure’ is part of the multi regression model though not a significant variable. Its p-value (0.19) was marginally outside the significance limit (i.e. 0.10). Two conclusions can be drawn from this. The first one is that investment in port infrastructure is a necessary determinant and hence this forms a part of the multi regression model that determines port throughput. Secondly and more importantly, it appears that the level of investment in port infrastructure has not been ‘optimal’ due to which its significance in the multi regression model is not being established. This argument is supported by the statement made by the Port Authority of Port of Antwerp where it has declared that there has been a fall in the level of investments especially in the maritime cluster in recent years (Port of Antwerp, 2015).

Based on these analysis it would be advisable for the Port of Antwerp to follow a consistent port infrastructure investment policy and invest in such areas of the determinants of its container throughput which are positive and significant.

Inland transport

As per the sustainability report of the Port of Antwerp, in 2014 the proportion of containers carried by road was at 55%, 38% by barge and 7% by rail (Port of Antwerp, 2015).

Road transport:

The sustainability report 2015 of the Port of Antwerp realizes the importance of road transport in hinterland transport and strives to improve the technology of the vehicle fleet and load factor of it (Port of Antwerp, 2015). It may be noted from the multi regression model that road transport (load factor) is a significant variable.

Another strategy of the Port of Antwerp is to set up an extensive information system that will permit intercommunication between road operators, road users and the port community (Port of Antwerp, 2015). The aim of this system is to optimise freight handling, trip planning and use of the road network, and so reduce the amount of time lost (Port of Antwerp, 2015). It would be interesting to note the impact of this strategy. However, intuitively, with a more efficient inland transport system, the port throughput would have a positive impact.

Inland waterways:

Further, as per the sustainability report, in 2014, 38% of freight transport was by inland waterways transport (Port of Antwerp, 2015). It may be noted that Inland waterways (load factor) is not a significant variable as per the multi regression model and neither is it correlated to container port throughput as per simple regression results. As such while the percentage of freight carried by it is appreciable, its significance for container port throughput is negligible according to the modelling results for the period.

Inland railways:

It may be noted that rail transport (load factor) could not be used in the model due to unavailability of data.

Inland transport modal split:

As per the sustainability strategy of the Port of Antwerp, the port aims to make the modal split even more sustainable by 2030, with 42% of containers carried by barge, 15% by rail and only 43% by road (Port of Antwerp, 2015). Based on the results of the regression model, it appears that this strategy would adversely impact the throughput of the Port of Antwerp. This is because shifting the load from roadways which is a significant variable to inland waterways which is an insignificant variable would reduce the container port throughput of the Port of Antwerp.

A reduction of 4% of load factor from road transport which is added to inland waterways reduces container throughput by 234,348 TEU's i.e. around 3% as per the below table 17.

Table 17 Multi regression model adjusted with new intermodal split for Port of Antwerp			
Variable	**Coefficient [A]**	**Variable Value (2015 figure) [B]**	**Product [A] * [B]**
Constant	-456490	1	(456,490)
BEL Road Ttonne	252.95	22957	5,807,084
BEL Inland Watwerways Ttonne	7.96	22612	179,988
P.o.A Short Sea Shipping	78.62	43464	3,417,140
Throughput as per Multi regression model adjusted with new intermodal split			8,947,722
Throughput as per initial Multi regression model			9,182,070
Difference			*(234,348)*

As such while there may be environmental benefits by the suggested modal split, it would adversely impact container throughput.

<u>Short sea shipping</u>

It is also noticed from the simple and multiple regression model that short sea shipping is significant for the competiveness of the Port of Antwerp. In this regard, its sustainability strategy does not include plans to strengthen this mode of transport. It would be advisable for the port authorities to investigate further opportunities in short sea shipping to/ from the Port of Antwerp to maintain and improve its container throughput.

<u>Conclusion</u>

Based on the analysis of the simple regression results and multi regression model of container throughput of the Port of Antwerp it is observed that the GDP of Belgium, exports & imports of France, exports of Switzerland, container vessels that call at its port and labour are its significant determinants. On the other hand, terminal area, quay length, Switzerland imports and investments in port infrastructure, though determinants are not significant for its throughput.

It was interesting to see that the exports and imports of Belgium did not appear in the multi regression model. Instead its hinterland exports & imports (i.e. of France & Switzerland) form part of the determinants of its container throughput.

Further, it is not advisable to implement the new modal split by reducing the percentage of freight carried by roadways and increasing the percentage of freight carried by inland waterways as this negatively impacts container throughput.

5.2 Port of Hamburg

<u>Analysis of the simple regression results and multi regression model</u>

The simple regression results of the Port of Hamburg are as follows:

Table 18

Simple regression results of Port of Hamburg

		Model					**Co-Efficient**		
Variable	**Category**	**Standard Error**	**R square**	**F Value**	**F Test**	**P Value**	**T Value**	**P Value**	**Strength of Linear Relationship**
AUT Export (MLN EUR)	Hinterland	554199	91.29	146.65	4.6	0.0001	12.11	0.0001	Strong
HUN Import (MLN EUR)	Hinterland	585248	90.28	130.05	4.6	0.0001	11.4	0.0001	Strong
DEU Export (MLN EUR)	Economy	634838	88.56	108.43	4.6	0.0001	10.41	0.0001	Strong
AUT Import (MLN EUR)	Hinterland	676123	87.03	93.93	4.6	0.0001	9.69	0.0001	Strong
Port of Hamburg Short Sea Shipping TT Ttonnes	Short Sea Shipping	374949	86.13	43.47	5.59	0.0003	6.59	0.0003	Strong
HUN Export (MLN EUR)	Hinterland	749124	84.08	73.92	4.6	0.0001	8.6	0.0001	Strong
DEU Import (MLN EUR)	Economy	749939	84.04	73.73	4.6	0.0001	8.59	0.0001	Strong
CZK Import (MLN EUR)	Hinterland	808927	81.43	61.4	4.6	0.0001	7.84	0.0001	Strong
CZK Export (MLN EUR)	Hinterland	830806	80.41	57.48	4.6	0.0001	7.58	0.0001	Strong
POL Import (MLN EUR)	Hinterland	858510	79.09	52.94	4.6	0.0001	7.28	0.0001	Strong
SVK Rep Import (MLN EUR)	Hinterland	903648	76.83	46.42	4.6	0.0001	6.81	0.0001	Strong
POL Export (MLN EUR)	Hinterland	934516	75.22	42.5	4.6	0.0001	6.52	0.0001	Strong
SVK Rep Export (MLN EUR)	Hinterland	967269	73.45	38.74	4.6	0.0001	6.22	0.0001	Medium
DEU GDP (MLN EUR)	Economy	1082635	66.74	28.1	4.6	0.0001	5.3	0.0001	Medium
CHE Exports (MLN EUR)	Hinterland	1250507	55.63	17.55	4.6	0.0009	4.19	0.0009	Medium

CHE Imports (MLN EUR)	Hinterland	1255630	55.26	17.3	4.6	0.001	4.16	0.001	Medium
Container Capacity (TEU)	Terminal	1393646	44.89	11.4	4.6	0.0045	3.38	0.0045	Weak
Quay length (meters)	Terminal	1413437	43.31	10.7	4.6	0.0056	3.27	0.0056	Weak
Quay Side Cranes (Nos)	Terminal	1418048	42.94	10.54	4.6	0.0059	3.25	0.0059	Weak
Terminal Area (Hectares)	Terminal	1445058	40.75	9.63	4.6	0.0078	3.1	0.0078	Weak
DEU Inland Waterways (TT Ttonnes)	Inland Transport	782841	39.55	4.58	5.59	0.0697	-2.14	0.0697	NIL
DEU Railway lines (TT Ttonees)	Inland Transport	868957	25.51	2.4	5.59	0.1654	1.55	0.1654	NIL
Labour Producivity Index	Labour	1819943	6.02	0.9	4.6	0.3598	-0.95	0.3598	NIL
DEU Motorways (Kms)	Inland Transport	991481	3.03	0.22	5.59	0.6544	-0.47	0.6544	NIL
Container Traffic (Nos)	Shipping Companies	1856799	2.17	0.31	4.6	0.5859	-0.56	0.5859	NIL
Investment in Sea Infrastructure (Euro)	Investment	1865705	1.23	0.17	4.6	0.6823	0.42	0.6823	NIL
DEU Motorways (TT Ttonnes)	Inland Transport	1002376	0.88	0.06	5.59	0.8099	-0.25	0.8099	NIL
DEU Railway lines (Kms)	Inland Transport	1005666	0.23	0.02	5.59	0.902	0.13	0.902	NIL
DEU Navigable rivers (Kms)	Inland Transport	946051	11.71%	0.93	5.59	0.3674	-0.96	0.3674	NIL
DEU Navigable canals (Kms)	Inland Transport	1006142	0.14%	0.01	5.59	0.9244	0.1	0.9244	NIL

From the results of the simple regression model (table 18 above), it is observed that the variables which impact the throughput of the Port of Hamburg are the German GDP, exports and imports. Further, each of the hinterland regions exports and imports are linearly related to throughput of the Port of Hamburg. Austrian exports and Hungarian imports had the highest linear relationship (R square of over 90%) while Swiss exports and imports, though linearly related to the throughput was relatively less strong (R square of 55%). The other hinterland regions were strongly positively linearly related where the R square was between 73-87%.

The variables pertaining to container terminals were encouraging with a R square between 40-45%, but however cannot be considered to be strongly linearly related to port throughput.

There were surprising results as well as observed from the simple regression model. Container traffic and investment in sea infrastructure returned with R square of less than 3%. This differs from the port of Antwerp where container traffic calling at the port was found to be strongly linearly related to port throughput.

Further, inland transportation also did not seem to have a linear relationship with the port throughput. There was no linear relationship established between the volume of container freight carried through inland waterways, motorways & railways and container port throughput. Further, there was no linear relationship established between length of motorways, railways, & navigable canals/ rivers and container port throughput.

On the positive side, short sea shipping returned with a R square of 86% thereby proclaiming its importance to the Port of Hamburg’s container throughput.

Multi regression model

From the multi regression model given below in table 19 it is observed that quay length, terminal area, labour productivity index, German GDP, German exports & imports, container vessels that call at Port of Hamburg, investments in port infrastructure, Slovak Republic Exports and Czech imports determine the container port throughput of the Port of Hamburg.

Table 19

Multi Regression Model of Port of Hamburg

TEU = −156426 − 4321 Quay Length (meter) + 71138 Terminal Area (ha) − 55196 Labour Productivity Index + 0.8318 DEU GDP (MLN EUR) + 33.168 DEU Export (MLN EUR) − 6.943 DEU Import (MLN EUR) − 463.4 Container Traffic (calling) + 0.0005157 Investment in Sea Infrastructure − 179.19 SVK Rep Export (MLN EUR) − 90.37 CZK Import (MLN EUR)

As can be observed from table 20 below, the multi regression model of the Port of Hamburg is valid with a high R square of 99.74%.

Table 20

Model Summary Port of Hamburg

R Square	**F-Value**	**F-Test**	**P-Value**	**Result**
99.74%	190.91	4.74	<0.0001	Valid

The terminal area, German GDP, German Export and investment in port infrastructure have a positive impact on the container port throughput as per table 21 given below. Amongst these determinants, terminal area and German exports are significant.

Further, quay length of terminals, Labour Productivity Index, German Imports, container vessels that call at the Port of Hamburg, Slovak Republic exports and Czech imports have a negative impact on the container port throughput of the Port of Hamburg. Amongst these variables quay length of terminals, container vessels that call at Port of Hamburg, Slovak Republic exports and Czech imports are significant.

Table 21

Significance of Determinants of Port of Hamburg

Determinant	T Value	P Value	Relationship	Result
DEU Export	8.16	0.0004	Positive	Significant
SVK Rep Export	-5.50	0.0027	Negative	Significant
Container Traffic	-4.27	0.0079	Negative	Significant
CZK Import	-2.76	0.0400	Negative	Significant
Terminal Area	2.58	0.0492	Positive	Significant
Quay Length	-2.43	0.0594	Negative	Significant
DEU Import	-1.61	0.1680	Negative	Insignificant
Investment in Port Infrastructure	1.15	0.3018	Positive	Insignificant
DEU GDP	0.86	0.4278	Positive	Insignificant
Labour Productivity Index	-0.81	0.4522	Negative	Insignificant

Using the data recorded in 2015 of the variables in the multi regression model, the throughput is calculated as per table 22 given below:

Table 22

Calculation of container throughput of Port of Hamburg using the multi regression model

Variable	Coefficient [A]	Variable Value (2015 figure) [B]	Product [A] * [B]
Constant	-156426	1	-156426
Quay length (meter)	-4321	7590	-32796390
Terminal Area (ha)	71138	415	29486701
Labour productivity index	-55196	0.57	-31319
DEU GDP (MLN EUR)	0.83	3463443	2880892
DEU Export (MLN EUR)	33	1198074	39737729

DEU Import (MLN EUR)	-7	950706	-6600755
Container Traffic (calling)	-463	4111	-1905037
Sea Infra Invest (EUR)	0.0005	671533333	346310
SVK Rep Export (MLN EUR)	-179	67731	-12136748
Czech Import (MLN EUR)	-90	110270	-9965122
Total as per Multi Regression Model			**8,859,833**
Total as per Recorded throughput (2015)			8,800,000
Difference			*59,833*

The multi regression model for inland transport for the Port of Hamburg is given below in table 23 below.

Table 23 Multi Regression Model for Inland Transport & Short Sea Shipping of Port of Hamburg TEU = 5774914 − 1.275 DEU MW TT TTonnes + 65.61 DEU RLY TT TTonnes − 229.85 DEU IW TT TTonnes + 157.58 PoHmbg SSS TT TTonnes

As can be observed from table 24 below, the multi regression model of Inland Transport & Short Sea Shipping of the Port of Hamburg is valid with a high R square of 97.05%.

Table 24

Model Summary
Inland Transport & Short Sea Shipping Port of Hamburg

R Square	**F-Value**	**F-Test**	**P-Value**	**Result**
97.05%	32.88	6.39	0.0026	Valid

As can be observed from the below table 25, the significant determinants for the Port of Hamburg are its short sea shipping (load volume), German inland waterways (load volume) and German railways (load volume) out of which short sea shipping and German railways have positive relationship to container throughput while German inland waterways has a negative relationship

German motorways (load volume) on the other hand has a negative relationship to container throughput and is an insignificant determinant.

Table 25

Significance of Determinants
(Inland Transport and Short Sea Shipping)

Determinant	T Value	P Value	Relationship	Result
Port of Hamburg Short Sea Shipping	4.52	0.0107	Positive	Significant
DEU Inland Waterways	-2.56	0.0624	Negative	Significant
DEU Railways	2.54	0.0640	Positive	Significant
DEU Motorways	-0.59	0.5892	Negative	Insignificant

The below given table 26 is helpful in visualizing the impact of increase of the significant determinants on the container throughput of the Port of Hamburg.

It is interesting to note that from the economy category only the exports of Germany is a significant determinant. An increase of 1 million euro of German exports results in an increase of 33 TEU's of the container throughput of the Port of Hamburg.

Terminals variables also are significant for the Port of Hamburg. While terminal area has positive relationship where an increase of a hectare results in 71,138 TEU's increase in container throughput, quay length returns a negative relationship where an increase of 1 meter of quay length reduces container throughput by 4,321 TEU's.

From the hinterland category, Slovak Republic Exports and Czech imports are significant though both have a negative relationship to the container throughput. In increase in 1 million euro Slovak Republic exports and Czech imports results in a decrease of 179 and 90 TEU's of container throughput.

It is observed that the container shipping companies though a significant determinant for the Port of Hamburg has a negative relationship with its container throughput. For every container vessel that calls at the Port of Hamburg, it reduces the container throughput by 463 TEU's.

However, short sea shipping has a positive relationship and is a significant determinant. An increase of 1 thousand tonne transported through short sea shipping mode increases the throughput by 158 TEU's.

From the inland transport category, inland waterways and railways resulted as significant variables. Inland waterways has a negative relationship to throughput where an increase of 1 thousand tonne transported by it reduces throughput by 230 TEU's. On the other hand railways has a positive relationship where an increase of 1 thousand tonnes transported by it increase throughput by 66 TEU's.

Table 26

Significant Coefficients of the Multi Regression Model for the Port of Hamburg

Determinant	Category	Unit Increase	TEU increases/ (decreases) by
German Exports	Economy	1 Million Euro	33
Quay length	Terminal	1 Meter	(4321)
Terminal Area	Terminal	1 Hectare	71138
Slovak Republic Exports	Hinterland	1 Million Euro	(179)
Czech Imports	Hinterland	1 Million Euro	(90)
Container vessels calling at port	Shipping Companies	1 vessel	(463)
Port of Hamburg Short Sea Shipping	Short Sea Shipping	1 Thousand Tonne	158
DEU Inland Waterways	Inland Transport	1 Thousand Tonne	(230)
DEU Railways	Inland Transport	1 Thousand Tonne	66

Analysis of simple regression results and multi regression model with port strategy of the Port of Hamburg

The strategy report for the Port of Hamburg upto 2025 is "Hamburg is staying on Course The Port Development Plan to 2025" (Hamburg Port Authority, 2012).

The strategies mentioned in this report was referred and is discussed in this section along with results from the regression model.

Inland Transport

Inland waterways for the Port of Hamburg:

The most frequently used route to approach the Port of Hamburg by sea is the 130km-long passage from the North Sea on the River Elbe (Hamburg Port Authority, 2012). Other relevant waterways are the Kiel Canal for feeder transports, the Mid Elbe/Upper Elbe and the Elbe Lateral Canal that link the port to the European inland water- way network (Hamburg Port Authority, 2012). The River Elbe is one of the most significant and most frequented waterways in Europe (Hamburg Port Authority, 2012). It is the basis of the economic success of the Port of Hamburg (Hamburg Port Authority, 2012).

The Sustainability Report 2015 mentions that the share of transports by inland waterway vessels as a part of the Port of Hamburg's container hinterland traffic is still rather low. The following strategies are being used by it to improve inland waterways transport.

a) Expansion of Kiel Canal

There is a planned expansion of the Kiel canal to accommodate larger ship sizes to further increase the cost-effectiveness on this route (Hamburg Port Authority, 2012). However, from the results of the simple regression results it is observed that inland waterways load and the length of navigable canals & rivers does not linearly impact the container throughput of the Port of Hamburg. In fact, the multi regression model of Inland Transport shows that, though a significant variable, inland waterways negatively impacts the container port throughput of the Port of Hamburg.

In view of the aforementioned, it is opined that the expansion of the Kiel Canal will not have a positive impact on the container throughput of the Port of Hamburg. However, this does not imply there are no benefits from this expansion. It would intuitively seem that there would be benefits, but not impacting container port throughput. In fact the literature about this expansion mentions that it would be necessary to expand the Kiel Canal, because if it is not expanded, there is a risk that cargo bound for the Baltic Sea area will shift from Hamburg (Hamburg Port Authority, 2012). Keeping this necessity in mind, it would be advisable for the Port Authority to pursue the project but not fund it. It would hence be advisable to allow other public authorities or private players to develop this project. The Port Authority's financial resources could be better utilized on projects that have a positive linear relationship with the container port throughput of the Port of Hamburg.

b) Enhancing navigability of Mid Elbe and Upper Elbe

The Hamburg Port Development Plan upto 2025 mentions that if the navigability of the Mid Elbe and Upper Elbe is ensured, cross-border transports towards the Czech Republic are likely to increase (Hamburg Port Authority, 2012). However, as per the multi regression model it is observed that Czech exports is not a determinant of the container port throughput of the Port of Hamburg. Further, Czech imports though a significant variable has a negative impact on the container port throughput of the Port of Hamburg. As such this particular project should be cautiously pursued as there would not be any benefit for the container port throughput.

c) Fairway adjustment of the Lower Elbe and Outer Elbe River Channels

Another strategy of the Port of Hamburg is deepening the Lower Elbe and Outer Elbe River Channel by one metre for both tidal and non- tidal passages. This it predicts will bring effective short-term economic benefits and also enhance the attractiveness of Hamburg as a port site (Hamburg Port Authority, 2012). This measure should increase the throughput of the port of Hamburg. This is because large container ships which have deep draughts would be able to access the Port of Hamburg through the Lower Elbe and Outer Elbe river channels. The intended channel deepening will allow ships to carry approximately 1,000 TEU in addition to its load (Hamburg Port Authority, 2012).

d) Promotion of inland waterway transport services

The Port Development Plan 2015 mentions that in order to realise inland waterway potential, a marketing campaign to promote inland waterway vessels needs to be launched that emphasizes the ecological potential and helps to acquire potential large-volume shippers and new providers of inland waterway transport services (Hamburg Port Authority, 2012). This strategy would not yield much benefit on the container port throughput as per the results of the simple regression results and multi regression model but can be pursued as it is not capital intensive.

Road transport:

The Port Development Plan up to 2025 also mentions that the most significant mode of transport in the metropolitan region and the surrounding countries of Germany is the road (Hamburg Port Authority, 2012). The results of the simple regression results differ from this as it did not validate a linear relationship between motorways load factor and container port throughput. Further, the multi regression model showed that it was non-significant variable that had a negative relationship to the container port throughput of the Port of Hamburg. As such, while roadways may be important on account of carrying the highest container volume traffic in the inland transportation network in Germany, its impact could not be interpreted by the multi regression model.

Other plans as part of its Port Development strategy upto 2025 to ensure the long-term competitiveness of the port of Hamburg are:

1) Extending links to the main routes towards Berlin and Hanover to improve access to central and eastern Europe
2) Relieving congestion in the Elbtunnel and on Köhlbrand- brücke by building the new A 26 autobahn which connects the A 7 to the A 1
3) Expanding and extending the trunk road network
   (Hamburg Port Authority, 2012)

Based on the multi regression model, the impact of the above three plans on the container port throughput of the Port of Hamburg cannot be determined.

Shift in inter modal split:

The Hamburg Port Development Plan 2025 strives to increase the share of containers transported by rail and inland waterway vessels as these have a lower carbon footprint compared to road transport (Hamburg Port Authority, 2012). As per the results of the multi regression model, rail transport holds most promise as it is the only one which is a significant variable that has a positive impact on the container port throughput. As such it would be advisable to increase the share of containers transported by railways.

To summarise, we can observe that the Port of Hamburg is developing several strategies for improving hinterland transport. While this might be necessary, it would be advisable to look at ways of getting the funding from private players and avoid utilizing the Port Authorities budget.

Terminals

During the 2009 financial crisis, container port throughput of the Port of Hamburg dropped significantly (Hamburg Port Authority, 2012). The throughput fell from 9,737,000 TEU's in 2008 to 7,008,000 TEU's in 2009 (Port Authorities & Port of Rotterdam, 2015). It took almost 5 years to recover wherein in 2014 recorded throughput was 9,729,000 (Port Authorities & Port of Rotterdam, 2015). One of the reason why a significant drop was witnessed was low share of dedicated terminals in Hamburg compared to competing ports (Hamburg Port Authority, 2012). The simple regression results also indicates this weakness, as container terminal determinants such as quay length and number of container cranes does not show strong linear relationship to throughput. The R square was between 40-45% only. Further, the multi regression model presents terminal area as a positive significant determinant. Quay length, though part of the model shows to have a negative relationship.

One of the reasons for the different variables under terminals to have a low impact on container port throughput could be that the planning and development of the terminals, though, have taken place are not 'optimal'. Better planning would help to have a stronger impact on the container throughput of the Port of Hamburg.

Efficient utilization of space:

To enable the Port of Hamburg to actually achieve the forecasted handling potential, the Hamburg Port Development Plan 2025 prescribes sufficient capacities to be available. Due to spatial restrictions the Senate of Hamburg and the port industry has assigned priority to the subsequent areas of action:

a) Upgrading existing infrastructure and suprastructure
b) Increasing productivity at the terminals
c) Restructuring areas in the port (port expansion to the inside)
d) Developing further site potentials
(Hamburg Port Authority, 2012)

These measures should improve the container throughput. Using the multi regression model, the impact of restructuring and developing further terminal area sites on container port throughput is predicted. An increase in total terminal area from the present 415 hectares to 425 hectares increases throughput from around 8.8 million TEU to around 9.6 million (table 27) TEU while an increase to 450 hectares improves TEU to around 11.4 million TEU (table 28)

Table 27

Impact on throughput by increase in terminal area to 425 hectares

Variable	**Coefficient [A]**	**Variable Value (2015 figure) [B]**	**Product [A] * [B]**
Constant	-156426	1	-156426
Quay length (meter)	-4321	7590	-32796390

Terminal Area (ha)	71138	425	30233650
Labour productivity index	-55196	0.57	-31319
DEU GDP (MLN EUR)	0.83	3463443	2880892
DEU Export (MLN EUR)	33	1198074	39737729
DEU Import (MLN EUR)	-7	950706	-6600755
Container Traffic (calling)	-463	4111	-1905037
Sea Infra Invest (EUR)	0.0005	671533333	346310
SVK Rep Export (MLN EUR)	-179	67731	-12136748
Czech Import (MLN EUR)	-90	110270	-9965122
Total as per Multi Regression Model			**9,606,782**
Total as per Recorded throughput 2015			8,800,000
Increase in TEU			806,782

Table 28

Impact on throughput by increase in terminal area to 450 hectares

Variable	**Coefficient [A]**	**Variable Value (2015 figure) [B]**	**Product [A] * [B]**
Constant	-156426	1	-156426
Quay length (meter)	-4321	7590	-32796390
Terminal Area (ha)	71138	450	32012100
Labour productivity index	-55196	0.57	-31319
DEU GDP (MLN EUR)	0.83	3463443	2880892
DEU Export (MLN EUR)	33	1198074	39737729
DEU Import (MLN EUR)	-7	950706	-6600755
Container Traffic (calling)	-463	4111	-1905037
Sea Infra Invest (EUR)	0.0005	671533333	346310
SVK Rep Export (MLN EUR)	-179	67731	-12136748
Czech Import (MLN EUR)	-90	110270	-9965122
Total as per Multi Regression Model			**11,385,232**
Total as per Recorded throughput 2015			8,800,000
Increase in TEU			2,585,232

Terminal Capacities:

The port of Hamburg realizes the potential of upgrading container terminal facilities. It includes in its port development strategy the further optimisation and expansion of terminal sites both in Altenwerder and Tollerort that would create a further 2m to 3m TEU handling capacity annually and ensure that Hamburg will stays in the growth lane

(Hamburg Port Authority, 2012).

The Association of Hamburg Port Operators [Unterneh-mensverband Hafen Hamburg] reckons with the following future container handling capacities:

1) Container Terminal Altenwerder – 4mln TEU
2) Container Terminal Burchardkai - 6mln TEU
3) Container Terminal Hamburg (Waltershof) – 6mln TEU
4) Container Terminal Tollerort - 4mln TEU
   (Hamburg Port Authority, 2012)

From the results of the simple regression it is observed that increase in terminal capacity has a weak linear relationship with port throughput (R square 44.89%) while the multi regression model does not include terminal capacity in the model. As such the above expansion would not have a strong impact on the container port throughput of the Port of Hamburg.

Quay Length:

As part of its Land Strategy, the Port of Hamburg has aimed to optimize, make compact and intensify land including quay facilities (Hamburg Port Authority, 2012).

It is noted from the multi regression model that quay length of terminals shows a negative relationship to the container port throughput. This gives an indication that the quay length of its terminals are not being utilized efficiently. Given this scenario, the aforementioned strategy appears to be in the right direction.

Short Sea Shipping

Short-sea shipping and feeder services to and from northern, central and eastern Europe and Hamburg moved a significant 1.6m TEU in 2010 and about 2.4m TEU in 2011 (Hamburg Port Authority, 2012). This validates the results of the regression where short sea shipping showed a strong 86.13% R square linear relationship with the container port throughput. Further the multi regression model also shows that short sea shipping is a significant variable and has a positive relationship to container port throughput.

There were no strategies found in the Port Development Plan upto 2025 of the Port of Hamburg regarding measures to develop this segment. It would be advisable to invest in short sea shipping projects as this definitely has positive impact on the container throughput of the Port of Hamburg.

Hinterland

The Port of Hamburg recognizes that it faces competition with other ports for its hinterland. It is observed that the hinterland is crucial for the competitiveness of the Port of Hamburg as validated by several authors and also from the results of the simple regression and multi regression model. In this regard, as part of its development plans, the Port of Hamburg has improvement of hinterland connections as an important target (Hamburg Port Authority, 2012).

Based on the analysis of the hinterland transport of the Port of Hamburg made earlier, it would be advisable to use railways and short sea shipping to pursue this strategy as both forms of transport have a positive impact on container port throughput.

Investment in port infrastructure

The Hamburg Port Development Plan upto 2025 mentions that new production and consumption centres as well as larger overall production, trade and transport volumes will require considerable investment in all areas of infrastructure. (Hamburg Port Authority, 2012). Further, new funding models involving private partners will be leaned on to provide infrastructure facilities in accordance with demand (Hamburg Port Authority, 2012). New funding models by involving private players is a very good decision by the Port of Hamburg.

The simple regression results show that sea infrastructure investments do not have a linear relationship with port throughput. Further, the multi regression model show that while investment in port infrastructure is a determinant, it is not significant. These results indicate that investment in port infrastructure is not optimal.

As such it would be advisable to invest only in those areas of port infrastructure which have a positive and significant impact on container port throughput and involve private players for the funding of other port projects allowing the budget of the Port Authority of Hamburg to be used effectively.

Shipping Companies

All over the world shipping companies hold interests in terminals to use them exclusively. Such terminals are known as dedicated terminals. From a port-strategic point of view dedicated terminals offer advantages as well as dis advantages. Dedicated terminals help in stabilizing handling of cargo in economically weak periods and generate additional volume during an upswing. A possible disadvantage of dedicated terminals may lie in the fact that a port becomes economically dependent on specific shipping companies.

From the results of the simple regression it is observed that the number of container vessels calling at the Port of Hamburg does not have a linear relationship to its container throughput. Further, as per the multi regression model also, the number of vessels that call at the Port of Hamburg, though a significant variable has a negative relationship to the container port throughput.

As such in light of the aforementioned results, the plan to have dedicated terminals can thus be anlaysed from two views. First, the ratio of dedicated terminals should be on the lower side to allow more number of vessels of different shipping companies to call at the Port of Hamburg. This strategy is used taking the Port of Antwerp as an example for whom the number of shipping companies represented by the number of container vessels calling at its port has a strong linear relationship to its throughput.

Another strategy would be to have a higher ratio of dedicated terminals provided though that the agreement allows minimum committed cargo handling loads. This will allow the terminal area to be used effectively contributing to high port throughput.

It may be noted here that the within the scope of the future allocations of the Port of

Hamburg, the option to establish dedicated terminals has not been excluded outright by it (Hamburg Port Authority, 2012).

Land constraints

"Hamburg faces stiff competition from other ports in North-Western Europe most of which unlike Hamburg are able to offer large sites when it comes to attracting businesses that benefit economically from being close to a waterway and look for a site. The only sites available in Hamburg suitable to house modern port facilities are located in the area of the Southern Elbe. The northern banks of the River Elbe mark the state boundary and in Harburg, the Elbbrücken and the densely populated Wilhelmsburg area restrict development". (Hamburg Port Authority, 2012)

The zone I expansion area (Moorburg) offers the last large cohesive site with excellent infrastructure connections to the navigation channel, the railway network and the autobahns and thus represents the only option to develop another section of the port (Hamburg Port Authority, 2012).

As such land constraints will in the long run compromise the competitiveness of the Port of Hamburg. This is a weakness of the Port of Hamburg.

Conclusion

From the analysis of the Port of Hamburg it is observed that the significant determinants of its container throughput are German exports and terminal area which have a positive relationship to it. The other significant determinants include, Slovak Republic exports, container vessels that call at the Port of Hamburg, Czech imports and quay length, all of which have a negative relationship to its throughput.

While comparing the strategies of the port of Hamburg to the simple regression results and multi regression model, it is observed that the plans with regard to inland transport i.e. expansion of Kiel Canal, enhancing navigability of Mid Elbe and Upper Elbe, fairway adjustment of the Lower Elbe and Outer Elbe River Channels and promotion of inland waterways transport services would not have a positive linear relationship to container throughput. As such it is advisable for the Port of Hamburg to involve private players and other institutions to invest in these projects.

Further, roadways resulted as an insignificant determinant and as such the impact other road strategies of the Port of Hamburg cannot be determined. As such the Port of Hamburg is cautioned on their road stratgies and should thoroughly analyze with other statisticala and econometeric models to gauge the impact on container throughput.

With regard to inter modal split of transport, it is advisable to implement strategies to increase the load of freight in favour of rail transport as it is a positive significant determinant and will thereby increase the container throughput of Port of Hamburg.

Moving onto terminals it is observed that apart from terminal area, the other variables do not have a positive relationship to container throughput. The Port of Hamburg is aware of the shortcomings of its terminals and has formulated strategies with respect tou upgrading infrastructure and increasing productivity at the terminals which intuitevely should show positive results in the future. Further, as it faces sever space constraints its strategies pertaining to restructuring areas in the port and developing further site potentials are a welcome move and will have a positive impact on container throughput.

On the other hand, strategies pertaining to increase of terminal capacities should be purused with caution as it did not appear as a determinant in the multi regression model. Strategies with regard to optmisation of quay length is in the right direction.

Short sea shipping holds a lot of promise, though there does not seem to be any strategies for its development by the Port of Hamburg. The port should promote this mode of transport for higher container throughput levels.

Investment in port infrastructure should be done carefully because even though it was a determinant of container throughput as per the multi regression model, it was found not be significant and hence its impact cannot be gauged. It would be advisable to use different statistical and econometeric models to aid in future investment strategies.

Lastly, with regard to the attraction value of shipping companies to the Port of Hamburg, it was observed that container vessels calling at the port is a significant determinant, but negative. As such formulation of strategies relating to dedicated terminals can be made in either direction, i.e. infavour of it or against it

5.3 Port of Le Havre

The simple regression results of the Port of Le Havre are as follows in table 29 below:

Table 29

Simple regression results of the Port of Le Havre

		Model					Co-Efficient		
Variable	Categories	Standard Error	R square	F Value	F Test	P Value	T Value	P Value	Strength of Linear Relationship
FRA GDP (MLN EUR)	Economy	195126	87.48	125.78	4.41	0.0001	11.22	0.0001	Strong
FRA Export (MLN EUR)	Economy	219955	84.09	95.15	4.41	0.0001	9.75	0.0001	Strong
FRA Import (MLN EUR)	Economy	233034	82.14	82.81	4.41	0.0001	9.1	0.0001	Strong
Investment in Sea Infrastructure (Euro)	Investment	416957	42.84	13.49	4.41	0.0170	3.67	0.0170	Weak
Labour Producivity Index	Labour	454743	32	8.47	4.41	0.0093	-2.91	0.0093	Weak
Container Traffic (Nos)	Shipping Companies	380636	18.45	1.58	5.59	0.2486	1.26	0.2486	NIL

FRA Railway lines (TT Ttonees)	Inland Transport	169465	10.16	0.79	5.59	0.4032	0.89	0.4032	NIL
FRA Motorways (TT Ttonnes)	Inland Transport	175163	4.02	0.29	5.59	0.6052	-0.54	0.6052	NIL
FRA Motorways (Kms)	Inland Transport	177084	1.9	0.14	5.59	0.7236	0.37	0.7236	NIL
FRA Railway lines (Kms)	Inland Transport	177664	1.26	0.09	5.59	0.7740	0.3	0.7740	NIL
FRA Inland Waterways (TT Ttonnes)	Inland Transport	178712	0.09	0.01	5.59	0.9397	-0.08	0.9397	NIL
*Quay length (meters)	Terminal	-	-	-	-	-	-	-	-
*Terminal Area (Hectares)	Terminal	-	-	-	-	-	-	-	-
*Quay Side Cranes (Nos)	Terminal	-	-	-	-	-	-	-	-
*Container Capacity (TEU)	Terminal	-	-	-	-	-	-	-	-
*FRA Navigable canals (Kms)	Inland Transport	-	-	-	-	-	-	-	-
*FRA Navigable rivers (Kms)	Inland Transport	-	-	-	-	-	-	-	-
*Port of Le Havre Short Sea *Shipping TT Ttonnes	Short Sea Shipping	-	-	-	-	-	-	-	-
** Data unavailable or is constant*									

<u>Analysis of the results of simple regression</u>

The most significant variable were the French GDP, exports and imports. The linear relationship was established for all 3 variables with a R square of 87% for French GDP, 84% for French exports and 82% for French imports.

French labour productivity index returned with a valid model, though the linear relationship was weak with R square of 32%. However, it is interesting to note that the Port of Le Havre is the only port amongst all four ports analyzed in this thesis to have a linear relationship of the labour productivity index of its country (France) to its container port throughput. As such it is advisable for the Port Authorities to find out opportunities to improve the quality of labour. This in future holds potential to increase the strength of the linear relationship which would have a positive impact on the container port throughput.

Investment in sea infrastructure (including ports) returned with R square of 43% for sea infrastructure investment. As such the linear relationship though was found to be present is ‘weak’. Again it was interesting to note that, the Port of Le Havre was the only port amongst all four analyzed to have linear relationship between the investments made in sea infrastructure and its container port throughput. This finding is a welcome observation which would give a lot of confidence to the Port Authorities and other investors to invest in sea infrastructure projects such as sea locks and other port infrastructure projects.

The model was found to be invalid for the test with respect to inland transportation means which included motorways (length and load factor), railway lines (length and load factor) and inland waterways (load factor). Data was not available for the length of navigable rivers & canals and hence the model could not be tested for these variables.

The model could also not be tested for short sea shipping due to unavailability of data.

The model was found to be invalid for container vessel calling at the Port of Le Havre.

Terminal variables such as quay length, cranes and terminal areas have been constant during the previous years. Hence the simple regression results for these variables could not be produced.

Multi regression model

The determinants of the container port throughput of the Port of Le Havre are the GDP of France, French exports & imports, French labour productivity index and investment in port infrastructure.

The multi regression model for the Port of Le Havre containing the determinants of its container port throughput is as follows in table 30.

Table 30

Multi Regression Model for Port of Le Havre

TEU = −1778291 − 29253 Labour Productivity Index + 1.3850 FRA GDP (MLN EUR) + 18.743 FRA Export (MLN EUR) − 13.874 FRA Import (MLN EUR) + 0.0000376 Investment in Port Infrastructure

As can be seen from the table 31 below the multi regression model for the Port of Le Havre is valid and has a R square of 95.15%

Table 31

Model Summary of Multi regression model
Port of Le Havre

R Square	**F-Value**	**F-Test**	**P-Value**	**Result**
95.15%	54.9	2.96	<0.0001	Valid

The significance of determinants of the Port of Le Havre are presented in table 32 below.

The French GDP, French exports and investment have a positive impact on the throughput, among which French GDP and French exports are significant.

French imports and French labour productivity index have a negative impact on the throughput among which French imports is significant.

Table 32

Significance of determinants of Port of Le Havre

Determinant	T Value	P Value	Relationship	Result
FRA Export	4.29	0.0007	Positive	Significant
FRA GDP	4.1	0.0011	Positive	Significant
FRA Import	-4.01	0.0013	Negative	Significant
Labour Productivity Index	-0.83	0.4219	Negative	Insignificant
Investment in Port Infrastructure	0.08	0.9359	Positive	Insignificant

Using the data recorded in 2014 of the variables in the multi regression model, the throughput is calculated as per below table 33:

Table 33

Calculation of container throughput of Port of Le Havre using the multi regression model

Variable	Coefficient [A]	Variable Value (2014 figure) [B]	Product [A] * [B]
Constant	-1778291	1	-1778291
FRA GDP (MLN EUR)	1.39	2352033	3257566
FRA Export (MLN EUR)	19	509991	9558753
FRA Import (MLN EUR)	-14	593885	-8239559
Investment in Port Infrastructure	0.000038	460000000	17296
Labour Productivity	-29253	0	1747
Total as per Multi Regression Model			**2,817,512**
Total as per recorded throughput (2014)			2,551,000
Difference			*266,512*

Multi regression model for inland transport

The multi regression model for inland transport of the Port of Le Havre did not present a valid model. The following table 34 gives the details of its invalidity.

Table 34

Model Summary of Port of Le Havre
(Inland Transport & Short Sea Shipping)

R Square	F-Value	F-Test	P-Value	Result
12.99%	0.25	5.41	0.8592	Invalid

The significant coefficients of the multi regression model of the Port of Le Havre are presented in the below table 35.

As can be seen observed from the table, an increase of 1 million euro of French GDP and exports increase the container throughput of the Port of Le Havre by 1 TEU and 19 TEU respectively. As such French exports is extremely crucial for the container throughput of the Port of Le Havre.

On the other hand an increase of 1 million euro in the French imports reduces the container throughput by 14 TEU's.

Table 35

Port of Le Havre - Coefficients

Determinant	Category	Unit Increase	TEU increases by
French GDP	Economy	1 Million Euro	1
French Exports	Economy	1 Million Euro	19
French Imports	Economy	1 Million Euro	(14)

Analysis of the simple regression results and multi regression model with port strategy of the Port of Le Havre

The 2014-19 Strategic Plan of the Port of Le Havre was referred to understand its long term objectives and strategies that would be adopted to increase its competitiveness. The 2014 - 2019 Strategic Plan was approved by the Supervisory Board on 26 June 2015 (Grand Port Maritime Du Havre, 2015).

As per the 2014-19 Strategic Plan containers has been identified as the activity that has the greatest potential for development and is a major stake for the institution, the port community and the Seine corridor as a whole. (Grand Port Maritime Du Havre, 2015)"

Container Traffic

The 2014-19 plan outlines for the berthing of larger vessels (Grand Port Maritime Du Havre, 2015). While this strategy is appreciable, the maximum draft of Port of Le Havre currently is at 15.50 meters. Vessels such as the Emma Maersk have a draught of around 16 meters (Maersk, n.d.). As such the depth of port would need to be sufficiently increased to allow the larger vessels to call. Deepening of the depth, was not an identified strategy in the 2014-19 plan.

Hinterland

The 2014-19 Plan provides for the establishment of the Multimodal Terminal, improving rail connections (in particular the Serqueux-Gisors line), and the development of combined maritime and inland waterway transport that would help improve the performance of multimodal solutions and the port's capacity to expand its hinterland and increase traffic (Grand Port Maritime Du Havre, 2015).

It would be challenge to implement this strategy as the hinterland of Port of Le Havre has been captured by other ports. As such it would need to compete with ports who would already have established themselves in the hinterland regions. Secondly, based on the results of simple regression it was observed that there was no linear relationship found between TEU throughput of Port of Le Havre and any of the inland transport variables. Further, the multi regression model for France inland transport on container port throughput was found to be invalid.

Investment in Port Infrastructure

From the simple regression results it is observed that investment in port infrastructure has a weak linear relationship with container throughput of the Port of Le Havre. Also, the multi regression model does not include investment in port infrastructure as a determinant of throughput.

The Port 2014-19The Port 2014-19 Plan mentions that European funding can be solicited to develop ports, railways, inland waterways and multimodal systems, such as the facilities needed to increase capacity on the Paris-Le Havre rail link via the traditional route, or through Gisors-Serqueux in particular (Grand Port Maritime Du Havre, 2015).

It is observed from the simple regression results that inland transport load factor does not have a linear relationship to container throughput and neither do railways or motorways. As such investing in these systems from the budget of the Port Authority would not have a positive impact on the container port throughput. However, if the funding is available from other sources, such as the financial institutions or authorities of Europe, the same could be pursued.

Further the following Major investment plans have been outlined in its 2014-19 Plan (Grand Port Maritime Du Havre, 2015):

1. Terminals, including container terminals - 87 Mln Euro

While the regression model could not be run for the container terminals as the same was found constant for the past several years, intuitively any investment in container terminals should have a positive impact on the port throughput.

2. Creation of logistics park – 40 Mln Euro

This strategy should be carefully analysed. Any logistics park would depend on the internal transport system for it to be successful. However, based on the results of the simple regression and multi regression model for inland transport, none of the internal transport means are linearly related to container port throughput. As such the funding of this project should be better left to private players or other authorities.

3. Port railway network and rail access to container terminals - 13 Mln Eur and studies for river access to Port 2000 (through a passage in the breakwater)- 2 Mln Eur

Again, as mentioned in point 3, railways transport and inland waterways do not have a linear relationship to container port throughput. More importantly the multi regression model did not show any inland transport mode as a determinant of throughput. As such this project should not be funded by the Port Authority of the Port of Le Havre

4. <u>Modernization of locks – 27 M euro</u>

From the results of the regression model it is observed that investment in sea infrastructure has a linear relationship on container port throughput. However, this relationship currently is weak. As such it would be advisable to thoroughly analyze the project and then make the investment. However, it holds promise and the potential exists. With careful planning and execution, the linear relationship could become stronger in the future.

<u>Labour</u>

It is observed from the simple regression results that labour productivity index has a weak negative linear relationship with container throughput of the Port of Le Havre. The Port of Le Havre should initiate plans to improve the quality of labour. As port of its Port 2014-19 plan it includes adapting skills and manpower to the port’s new assignments and new business lines in accordance with its strategic objectives (Grand Port Maritime Du Havre, 2015). This measure appears to be in right direction.

<u>Conclusion</u>

Based on the analysis of the Port of Le Havre it is observed that significant determinants of its container throughput are the French GDP, exports and imports.

While French GDP and exports have a positive relationship to container throughput French import was found to have a negative relationship.

With respect to the port strategies of the Port of Le Havre it was observed that the plan to develop its inland transport system and reach out to its hinterland to attract cargo would be a challenging one as its hinterland is already captured by rival ports and further its inland transport system is not a determinant of its container throughput. It would be advisable to carefully implement the same.

Further, the strategies to create the logistics park and port rail network to access terminals should be carefully assessed. The simple regression results did not show any linear relationship between any inland transport mode and throughput. More importantly the multi regression model did not show any inland transport mode as a determinant of throughput. As such it is advisable to allow private players to fund these projects leaving the funds of the Port Authority of the Port of Le Havre available to invest in projects that have a positive impact on container throughput.

Strategy with respect to modernization of sea locks should be carefully assessed again. It may be noted that investment in port infrastructure shows a weak linear relationship to throughput as per the simple regression results and was not found as determinant of throughput in the multi regression model. As such it is better to have private players invited to fund this project.

The 2014-19 plan outlines for the berthing of larger vessels. This would help increase the traffic of container vessels that call at Port of Le Havre. However there were no plans regarding the deepening of the draft to accommodate larger vessels in the 2014-19 plan which would be necessary for the success of this objective.

There are several strategies pertaining to terminals which could not be analyzed by the regression model as all container variables were a constant during the time period which was used to run the regression tests and model.

When compared to the other three ports, Port of Le Havre showed a linear relationship between the investment it makes in port infrastructure and container throughput. Even though the relationship is weak, it is a promising sign and shows that the investments are being made in the right direction. By focusing on making investment in projects that have a strong positive impact on throughput, the relationship will grow stronger.

Lastly, with regard to labour it was noted that it had a negative linear relationship with throughput. In this regard the Port of Le Havre has adopted a strategy to adapt skills and manpower with its strategic objectives. This strategy appears to be in the right direction.

5.4 Port of Rotterdam

The simple regression results of the Port of Rotterdam are as follows in table 36:

Table 36

Simple regression results of the Port of Rotterdam

Variable	**Category**	**Standard Error**	**R square**	**F Value**	**F Test**	**P Value**	**T Value**	**P Value**	**Strength of Linear Relationship**
CZK Export (MLN EUR)	Hinterland	351651	98.1	876.89	4.45	0.0001	29.61	0.0001	Strong
CZK Import (MLN EUR)	Hinterland	390481	97.65	707.95	4.45	0.0001	26.61	0.0001	Strong
HUN Export (MLN EUR)	Hinterland	432002	97.13	575.29	4.45	0.0001	23.99	0.0001	Strong
DEU Exports (MLN EUR)	Hinterland	466018	96.66	491.98	4.45	0.0001	22.18	0.0001	Strong
SVK Rep Import (MLN EUR)	Hinterland	510186	96.00	407.67	4.45	0.0001	20.19	0.0001	Strong
DEU Imports (MLN EUR)	Hinterland	533938	95.62	370.73	4.45	0.0001	19.25	0.0001	Strong
SVK Rep Export (MLN EUR)	Hinterland	550287	95.34	348.03	4.45	0.0001	18.66	0.0001	Strong
NLD Export (MLN EUR)	Economy	568242	95.03	325.33	4.45	0.0001	18.04	0.0001	Strong
NLD GDP (MLN EUR)	Economy	569982	95.00	323.24	4.45	0.0001	17.98	0.0001	Strong
NLD Import (MLN EUR)	Economy	575229	94.91	317.06	4.45	0.0001	17.81	0.0001	Strong
AUT Import (MLN EUR)	Hinterland	586595	94.71	304.24	4.45	0.0001	17.44	0.0001	Strong
HUN Import (MLN EUR)	Hinterland	591292	94.62	299.16	4.45	0.0001	17.3	0.0001	Strong
AUT Export (MLN EUR)	Hinterland	599435	94.47	290.63	4.45	0.0001	17.05	0.0001	Strong
NLD Inland Waterways (TT Ttonnes)	Inland Transport	233523	93.05	80.39	5.99	0.0001	8.97	0.0001	Strong
CHE Exports (MLN EUR)	Hinterland	1065965	82.52	80.28	4.45	0.0001	8.96	0.0001	Strong
CHE Imports (MLN EUR)	Hinterland	1105459	81.21	73.45	4.45	0.0001	8.57	0.0001	Strong
Port of Rotterdam Short Sea Shipping TT Ttonnes	Short Sea Shipping	441979	80.52	28.93	5.59	0.001	5.38	0.001	Strong
Quay length (meters)	Terminal	1138221	80.08	68.32	4.45	0.0001	8.27	0.0001	Strong
Container Capacity (TEU)	Terminal	1246575	76.1	54.13	4.45	0.0001	7.36	0.0001	Strong
Quay Side Cranes (Nos)	Terminal	1259935	75.59	52.63	4.45	0.0001	7.25	0.0001	Strong

Terminal Area (Hectares)	Terminal	1418048	69.07	37.97	4.45	0.0001	6.16	0.0001	Medium
NLD Railway lines (Kms)	Inland Transport	575695	66.95	14.18	5.59	0.007	3.77	0.007	Medium
NLD Railway lines (TT Ttonees)	Inland Transport	676524	54.36	8.34	5.59	0.0234	2.89	0.0234	Medium
NLD Motorways (Kms)	Inland Transport	733712	46.32	6.04	5.59	0.0436	2.46	0.0436	Weak
Container Traffic (Nos)	Shipping Companies	1917088	43.48	13.08	4.45	0.0021	3.62	0.0021	Weak
Investment in Port of Rotterdam Infrastructure (Euro)	Investment	1676851	26.12	4.24	4.75	0.0618	2.06	0.0618	NIL
NLD Motorways (TT Ttonnes)	Inland Transport	875340	23.59	2.16	5.59	0.185	-1.47	0.185	NIL
Labour Producivity Index	Labour	2273899	20.48	4.38	4.45	0.0517	-2.09	0.0517	NIL
NLD Navigable canals (Kms)	Inland Transport	904023	18.50%	1.59	5.59	0.2479	1.26	0.2479	NIL
NLD Navigable rivers (Kms)	Inland Transport	990249	2.21%	0.16	5.59	0.7026	-0.4	0.7026	NIL

<u>Analysis of the simple regression results and multi regression model with port strategy of the Port of Rotterdam</u>

The results of the simple regression for the Port of Rotterdam show that almost all the variables are linearly related to its container port throughput.

The results show that the container port throughput is strongly related to the Dutch GDP, exports and imports where the R square for all three components are around 95%.

Further, its hinterland plays a crucial part in its throughput too. All its hinterland regions produced a R square of over 90% except for Switzerland which produced a R square of 83% for swiss exports and 81% for swiss imports.

With respect to the results of terminal related components it was observed that quay length of terminal area was most linear related with a R square of 80%. Quay side cranes and container capacity produced strong results too, both producing around 76% R square results. Terminal area was also linearly related with a relatively strong R square of 69%.

The modes of transport that were strongly linearly related to container port throughput were railways and inland waterways. Railways track length produced R square of 67% while the goods load factor through railways produced result of R square of 54%.

Inland waterways showed a very strong linear relationship of 93%.

Further, short sea shipping result showed a linear relationship of 81% R square with respect to the container throughput of the Port of Rotterdam.

Motorways showed a weak liner relationship to container throughput in both categories, motorway length (46%) and load factor (24%).

It was observed that container traffic calling at the Port of Rotterdam also showed a weak liner relationship of 43%.

Investment in port infrastructure showed a weak liner relationship of 26%. It may be noted that while for the Port of Antwerp, Hamburg and Le Havre, the data with respect to investment was pertaining to "sea infrastructure including ports" extracted from the Eurostat database, the data for the Port of Rotterdam pertains exclusively to investment in the port infrastructure of the Port of Rotterdam taken from the annual reports of the Port of Rotterdam. The results though, as observed produce a weak relationship.

Across the remaining three ports, analyzed in this thesis, the same results were observed. Once could assume the reason for a weak linear relationship, is that infrastructure investment takes time to have an impact on port throughput, its benefit felt only in successive years. Further, it is difficult to segregate port infrastructure for each segment, ie. container, dry-bulk, liquid bulk etc. Lastly, infrastructure investment could also include in areas that are necessary, but not impacting port throughput (eg. administrative buildings, safety equipment etc)

Multi regression model

The multi regression model of the Port of Rotterdam is presented below in table 37 below. From the multi regression model it is observed that the Dutch GDP, Dutch exports & imports, all four components of terminals viz. quay length, quay cranes, terminal area & terminal capacity and container vessels that call at the Port of Rotterdam determine the container port throughput of the Port of Rotterdam.

Table 37

Multi Regression Model for Port of Rotterdam

TEU = 24384971 + 3469 Quay Length (meter) Cumulative + 177099 Terminal Area Cumulative (ha) − 2616561 No of Quayside Cranes cumulativ + 4.528 Cumulative Capacity Increase + 24.218 NLD GDP (MLN EUR) − 14.94 NLD Export (MLN EUR) + 20.86 NLD Import (MLN EUR) + 543.6 Container Traffic (calling)

As can be observed from table 38 the multi regression model of the Port of Rotterdam is valid with a high R square of 99.05%.

Table 38 Model Summary for Port of Rotterdam				
R Square	**F-Value**	**F-Test**	**P-Value**	**Result**
99.05%	65.15	4.82	0.0001	Valid

From the below table 39 it is observed that the determinants in the multi regression model which have a positive relationship to the container port throughput are quay length, terminal area, terminal capacity, Dutch GDP & imports and container vessels that call at the Port of Rotterdam. Out of these, terminal area & capacity, Dutch GDP and container traffic are significant.

Further, the determinants which have a negative impact on the container port throughput are quayside cranes and Dutch exports. Out of these two only quayside cranes are significant.

Table 39 Significance of determinants of the Port of Rotterdam				
Determinant	**T Value**	**P Value**	**Relationship**	**Result**
Terminal Area	3.33	0.0208	Positive	Significant
Terminal Capacity	2.95	0.0320	Positive	Significant
Quayside Cranes	-2.87	0.0349	Negative	Significant
NLD GDP	2.7	0.0429	Positive	Significant
Container Traffic	2.46	0.0570	Positive	Significant
Quay Length	1.9	0.1152	Positive	Insignificant
NLD Import	1.17	0.2947	Positive	Insignificant
NLD Export	-0.81	0.4539	Negative	Insignificant

Using the data recorded in 2015 of the variables in the multi regression model, the throughput is calculated as per below table 40:

Table 40 Calculation of container throughput of Port of Rotterdam using the multi regression model			
Variable	**Coefficient [A]**	**Variable Value (2015 figure) [B]**	**Product [A] * [B]**
Constant	24384971	1	24384971

Quay length (meter)	3469	16325	56631425
Terminal Area (ha)	177099	799	141502101
Quayside cranes	-2616561	129	-337536369
Terminal Capacity	5	23120000	104687360
NLD GDP (MLN EUR)	24	738653	17888694
NLD Export (MLN EUR)	-15	424762	-6345943
NLD Import (MLN EUR)	21	377169	7867755
Container Traffic (calling)	544	5814	3160490
Total as per Multi Regression Model			**12,240,485**
Total as per recorded throughput (2015)			12,234,535
Difference			*5,950*

The multi regression model for the inland transport for the Port of Rotterdam is given below in table 41. As can be observed from the table the inland transport variables that are the determinants of the container throughput of the Port of Rotterdam are motorways (load factor), railways (load factor) and inland waterways (load factor). Short sea shipping (load factor) is included also as a determinant.

Table 41

Multi Regression Model for Inland Transport

TEU = 8035009 + 8.506 Motorways Total Transport - Tho + 27.78 Railway Total Transport - Thous + 143.80 Inland Waterways Total Transpor − 81.3 PoR Short Sea Shipping Total Tr

From the below table 42 it is observed that the multi regression model for the Port of Rotterdam comprising of inland transport determinants and short sea shipping is valid with a high r square of 95.34%

Table 42

Model Summary Port of Rotterdam
(Inland Transport & Short Sea Shipping)

R Square	**F-Value**	**F-Test**	**P-Value**	**Result**
95.34%	15.33	9.12	0.0245	Valid

From the below table 43 it is observed that the while inland waterways (load factor), motorways (load factor) and railways (load factor) have a positive relationship to container throughput, only inland waterways (load factor) is significant.

Short sea shipping has a negative relationship but is insignificant.

Table 43 Significance of Determinants of Port of Rotterdam (Inland Transport & Short Sea Shipping)				
Determinant	**T Value**	**P Value**	**Relationship**	**Result**
Inland Waterways (Ttonne)	2.67	0.0757	Positive	Significant
Motorways (Ttonne)	1.07	0.3626	Positive	Insignificant
PoR Short Sea Shipping	-0.58	0.6034	Negative	Insignificant
Railways (Ttonne)	0.41	0.7096	Positive	Insignificant

The following table 44 shows the significant co-efficient which helps in visualizing the impact on the container throughput of the Port of Rotterdam. It is observed that an increase of 1 million euro in the Dutch GDP increases throughput by 24 TEU. Further, terminal area has as strong impact as well, as an increase of 1 hectare increases the throughput by 177,099 TEU. Further an increase of 1 container vessel that calls at the Port of Rotterdam increases the throughput by 544 TEU's. Further, inland waterways transport also has a strong impact as an increase of 1 thousand tonnes carried by it increases throughput by 144 TEU. On the other hand an increase of 1 quayside terminal reduces throughput by around 2.6 million which gives an indication that quayside crane planning and development is not at an optimal level.

Table 44 Significant Coefficients of the Multi Regression Model for the Port of Rotterdam			
Determinant	**Category**	**Unit Increase**	**TEU increases/ (decreases) by**
Dutch GDP	Economy	1 Million Euro	24
Terminal Area	Terminal	1 Hectare	177,099
Quayside Cranes	Terminal	1 Nos	(2,616,561)
Terminal Capacity	Terminal	1 TEU	5
Container vessels calling at port	Shipping Companies	1 vessel	544
Inland Waterways	Inland Transport	1 Thousand Tonnes	144

Analysis of simple regression results and multi regression model with port strategy of the Port of Rotterdam

The literature that has been referred to extensively in this section is the "Port Vision 2030 – Port Compass" of the Port of Rotterdam Authority.

Inland Transport

Under its Vision 2030 Plan, the Port of Rotterdam Authority has expansion of the European network of inland hubs as well as rail and inland shipping infrastructure (Port of Rotterdam, 2011) as one of the main areas for attention. From the simple regression results it is noted that both inland waterways (R square 93.05%) and rail transport (R square of 54.36%) show a positive linear relationship to container port throughput. As per the multi regression model for inland transport (table 41) also both these modes have a positive relationship though only inland waterways is significant. In view of the overall observations, this strategy should be pursued as it would have positive impact on the container port throughput.

Roadways:

Another objective of the Vision Plan 2030 is the energetic expansion of the national road network, including the Blankenburg tunnel and A4 South motorway (Port of Rotterdam, 2011). This plan should not be funded by Port Authority of Port of Rotterdam as from the simple regression results, the linear relationship of motorway length and load factor is weak to container throughput (R square 23.59%). Also, as per the multi regression model for Inland Transport road transport though shows a positive relationship is not significant.

Regarding motorways, there are several objectives as well in the Port Vision 2030 Plan. It mentions that on the north-eastern edge of Rotterdam, the A13-A16 must be constructed before 2020, and following that, the capacity of the Van Brienenoord corridor must be increased: if the east side of the ring route deadlocks, the accessibility of the port via the A15 and in a north- easterly direction will be impacted negatively (Port of Rotterdam, 2011).

Further it also mentions that the A4 South must be constructed between 2020 and 2030, to relieve the ring road and secure a robust north-south connection (Port of Rotterdam, 2011). This route is the last missing link in the direct Rotterdam-Antwerp connection (Port of Rotterdam, 2011). The A4 South Rotterdam Antwerp Connection would increase the reach of the Netherlands to Belgium which though not its dominant hinterland region, could allow it to increase its presence there.

It may be noted here that though motorways is not linearly related to container port throughput, it may be a necessity to invest in these projects. As such it is advisable to include private players to invest in these projects allowing the budget of the Port of Rotterdam to be utilized in areas that improve its competitiveness of its port throughput.

Inland waterways:

Another plan is the construction of the Seine-Nord Europe Canal that will bring Northern France within reach as a new inland shipping market in about 2020 (Port of Rotterdam, 2011). This is a welcome plan as from the simple regression results it was observed that inland transport has a strong linear relationship to container port throughput (R square 93%). Also as per the multi regression model, inland waterways has a positive relationship and is significant. Further, the construction of the Canal provides the opportunity for the Port of Rotterdam to extend its hinterland to France.

Next, the development of inland shipping terminals at Alphen aan den Rijn and Alblasserdam (transfer hub) is also a measure under the Port Vision 2030 plan (Port of Rotterdam, 2011). These measures should be actively pursued by the Port of Rotterdam based on the favourable results of the simple and multiple regression model which produced a strong linear relationship between container throughput and inland waterways load factor.

Other measures under the Port Vision 2030 plan includes the operationalization of the Blankenburg tunnel that will have to go into service before 2020 (Port of Rotterdam, 2011). This tunnel is closer to the Benelux tunnel and will therefore provide a considerably better traffic flow on the ring road than the alternative Oranje tunnel (Port of Rotterdam, 2011). The Port of Rotterdam Authority feels that the Oranje tunnel would be particularly useful in connecting the port and the Greenport and for the spatial-economic development of the coastal area. Construction of the Oranje tunnel around 2030 would be opportune for the port. Based on the simple regression results and multi regression model both these strategies would be ideal for the competitiveness of the Port of Rotterdam as inland waterways in strongly linearly related to container port throughput of the Port of Rotterdam. As such either or both could be selected. (Port of Rotterdam, 2011)

The Port Vision 2030 also mentions that the Volkerak and Kreekrak lock capacity on the inland shipping route between Rotterdam and Antwerp would require increasing, because of the growth in cargo shipped between the two ports and the construction of the Seine-Nord link (Port of Rotterdam, 2011). This will open up the Paris region for inland shipping, signicantly increasing the potential of the sector (Port of Rotterdam, 2011). This measure should be actively pursued by the Port of Rotterdam. The regression results show that inland waterways is strongly related to container throughput. Further, the inland shipping route would also allow the Netherlands to extend its hinterland region to Belgium.

Railways:

The port Vision plan also mentions that in order to facilitate further growth in rail transport, the government’s High-Frequency Rail Programme must be implemented on schedule (Port of Rotterdam, 2011). This will secure the freight capacity on the rail corridors to the North of the Netherlands, Germany, Belgium and France (Port of Rotterdam, 2011). This strategy should be actively pursued as railways is positively linearly related to container port throughput of the Port of Rotterdam (R square 54.36%)

Also mentioned in the Vision 2030 Plan is the plan for the connection of the Betuweroute to the German railway system, improvement of East-west connections to realise good connections to Central Europe and attention to the rail corridors to Switzerland and Italy (Port of Rotterdam, 2011). These should be actively pursued as it would strengthen the access of the Port of Rotterdam to its current dominant hinterland regions of Germany and Switzerland.

Realizing a modal shift:

The Port Vision 2030 has advised to change the modal split of inland transport. It prefers more transport by water and rail, less by road. The aim for 2030 is a maximum 35% of containers transported to and from the Maasvlakte by road (Port of Rotterdam, 2011). Currently, it stands at 47% (Port of Rotterdam, 2011). This modal split change calls for a substantial improvement in the quality of transport by rail and inland waterway. It would require the use of high-frequency permanent shuttles between maritime and inland terminals.. (Port of Rotterdam, 2011).

The results of the simple regression and multi regression model are favourable to implement this change and will bear positive results on container port throughput of the Port of Rotterdam. The following table 45 shows that if containers are reduced from roadways and absorbed by railways and inland waterways the container throughput would increase by 876,752 TEU's, i.e. an increase of 6.65%

Table 45

Impact of inland transport modal split on container throughput as per Port of Rotterdam Vision 2030

Variable	**Coefficient [A]**	**Variable Value (2015 figure) [B]**	**Product [A] * [B]**
Constant	8,035,009	1	8,035,009
Motorways (Ttonnes)	8.506	35,843	304,879
Railways (Ttonnes)	27.78	17,046	473,530
Inland Waterways (Ttonnes)	143.8	49,519	7,120,900
Short Sea Shipping (Ttonnes)	-81.3	33,943	(2,759,566)
Throughput as per multi regression model			13,174,752
Recorded throughput in 2014			12,298,000
Increase in TEU			876,752

Investment in Port Infrastructure

From the Port Vision 2030 plan it was noticed that the (central) government and the Port Authority will be investing heavily upto 2030. Private investments is also being made which would be around € 25 to € 35 billion for the same period and the central government will invest € 5 to € 6 billion (Port of Rotterdam, 2011). This money will be invested mainly in infrastructure to maintain accessibility, which is not only important for the port (Port of Rotterdam, 2011).

In concrete terms, the projects that would be included are the widening of the A15 motorway between Maasvlakte and Vaanplein, the construction of a tunnel beneath the Nieuwe Waterweg, the construction of the A4 South, solving the Caland rail bridge bottleneck, increasing the capacity of the Volkerak and Kreekrak locks, solving other inland waterway bottlenecks in the Netherlands, and implementation of the High-Frequency Rail Programme. (Port of Rotterdam, 2011)"

In the period up to 2030, the Port Authority will invest € 5 to € 6 billion where around € 2 billion of this is earmarked for completing and developing Maasvlakte 2, and € 3 to € 4 billion for investment in the existing ports of Rotterdam, Dordrecht and Moerdijk (Port of Rotterdam, 2011). This involves public infrastructure such as roads, docks and berths, and more customer-specific infrastructure such as quays, jetties, pipelines and site restructuring (Port of Rotterdam, 2011). Investments to boost the hinterland network also form part of this. (Port of Rotterdam, 2011).

As observed from the regression model, investment in inland waterways and railways would be fruitful while for motorways it would not.

The Port Authority will also be investing in public space, safety (including a car park with facilities for truckers) and ground decontamination in Waalhaven East, Waalhaven South and on Sluisjesdijk (Port of Rotterdam, 2011).

The amount of money that is being invested in these projects are appreciable, though as per the results of the regression model, it is observed that they would not have a positive linear relationship with container port throughout. One of the reasons would be that investment amount includes areas that would not contribute to port throughput directly such as car parking facilities, facilities for truckers, ground decontamination facility etc. It would be advisable for private players to invest in these projects.

Labour

The Port Vision 2030 also mentions strategies relating to labour. These include long-term work-study programmes focusing on technical and logistics skills, policies geared towards enthusing and recruiting special target groups, facilitating state of the art educational facilities for technical and port related schools. (Port of Rotterdam, 2011)

Investments are being made in academic chairs for port studies at the universities of Rotterdam and Delft and lectureships at the Rotterdam colleges of higher professional education (Port of Rotterdam, 2011). Further partnerships between universities and technical colleges are reinforced (Port of Rotterdam, 2011).

The results of the simple regression model do not show a positive linear relationship between productivity of labour and container port throughput. Further, labour is not included as a determinant in the multi regression model. As such it is advisable for the Port Authority to pursue only those labour strategies that are not financial intensive.

Hinterland

The Port Vision 2030 plan includes the strategy of integration of the Antwerp and the Rotterdam industrial clusters that offers advantages to businesses in Antwerp and

Rotterdam, as they can produce more efficiently (Port of Rotterdam, 2011). If further mentions that without this integration, efficiency-related advantages will not be as great, making it harder for both ports to attract investments. (Port of Rotterdam, 2011). It may noted here that one of the dominant hinterland regions for the Port of Antwerp is the Netherlands, while Belgium is not a dominant hinterland region for the Port of Rotterdam. As such while this strategy would pose several opportunities for the Port of Rotterdam to extend its hinterland region to Belgium, it could also allow the Port of Antwerp to compete more intensively in the Netherlands, thereby adversely impacting the Port of Rotterdam's container throughput.

Another plan under the Vision 2030 is the development of more extended gates in the hinterland, enabling administrations to take place at multiple locations (Port of Rotterdam, 2011). This strategy should increase the operational efficiency in the hinterland regions and as such will have a positive impact on the container throughput. As such it should be pursued.

Container vessel Traffic

As per the literature review it was found that Rotterdam is one of the most central and accessible turntables in the global container liner service network. As per the multi regression model, container vessel traffic has a positive impact and is significant, though simple linear regression showed weak correlation (R square 43.48%) to container port throughput.

The Port Vision 2030 includes measures to stimulate the use of terrain, quays and jetties by multiple companies (Port of Rotterdam, 2011). It further has plans to optimise the calling of sea going vessels in Rotterdam, by directing sailing speeds at sea (from Gibraltar) (Port of Rotterdam, 2011). As such the aforementioned measures should make the linear relationship stronger and this would have a better positive impact on the Port of Rotterdam's container throughput.

Conclusion

Based on the analysis of the Port of Rotterdam it is observed that the significant determinants of its container throughput are its terminal area, terminal capacity, Dutch GDP and container vessels that call at its port. All of these determinants have a positive impact. On the other hand, quayside cranes is a significant determinant, though having a negative impact.

Other variables which are the determinants of the Port of Rotterdam are quay length & Dutch imports which have a positive relationship and Dutch exports which has a negative relationship to container throughput.

With respect to the port strategies of the Port of Rotterdam, it is observed from the simple regression results and multi regression model that the strategy with respect to expansion of the European network of inland hubs as well as rail and inland shipping infrastructure should be pursued as it would have positive impact on the container port throughput.

With respect to inland waterways, the strategy of construction of the Seine-Nord Europe Canal should be pursued (and funded by the port authority of Port of Rotterdam it needed be) as inland transport is a significant determinant of the container throughput of the Port of Rotterdam which has as positive impact on the throughput. Other inland waterways projects such as (a) development of inland shipping terminals at Alphen aan den Rijn and Alblasserdam, (b) operationalization of the Blankenburg tunnel or Oranje tunnel and (c) increasing Volkerak and Kreekrak lock capacity should be actively pursued by the Port of Rotterdam as it will have a positive impact on its container throughput.

With respect to railways the projects are implemented by the Government. The simple regression results show that railways (load actor) has a medium correlation to container throughput. Based on this result the projects should have a positive impact on throughput. However, the multi regression model, though found railways (load factor) as determinant did not find it significant and as such its impact cannot be determined.

Further, the strategy with respect to its roadways such as (a) expansion of national road network, the Blankenburg tunnel & A4 South motorway, (b) construction of A4 South & A13-A16 and (c) increase in capacity of Van Brienenoord corridor should not be funded by Port Authority of Port of Rotterdam as it would not impact the throughput positively.

The modal shift plan to decrease the load carried by roadways from the current 47% to proposed 35% is a favourable strategy as per the multi regression model (inland transport and short sea shipping) as the same would increase throughput by 6.65%.

Investment in port infrastructure had disappointing results. The simple regression result did not show a linear relationship between investment in port infrastructure and throughput. Further the multi regression model did not include investment in port infrastructure as a determinant. These results give an insight into port infrastructure investment planning and shows that it has not been ‘optimal’.

With respect to labour, the results of the simple regression model do not show a positive linear relationship between productivity of labour and container port throughput. Further, labour is not included as a determinant in the multi regression model. As such it is advisable for the Port Authority to pursue only those labour strategies that are not financial intensive.

Based on the simple regression results, strategies with respect to development of more extended gates in the hinterland should have a positive impact on throughput. The integration of the Antwerp and the Rotterdam industrial clusters should be implement carefully as this might benefit the Port of Antwerp at cost of Port of Rotterdam’s container throughput interests.

Finally strategies to invite more container shipping companies such as (a) stimulating the use of terrain, quays and jetties by multiple companies and (b) optimize the calling of sea going vessels in Rotterdam, by directing sailing speeds at sea (from Gibraltar) will have a positive impact on container throughput as simple regression result show a positive linear relationship and multi regression model shows container vessels that call at the Port of Rotterdam are a positive significant determinant.

6. Conclusion

6.1 Answering the research questions

Based on the literature review and results of the regression model, it is observed that the determinants of container port throughput of the Port of Antwerp, Port of Hamburg, Port of Le Havre and Port of Rotterdam are unique and varied.

For the Port of Antwerp, 10 variables formed the determinants of its container throughput out of which 6 were found significant comprising of 4 positive determinants and 2 negative determinants. It was interesting to observe that the hinterland regions of France and Switzerland are important for the container throughput of Port of Antwerp. It was surprising to see that none of the terminal variables formed part of the variable set that determine throughput. It was also observed that investment in port infrastructure was a determinant for throughput but was found to be insignificant. Among inland transport variables short sea shipping and road transport were found to be significant.

For the Port of Hamburg, 10 variables also formed the determinants of its container throughput out of which again 6 were found to be significant comprising however of only 2 positive determinants and 4 negative determinants. It was interesting to observe that Slovak Republic exports and Czech imports were found to be important hinterland regions for the Port of Hamburg thought however both being significant has a negative impact on throughput. It was further interesting to observe that unlike the Port of Antwerp, Port of Hamburg had two variables from the terminal category that determine its container throughput. Container terminal area was found to have a positive impact while quay length of terminals was found to have a negative impact. Further, the container vessels that call at the Port of Hamburg, though a significant determinant was found to have a negative impact. This differs from the Port of Antwerp, for whom it has a positive impact. However, investment in port infrastructure, though a determinant was found to be insignificant similar to the Port of Antwerp. Among inland transport variables inland waterways, railways and short sea shipping were found to be significant though inland waterways showed a negative impact. Roadways was found to be an insignificant variable which differs from Port of Antwerp where it was a significant determinant.

The Port of Le Havre returned with only 5 variables that determine its container throughput out which 3 were found to be significant and 2 insignificant. The results showed that all variables of the economy, i.e. French GDP, exports and imports are significant determinants though French imports has a negative impact. Similar to Port of Antwerp and Port of Hamburg, investment in port infrastructure was found to be an insignificant determinant. It was surprising to see that the multi regression model for inland transport resulted as invalid. This was not the case for any of the other three ports.

Finally, for the Port of Rotterdam, 8 variables were found to determine its container throughput, 5 out which were significant and 3 insignificant. It was interesting to note that all four terminal variables determine the throughput, though only 3 are significant, i.e. terminal area and terminal capacity both having a positive impact while quayside cranes has a negative impact. Also, as compared to Port of Antwerp container vessels that call at the Port of Rotterdam has a positive impact and is significant. It was surprising to note that unlike the other three ports, investment in port infrastructure was not found to be a determinant of the container throughput of the Port of Rotterdam. Among the inland transport variables and short sea shipping, all were determinants though only inland waterways showed a positive significant relationship.

There were common observations also. The GDP for all four ports was a positive determinant though for the Port of Hamburg it was found to be insignificant.

Another observation was that imports and exports of the home country of the port were found to be determinants for all ports except Port of Antwerp which would imply for the later that its hinterland region then becomes very important for its throughput.

The study also showed that there is a good potential to further develop short sea shipping as it has a positive impact on the container port throughput for two of the three leading container ports i.e. Port of Antwerp and Port of Hamburg.

While the results for the Port of Le Havre were less impressive compared to its rivals there is a potential for it to be modeled as a transshipment port. The reason for this are two. Firstly, its natural hinterland has been captured by rival ports. Further, most of the industrial development on the port site is not linked to port activities or Le Havre’s local economic structure. Secondly, its position as the first port of arrival and the last port of departure in the North-European range makes it a convenient port for transshipment.

The most interesting observation from this study was that investment in port infrastructure was found to be an insignificant determinant (positive though) for three ports, i.e. Port of Antwerp, Port of Hamburg and Port of Le Havre. For the Port of Rotterdam it did not show as a determinant. The reasons for this could be several. Investment in port infrastructure takes many years to reap benefits and as such this time distorts the linear relationship between port and investment. Hence, it appears that investment in ports are not optimal or not in areas that would positively impact the container port throughput of the port. It would be advisable for ports to understand their main determinants of container throughput and only invest in them. For other areas of the port infrastructure, private players should be invited thereby saving scarce financial resources of the port.

With regard to the regression model it was found that it is useful tool in ascertaining the determinants of container throughput and analyzing the strategies of ports along with the results.

6.2 Limitations of the study

There have been several limitations of this study. Firstly, there would be many more determinants which impact the container port throughput which has not been tested here. For example, berth productivity and crane productivity are extremely important which could not be tested due to unavailability of date in public sources.

Other factors include the presence of organized labour forces, i.e. trade unions, customs procedures, port policy, domestic legislations and regulations, enforcement level, political stability and environmental aspects. A thorough qualitative review would need to be done and quantified and tested using the regression model.

Secondly, it would be important to test the determinants using different econometric models and compare the results for greater accuracy and usefulness. However, the regression model proves that it is useful in testing the existence of linear relationship between determinants of container port throughput.

Lastly studies should be made regarding future determinants of container port throughput and have them quantified. The regression model could then be tested to see its impact on container port throughput.

6.3 Suggestion for future studies

Future studies is suggested to be made in the field of determinants of information technology and automation on container port throughput. This is because as information technology is replacing labour and several other systems which would impact the ports. Further, port community systems seeks to integrate the port complex and stakeholders into one large business family. All these factors would impact port throughput. It would be important to conduct a qualitative research on these factors and quantify its future impact to enable better decision making and planning today.

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Appendix:

Port of Antwerp – Minitab Results

Simple Regression: TEU versus Quay length (meter)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.02063E+13	5.02063E+13	66.61	<0.0001
Error	15	1.13062E+13	7.53745E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
868185	81.62%	80.39%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2814198	553271	5.09	0.0001
Quay length (meter)	518.43	63.52	8.16	<0.0001

Regression Equation

TEU = 2814198 + 518.43 Quay length (meter)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
7	6482000	8192955	-1710955	-2.06	R

R Large residual

Simple Regression: TEU versus Terminal Area (ha)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.05644E+13	5.05644E+13	69.28	<0.0001
Error	15	1.09481E+13	7.29872E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
854325	82.20%	81.02%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	3017222	520326	5.80	<0.0001
Terminal Area (ha)	8128.9	976.6	8.32	<0.0001

Regression Equation

TEU = 3017222 + 8128.9 Terminal Area (ha)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
7	6482000	8211614	-1729614	-2.12	R

R Large residual

Simple Regression: TEU versus Number of cranes

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.05799E+13	5.05799E+13	69.40	<0.0001
Error	15	1.09325E+13	7.28836E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
853719	82.23%	81.04%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2742756	550267	4.98	0.0002
Number of cranes	78140	9380	8.33	<0.0001

Regression Equation

TEU = 2742756 + 78140 Number of cranes

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
7	6482000	8212540	-1730540	-2.12	R

R Large residual

Simple Regression: TEU versus Container Capacity (TEU)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.06005E+13	5.06005E+13	69.56	<0.0001
Error	15	1.09120E+13	7.27465E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
852916	82.26%	81.08%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2903819	531811	5.46	<0.0001
Container Capacity (TEU)	0.36122	0.04331	8.34	<0.0001

Regression Equation

TEU = 2903819 + 0.36122 Container Capacity (TEU)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
7	6482000	8213789	-1731789	-2.13	R

R Large residual

Simple Regression: TEU versus Labour Productivity Index

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	7.97924E+12	7.97924E+12	2.24	0.1556
Error	15	5.35332E+13	3.56888E+12		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
1889148	12.97%	7.17%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	7558857	595593	12.69	<0.0001
Labour Productivity Index	-641418	428969	-1.50	0.1556

Regression Equation

TEU = 7558857 – 641418 Labour Productivity Index

Simple Regression: TEU versus BEL GDP (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.59125E+13	5.59125E+13	149.77	<0.0001
Error	15	5.59996E+12	3.73331E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
611008	90.90%	90.29%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-2651622	801655	-3.31	0.0048
BEL GDP (MLN EUR)	27.777	2.270	12.24	<0.0001

Regression Equation

TEU = −2651622 + 27.777 BEL GDP (MLN EUR)

Simple Regression: TEU versus BEL Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.57720E+13	5.57720E+13	145.73	<0.0001
Error	15	5.74046E+12	3.82698E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
618626	90.67%	90.05%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1126710	508330	2.22	0.0425
BEL Export (MLN EUR)	18.382	1.523	12.07	<0.0001

Regression Equation

TEU = 1126710 + 18.382 BEL Export (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
17	9654000	7706809	1947191	3.26	R

R Large residual

Simple Regression: TEU versus BEL Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.49792E+13	5.49792E+13	126.23	<0.0001
Error	15	6.53331E+12	4.35554E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
659965	89.38%	88.67%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1425215	520514	2.74	0.0152
BEL Import (MLN EUR)	18.268	1.626	11.24	<0.0001

Regression Equation

TEU = 1425215 + 18.268 BEL Import (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
17	9654000	7525385	2128615	3.33	R

R Large residual

Simple Regression: TEU versus Container Traffic (calling)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.50002E+13	4.50002E+13	40.88	<0.0001
Error	15	1.65123E+13	1.10082E+12		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
1049198	73.16%	71.37%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-4310657	1785684	-2.41	0.0290
Container Traffic (calling)	2973.5	465.1	6.39	<0.0001

Regression Equation

TEU = −4310657 + 2973.5 Container Traffic (calling)

Simple Regression: TEU versus Sea Infra Invest (EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	6.10588E+12	6.10588E+12	1.65	0.2180
Error	15	5.54066E+13	3.69377E+12		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
1921919	9.93%	3.92%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	3323359	2889620	1.15	0.2681
Sea Infra Invest (EUR)	0.01848	0.01437	1.29	0.2180

Regression Equation

TEU = 3323359 + 0.01848 Sea Infra Invest (EUR)

Simple Regression: TEU versus NLD Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.71551E+13	5.71551E+13	196.75	<0.0001
Error	15	4.35735E+12	2.90490E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
538971	92.92%	92.44%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1668057	401289	4.16	0.0008
NLD Export (MLN EUR)	14.781	1.054	14.03	<0.0001

Regression Equation

TEU = 1668057 + 14.781 NLD Export (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
17	9654000	7946582	1707418	3.29	R

R Large residual

Simple Regression: TEU versus NLD Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.64639E+13	5.64639E+13	167.76	<0.0001
Error	15	5.04860E+12	3.36573E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
580149	91.79%	91.25%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1639112	436420	3.76	0.0019
NLD Import (MLN EUR)	16.544	1.277	12.95	<0.0001

Regression Equation

TEU = 1639112 + 16.544 NLD Import (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
17	9654000	7878846	1775154	3.18	R

R Large residual

Simple Regression: TEU versus DEU Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.85064E+13	5.85064E+13	291.95	<0.0001
Error	15	3.00603E+12	2.00402E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
447663	95.11%	94.79%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1261953	352377	3.58	0.0027
DEU Export (MLN EUR)	5.8783	0.3440	17.09	<0.0001

Regression Equation

TEU = 1261953 + 5.8783 DEU Export (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
17	9654000	8304558	1349442	3.16	R

R Large residual

Simple Regression: TEU versus DEU Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.70925E+13	5.70925E+13	193.75	<0.0001
Error	15	4.41999E+12	2.94666E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
542831	92.81%	92.34%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1241159	433474	2.86	0.0118
DEU Import (MLN EUR)	7.1809	0.5159	13.92	<0.0001

Regression Equation

TEU = 1241159 + 7.1809 DEU Import (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
17	9654000	8068119	1585881	3.04	R

R Large residual

Simple Regression: TEU versus CHE Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.66228E+13	4.66228E+13	46.97	<0.0001
Error	15	1.48896E+13	9.92643E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
996314	75.79%	74.18%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	3574210	553884	6.45	<0.0001
CHE Export (MLN EUR)	20.873	3.046	6.85	<0.0001

Regression Equation

TEU = 3574210 + 20.873 CHE Export (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
15	8578000	10297820	-1719820	-2.05	R

R Large residual

Simple Regression: TEU versus CHE Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.53332E+13	4.53332E+13	42.03	<0.0001
Error	15	1.61793E+13	1.07862E+12		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
1038566	73.70%	71.94%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	3401076	608188	5.59	<0.0001
CHE Import (MLN EUR)	23.808	3.672	6.48	<0.0001

Regression Equation

TEU = 3401076 + 23.808 CHE Import (MLN EUR)

Simple Regression: TEU versus FRA Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.91376E+13	5.91376E+13	373.52	<0.0001
Error	15	2.37487E+12	1.58324E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
397900	96.14%	95.88%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-759320	412408	-1.84	0.0855
FRA Export (MLN EUR)	18.6869	0.9669	19.33	<0.0001

Regression Equation

TEU = −759320 + 18.6869 FRA Export (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
17	9654000	8878461	775539	2.08	R

R Large residual

Simple Regression: TEU versus FRA Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.85808E+13	5.85808E+13	299.73	<0.0001
Error	15	2.93170E+12	1.95447E+11		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
442094	95.23%	94.92%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	707115	378410	1.87	0.0813
FRA Import (MLN EUR)	13.4864	0.7790	17.31	<0.0001

Regression Equation

TEU = 707115 + 13.4864 FRA Import (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
17	9654000	8614800	1039200	2.48	R

R Large residual

Simple Regression: BEL TEU versus BEL Road TT - Ttonne

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	8.82709E+11	882708716641	2.30	0.1734
Error	7	2.69036E+12	384336596035		
Total	8	3.57306E+12			

Model Summary

S	R-sq	R-sq(adj)
619949	24.70%	13.95%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2902866	3552081	0.82	0.4407
BEL Road TT - Ttonne	240.4	158.6	1.52	0.1734

Regression Equation

BEL TEU = 2902866 + 240.4 BEL Road TT - Ttonne

Fits and Diagnostics for Unusual Observations

Obs	BEL TEU	Fit	Resid	Std Resid	
1	7019000	8199257	-1180257	-2.03	R

R Large residual

Simple Regression: BEL TEU versus BEL IW TT - Ttonne

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	8.19980E+11	819980470721	2.08	0.1920
Error	7	2.75308E+12	393297774024		
Total	8	3.57306E+12			

Model Summary

S	R-sq	R-sq(adj)
627135	22.95%	11.94%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	7390853	648265	11.40	<0.0001
BEL IW TT - Ttonne	40.27	27.89	1.44	0.1920

Regression Equation

BEL TEU = 7390853 + 40.27 BEL IW TT - Ttonne

Simple Regression: BEL TEU versus PoAtwp SSS TT-Ttonne

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.14050E+12	2.14050E+12	10.46	0.0144
Error	7	1.43256E+12	2.04652E+11		
Total	8	3.57306E+12			

Model Summary

S	R-sq	R-sq(adj)
452385	59.91%	54.18%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	5244818	949589	5.52	0.0009
PoAtwp SSS TT-Ttonne	82.08	25.38	3.23	0.0144

Regression Equation

BEL TEU = 5244818 + 82.08 PoAtwp SSS TT-Ttonne

Fits and Diagnostics for Unusual Observations

Obs	BEL TEU	Fit	Resid	Std Resid	
4	7310000	8225379	-915379	-2.15	R

R Large residual

Port of Hamburg Minitab results

Simple Regression: TEU versus Quay Length (meter)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.13708E+13	2.13708E+13	10.70	0.0056
Error	14	2.79693E+13	1.99780E+12		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
1413437	43.31%	39.26%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1711705	1897684	0.90	0.3823
Quay Length (meter)	1044.2	319.3	3.27	0.0056

Regression Equation

TEU = 1711705 + 1044.2 Quay Length (meter)

Simple Regression: TEU versus Terminal Area (ha)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.01054E+13	2.01054E+13	9.63	0.0078
Error	14	2.92347E+13	2.08819E+12		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
1445058	40.75%	36.52%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	3089191	1563653	1.98	0.0682
Terminal Area (ha)	15735	5071	3.10	0.0078

Regression Equation

TEU = 3089191 + 15735 Terminal Area (ha)

Simple Regression: TEU versus No of Quayside Cranes

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.11880E+13	2.11880E+13	10.54	0.0059
Error	14	2.81520E+13	2.01086E+12		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
1418048	42.94%	38.87%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1999456	1824749	1.10	0.2917
No of Quayside Cranes	95447	29404	3.25	0.0059

Regression Equation

TEU = 1999456 + 95447 No of Quayside Cranes

Simple Regression: TEU versus Container Capacity (TEU)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.21486E+13	2.21486E+13	11.40	0.0045
Error	14	2.71915E+13	1.94225E+12		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
1393646	44.89%	40.95%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2603631	1580576	1.65	0.1218
Container Capacity (TEU)	0.5312	0.1573	3.38	0.0045

Regression Equation

TEU = 2603631 + 0.5312 Container Capacity (TEU)

Simple Regression: TEU versus Labour Productivity Index

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.96937E+12	2.96937E+12	0.90	0.3598
Error	14	4.63707E+13	3.31219E+12		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
1819943	6.02%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	8193601	609353	13.45	<0.0001
Labour Productivity Index	-351093	370806	-0.95	0.3598

Regression Equation

TEU = 8193601 – 351093 Labour Productivity Index

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
10	7008000	9092398	-2084398	-1.85	X

X Unusual X

Simple Regression: TEU versus DEU GDP (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	3.29307E+13	3.29307E+13	28.10	0.0001
Error	14	1.64094E+13	1.17210E+12		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
1082635	66.74%	64.37%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-277575	1549594	-0.18	0.8604
DEU GDP (MLN EUR)	2.9992	0.5658	5.30	0.0001

Regression Equation

TEU = −277575 + 2.9992 DEU GDP (MLN EUR)

Simple Regression: TEU versus DEU Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.36978E+13	4.36978E+13	108.43	<0.0001
Error	14	5.64226E+12	4.03019E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
634838	88.56%	87.75%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2279256	554337	4.11	0.0011
DEU Export (MLN EUR)	5.5042	0.5286	10.41	<0.0001

Regression Equation

TEU = 2279256 + 5.5042 DEU Export (MLN EUR)

Simple Regression: TEU versus DEU Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.14663E+13	4.14663E+13	73.73	<0.0001
Error	14	7.87371E+12	5.62408E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
749939	84.04%	82.90%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2389629	658490	3.63	0.0027
DEU Import (MLN EUR)	6.5783	0.7661	8.59	<0.0001

Regression Equation

TEU = 2389629 + 6.5783 DEU Import (MLN EUR)

Simple Regression: TEU versus Container Traffic (calling)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.07222E+12	1.07222E+12	0.31	0.5859
Error	14	4.82678E+13	3.44770E+12		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
1856799	2.17%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	9050269	2272273	3.98	0.0014
Container Traffic (calling)	-206.3	370.0	-0.56	0.5859

Regression Equation

TEU = 9050269 − 206.3 Container Traffic (calling)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid		
1	4248000	7851792	-3603792	-2.01	R	
5	7003000	7189616	-186616	-0.13		X

R Large residual
X Unusual X

Simple Regression: TEU versus Investment in Sea Infrastructur

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	6.08099E+11	6.08099E+11	0.17	0.6823
Error	14	4.87320E+13	3.48085E+12		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
1865705	1.23%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	7105810	1747730	4.07	0.0012
Investment in Sea Infrastructur	0.001048	0.002508	0.42	0.6823

Regression Equation

TEU = 7105810 + 0.001048 Investment in Sea Infrastructur

Simple Regression: TEU versus CHE Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.74473E+13	2.74473E+13	17.55	0.0009
Error	14	2.18927E+13	1.56377E+12		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
1250507	55.63%	52.46%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4977682	744794	6.68	<0.0001
CHE Export (MLN EUR)	16.724	3.992	4.19	0.0009

Regression Equation

TEU = 4977682 + 16.724 CHE Export (MLN EUR)

Simple Regression: TEU versus CHE Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.72675E+13	2.72675E+13	17.30	0.0010
Error	14	2.20725E+13	1.57661E+12		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
1255630	55.26%	52.07%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4808792	786938	6.11	<0.0001
CHE Import (MLN EUR)	19.278	4.636	4.16	0.0010

Regression Equation

TEU = 4808792 + 19.278 CHE Import (MLN EUR)

Simple Regression: TEU versus AUT Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.50401E+13	4.50401E+13	146.65	<0.0001
Error	14	4.29991E+12	3.07137E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
554199	91.29%	90.66%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1968031	501906	3.92	0.0015
AUT Export (MLN EUR)	50.172	4.143	12.11	<0.0001

Regression Equation

TEU = 1968031 + 50.172 AUT Export (MLN EUR)

Simple Regression: TEU versus AUT Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.29401E+13	4.29401E+13	93.93	<0.0001
Error	14	6.39998E+12	4.57142E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
676123	87.03%	86.10%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2156703	607284	3.55	0.0032
AUT Import (MLN EUR)	47.124	4.862	9.69	<0.0001

Regression Equation

TEU = 2156703 + 47.124 AUT Import (MLN EUR)

Simple Regression: TEU versus SVK Rep Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	3.62415E+13	3.62415E+13	38.74	<0.0001
Error	14	1.30985E+13	9.35610E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
967269	73.45%	71.56%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4931523	521871	9.45	<0.0001
SVK Rep Export (MLN EUR)	62.80	10.09	6.22	<0.0001

Regression Equation

TEU = 4931523 + 62.80 SVK Rep Export (MLN EUR)

Simple Regression: TEU versus SVK Rep Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	3.79079E+13	3.79079E+13	46.42	<0.0001
Error	14	1.14321E+13	8.16579E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
903648	76.83%	75.17%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4659876	514557	9.06	<0.0001
SVK Rep Import (MLN EUR)	68.63	10.07	6.81	<0.0001

Regression Equation

TEU = 4659876 + 68.63 SVK Rep Import (MLN EUR)

Simple Regression: TEU versus HUN Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.14834E+13	4.14834E+13	73.92	<0.0001
Error	14	7.85661E+12	5.61187E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
749124	84.08%	82.94%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	3644290	519428	7.02	<0.0001
HUN Export (MLN EUR)	59.617	6.934	8.60	<0.0001

Regression Equation

TEU = 3644290 + 59.617 HUN Export (MLN EUR)

Simple Regression: TEU versus HUN Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.45448E+13	4.45448E+13	130.05	<0.0001
Error	14	4.79521E+12	3.42515E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
585248	90.28%	89.59%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2843721	459390	6.19	<0.0001
HUN Import (MLN EUR)	72.956	6.397	11.40	<0.0001

Regression Equation

TEU = 2843721 + 72.956 HUN Import (MLN EUR)

Simple Regression: TEU versus CZK Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	3.96767E+13	3.96767E+13	57.48	<0.0001
Error	14	9.66334E+12	6.90239E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
830806	80.41%	79.02%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4594095	472266	9.73	<0.0001
CZK Export (MLN EUR)	39.389	5.195	7.58	<0.0001

Regression Equation

TEU = 4594095 + 39.389 CZK Export (MLN EUR)

Simple Regression: TEU versus CZK Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.01790E+13	4.01790E+13	61.40	<0.0001
Error	14	9.16108E+12	6.54363E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
808927	81.43%	80.11%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4231494	499432	8.47	<0.0001
CZK Import (MLN EUR)	44.450	5.673	7.84	<0.0001

Regression Equation

TEU = 4231494 + 44.450 CZK Import (MLN EUR)

Simple Regression: TEU versus POL Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	3.71136E+13	3.71136E+13	42.50	<0.0001
Error	14	1.22265E+13	8.73320E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
934516	75.22%	73.45%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4749075	524427	9.06	<0.0001
POL Export (MLN EUR)	26.978	4.138	6.52	<0.0001

Regression Equation

TEU = 4749075 + 26.978 POL Export (MLN EUR)

Simple Regression: TEU versus POL Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	3.90215E+13	3.90215E+13	52.94	<0.0001
Error	14	1.03186E+13	7.37040E+11		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
858510	79.09%	77.59%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4247829	534520	7.95	<0.0001
POL Import (MLN EUR)	28.203	3.876	7.28	<0.0001

Regression Equation

TEU = 4247829 + 28.203 POL Import (MLN EUR)

Simple Regression: TEU versus DEU Motorways (Kms)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.14800E+11	214799514025	0.22	0.6544
Error	7	6.88124E+12	983033815457		
Total	8	7.09604E+12			

Model Summary

S	R-sq	R-sq(adj)
991481	3.03%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	22925518	29969010	0.76	0.4693
DEU Motorways (Kms)	-1096	2345	-0.47	0.6544

Regression Equation

TEU = 22925518 – 1096 DEU Motorways (Kms)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
4	7008000	8877854	-1869854	-2.01	R

R Large residual

Simple Regression: TEU versus PoHmbg SSS TT TTonnes

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	6.11193E+12	6.11193E+12	43.47	0.0003
Error	7	9.84108E+11	1.40587E+11		
Total	8	7.09604E+12			

Model Summary

S	R-sq	R-sq(adj)
374949	86.13%	84.15%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	3116295	888660	3.51	0.0099
PoHmbg SSS TT TTonnes	242.23	36.74	6.59	0.0003

Regression Equation

TEU = 3116295 + 242.23 PoHmbg SSS TT TTonnes

Simple Regression: TEU versus DEU Railway Lines (Kms)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.64890E+10	1.64890E+10	0.02	0.9020
Error	7	7.07955E+12	1.01136E+12		
Total	8	7.09604E+12			

Model Summary

S	R-sq	R-sq(adj)
1005666	0.23%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-2997875	93317795	-0.03	0.9753
DEU Railway Lines (Kms)	314	2463	0.13	0.9020

Regression Equation

TEU = −2997875 + 314 DEU Railway Lines (Kms)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
4	7008000	8931876	-1923876	-2.04	R

R Large residual

Simple Regression: TEU versus DEU RLY TT TTonnes

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.81044E+12	1.81044E+12	2.40	0.1654
Error	7	5.28560E+12	7.55086E+11		
Total	8	7.09604E+12			

Model Summary

S	R-sq	R-sq(adj)
868957	25.51%	14.87%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	3986197	3197806	1.25	0.2527
DEU RLY TT TTonnes	78.94	50.98	1.55	0.1654

Regression Equation

TEU = 3986197 + 78.94 DEU RLY TT TTonnes

Simple Regression: TEU versus DEU Naviable Canals (Kms)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	9.78761E+09	9.78761E+09	0.01	0.9244
Error	7	7.08625E+12	1.01232E+12		
Total	8	7.09604E+12			

Model Summary

S	R-sq	R-sq(adj)
1006142	0.14%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	8223869	7061629	1.16	0.2823
DEU Naviable Canals (Kms)	334	3400	0.10	0.9244

Regression Equation

TEU = 8223869 + 334 DEU Naviable Canals (Kms)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
4	7008000	8881416	-1873416	-2.14	R

R Large residual

Simple Regression: TEU versus DEU Navigable rivers (Kms)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	8.30945E+11	830945498939	0.93	0.3674
Error	7	6.26509E+12	895012960469		
Total	8	7.09604E+12			

Model Summary

S	R-sq	R-sq(adj)
946051	11.71%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	15713013	7059727	2.23	0.0614
DEU Navigable rivers (Kms)	-1195	1240	-0.96	0.3674

Regression Equation

TEU = 15713013 – 1195 DEU Navigable rivers (Kms)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
3	9737000	8350804	1386196	2.07	R
4	7008000	8350804	-1342804	-2.00	R

R Large residual

Simple Regression: TEU versus DEU IW TT TTonnes

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.80615E+12	2.80615E+12	4.58	0.0697
Error	7	4.28988E+12	6.12840E+11		
Total	8	7.09604E+12			

Model Summary

S	R-sq	R-sq(adj)
782841	39.55%	30.91%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	18252355	4370224	4.18	0.0042
DEU IW TT TTonnes	-481.2	224.9	-2.14	0.0697

Regression Equation

TEU = 18252355 − 481.2 DEU IW TT TTonnes

Simple Regression: TEU versus DEU MW TT TTonnes

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	6.27360E+10	6.27360E+10	0.06	0.8099
Error	7	7.03330E+12	1.00476E+12		
Total	8	7.09604E+12			

Model Summary

S	R-sq	R-sq(adj)
1002376	0.88%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	9178000	1094955	8.38	<0.0001
DEU MW TT TTonnes	-1.225	4.904	-0.25	0.8099

Regression Equation

TEU = 9178000 − 1.225 DEU MW TT TTonnes

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
4	7008000	8899400	-1891400	-2.01	R

R Large residual

Port of Rotterdam Minitab results

Simple Regression: TEU versus Quay Length (meter) Cumulative

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	8.85123E+13	8.85123E+13	68.32	<0.0001
Error	17	2.20243E+13	1.29555E+12		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
1138221	80.08%	78.90%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-1919974	1362290	-1.41	0.1768
Quay Length (meter) Cumulative	1002.6	121.3	8.27	<0.0001

Regression Equation

TEU = −1919974 + 1002.6 Quay Length (meter) Cumulative

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid		
19	12234535	14447981	-2213446	-2.45	R	X

R Large residual
X Unusual X

Simple Regression: TEU versus Terminal Area Cumulative (ha)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	7.63520E+13	7.63520E+13	37.97	<0.0001
Error	17	3.41846E+13	2.01086E+12		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
1418048	69.07%	67.25%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-1420586	1743065	-0.81	0.4263
Terminal Area Cumulative (ha)	20298	3294	6.16	<0.0001

Regression Equation

TEU = −1420586 + 20298 Terminal Area Cumulative (ha)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
19	12234535	14797866	-2563331	-2.49	R X

R Large residual
X Unusual X

Simple Regression: TEU versus No of Quayside Cranes cumulativ

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	8.35502E+13	8.35502E+13	52.63	<0.0001
Error	17	2.69864E+13	1.58744E+12		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
1259935	75.59%	74.15%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-1635007	1511925	-1.08	0.2946
No of Quayside Cranes cumulativ	124961	17225	7.25	<0.0001

Regression Equation

TEU = −1635007 + 124961 No of Quayside Cranes cumulativ

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid		
19	12234535	14485002	-2250467	-2.30	R	X

R Large residual
X Unusual X

Simple Regression: TEU versus Cumulative Capacity Increase

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	8.41195E+13	8.41195E+13	54.13	<0.0001
Error	17	2.64171E+13	1.55395E+12		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
1246575	76.10%	74.70%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2319551	969001	2.39	0.0285
Cumulative Capacity Increase	0.50709	0.06892	7.36	<0.0001

Regression Equation

TEU = 2319551 + 0.50709 Cumulative Capacity Increase

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
19	12234535	14043516	-1808981	-1.79	X

X Unusual X

Simple Regression: TEU versus Labour Productivity Index

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.26362E+13	2.26362E+13	4.38	0.0517
Error	17	8.79005E+13	5.17062E+12		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
2273899	20.48%	15.80%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	10164803	718385	14.15	<0.0001
Labour Productivity Index	-890868	425777	-2.09	0.0517

Regression Equation

TEU = 10164803 – 890868 Labour Productivity Index

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
13	9743000	12293977	-2550977	-1.58	X

X Unusual X

Simple Regression: TEU versus NLD GDP (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.05014E+14	1.05014E+14	323.24	<0.0001
Error	17	5.52295E+12	3.24879E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
569982	95.00%	94.71%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-1895588	627115	-3.02	0.0077
NLD GDP (MLN EUR)	19.068	1.061	17.98	<0.0001

Regression Equation

TEU = −1895588 + 19.068 NLD GDP (MLN EUR)

Simple Regression: TEU versus NLD Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.05047E+14	1.05047E+14	325.33	<0.0001
Error	17	5.48929E+12	3.22899E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
568242	95.03%	94.74%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	3126799	357523	8.75	<0.0001
NLD Export (MLN EUR)	17.7224	0.9826	18.04	<0.0001

Regression Equation

TEU = 3126799 + 17.7224 NLD Export (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
19	12234535	10654590	1579945	2.89	R

R Large residual

Simple Regression: TEU versus NLD Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.04912E+14	1.04912E+14	317.06	<0.0001
Error	17	5.62510E+12	3.30888E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
575229	94.91%	94.61%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	3063480	365436	8.38	<0.0001
NLD Import (MLN EUR)	19.927	1.119	17.81	<0.0001

Regression Equation

TEU = 3063480 + 19.927 NLD Import (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
12	10784000	11939937	-1155937	-2.15	R
19	12234535	10579423	1655112	2.99	R

R Large residual

Simple Regression: TEU versus DEU Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.06845E+14	1.06845E+14	491.98	<0.0001
Error	17	3.69194E+12	2.17173E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
466018	96.66%	96.46%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2616828	312559	8.37	<0.0001
DEU Export (MLN EUR)	7.0667	0.3186	22.18	<0.0001

Regression Equation

TEU = 2616828 + 7.0667 DEU Export (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
12	10784000	11941455	-1157455	-2.66	R
19	12234535	11083209	1151326	2.59	R

R Large residual

Simple Regression: TEU versus DEU Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.05690E+14	1.05690E+14	370.73	<0.0001
Error	17	4.84652E+12	2.85090E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
533938	95.62%	95.36%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2475350	366753	6.75	<0.0001
DEU Import (MLN EUR)	8.7613	0.4550	19.25	<0.0001

Regression Equation

TEU = 2475350 + 8.7613 DEU Import (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
12	10784000	11970762	-1186762	-2.38	R
19	12234535	10804788	1429747	2.79	R

R Large residual

Simple Regression: TEU versus CHE Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	9.12199E+13	9.12199E+13	80.28	<0.0001
Error	17	1.93168E+13	1.13628E+12		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
1065965	82.52%	81.50%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4940527	527810	9.36	<0.0001
CHE Export (MLN EUR)	27.257	3.042	8.96	<0.0001

Regression Equation

TEU = 4940527 + 27.257 CHE Export (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
17	11621000	13720325	-2099325	-2.33	R

R Large residual

Simple Regression: TEU versus CHE Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	8.97620E+13	8.97620E+13	73.45	<0.0001
Error	17	2.07747E+13	1.22204E+12		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
1105459	81.21%	80.10%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4677907	578219	8.09	<0.0001
CHE Import (MLN EUR)	31.305	3.653	8.57	<0.0001

Regression Equation

TEU = 4677907 + 31.305 CHE Import (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
17	11621000	13723238	-2102238	-2.25	R

R Large residual

Simple Regression: TEU versus AUT Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.04428E+14	1.04428E+14	290.63	<0.0001
Error	17	6.10848E+12	3.59323E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
599435	94.47%	94.15%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2637510	404987	6.51	<0.0001
AUT Export (MLN EUR)	61.018	3.579	17.05	<0.0001

Regression Equation

TEU = 2637510 + 61.018 AUT Export (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
12	10784000	12095541	-1311541	-2.35	R
19	12234535	10615559	1618976	2.81	R

R Large residual

Simple Regression: TEU versus AUT Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.04687E+14	1.04687E+14	304.24	<0.0001
Error	17	5.84960E+12	3.44094E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
586595	94.71%	94.40%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2470188	404913	6.10	<0.0001
AUT Import (MLN EUR)	60.370	3.461	17.44	<0.0001

Regression Equation

TEU = 2470188 + 60.370 AUT Import (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
12	10784000	11979809	-1195809	-2.19	R
19	12234535	10507934	1726601	3.05	R

R Large residual

Simple Regression: TEU versus SVK Rep Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.05389E+14	1.05389E+14	348.03	<0.0001
Error	17	5.14787E+12	3.02816E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
550287	95.34%	95.07%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	5469053	233403	23.43	<0.0001
SVK Rep Export (MLN EUR)	91.469	4.903	18.66	<0.0001

Regression Equation

TEU = 5469053 + 91.469 SVK Rep Export (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
9	9288000	8091182	1196818	2.25	R

R Large residual

Simple Regression: TEU versus SVK Rep Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.06112E+14	1.06112E+14	407.67	<0.0001
Error	17	4.42493E+12	2.60290E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
510186	96.00%	95.76%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	5197642	227284	22.87	<0.0001
SVK Rep Import (MLN EUR)	97.489	4.828	20.19	<0.0001

Regression Equation

TEU = 5197642 + 97.489 SVK Rep Import (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
9	9288000	8200601	1087399	2.20	R

R Large residual

Simple Regression: TEU versus HUN Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.07364E+14	1.07364E+14	575.29	<0.0001
Error	17	3.17263E+12	1.86625E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
432002	97.13%	96.96%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4333078	223257	19.41	<0.0001
HUN Export (MLN EUR)	77.369	3.226	23.99	<0.0001

Regression Equation

TEU = 4333078 + 77.369 HUN Export (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
12	10784000	11868050	-1084050	-2.68	R
19	12234535	11307898	926637	2.26	R

R Large residual

Simple Regression: TEU versus HUN Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.04593E+14	1.04593E+14	299.16	<0.0001
Error	17	5.94365E+12	3.49627E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
591292	94.62%	94.31%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	3800564	336741	11.29	<0.0001
HUN Import (MLN EUR)	87.574	5.063	17.30	<0.0001

Regression Equation

TEU = 3800564 + 87.574 HUN Import (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
12	10784000	12374614	-1590614	-2.92	R
19	12234535	10923596	1310939	2.32	R

R Large residual

Simple Regression: TEU versus CZK Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.08434E+14	1.08434E+14	876.89	<0.0001
Error	17	2.10219E+12	1.23658E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
351651	98.10%	97.99%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	5244164	154079	34.04	<0.0001
CZK Export (MLN EUR)	54.538	1.842	29.61	<0.0001

Regression Equation

TEU = 5244164 + 54.538 CZK Export (MLN EUR)

Simple Regression: TEU versus CZK Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.07945E+14	1.07945E+14	707.95	<0.0001
Error	17	2.59209E+12	1.52476E+11		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
390481	97.65%	97.52%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	4837666	184572	26.21	<0.0001
CZK Import (MLN EUR)	60.484	2.273	26.61	<0.0001

Regression Equation

TEU = 4837666 + 60.484 CZK Import (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
12	10784000	11669248	-885248	-2.41	R

R Large residual

Simple Regression: TEU versus Container Traffic (calling)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.80578E+13	4.80578E+13	13.08	0.0021
Error	17	6.24788E+13	3.67523E+12		
Total	18	1.10537E+14			

Model Summary

S	R-sq	R-sq(adj)
1917088	43.48%	40.15%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-3914968	3634567	-1.08	0.2965
Container Traffic (calling)	2169.0	599.8	3.62	0.0021

Regression Equation

TEU = −3914968 + 2169.0 Container Traffic (calling)

Simple Regression: TEU versus Motorways (Kms)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	3.25104E+12	3.25104E+12	6.04	0.0436
Error	7	3.76833E+12	5.38333E+11		
Total	8	7.01937E+12			

Model Summary

S	R-sq	R-sq(adj)
733712	46.32%	38.65%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-35837704	19096168	-1.88	0.1027
Motorways (Kms)	17821	7252	2.46	0.0436

Regression Equation

TEU = −35837704 + 17821 Motorways (Kms)

Simple Regression: TEU versus Motorways Total Transport - Tho

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.65583E+12	1.65583E+12	2.16	0.1850
Error	7	5.36354E+12	7.66220E+11		
Total	8	7.01937E+12			

Model Summary

S	R-sq	R-sq(adj)
875340	23.59%	12.67%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	12360809	914674	13.51	<0.0001
Motorways Total Transport - Tho	-29.61	20.14	-1.47	0.1850

Regression Equation

TEU = 12360809 − 29.61 Motorways Total Transport - Tho

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
8	11621000	12149916	-528916	-1.33	X

X Unusual X

Simple Regression: TEU versus Railway Lines (Kms)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.69940E+12	4.69940E+12	14.18	0.0070
Error	7	2.31997E+12	3.31425E+11		
Total	8	7.01937E+12			

Model Summary

S	R-sq	R-sq(adj)
575695	66.95%	62.23%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-12289437	6210788	-1.98	0.0883
Railway Lines (Kms)	7949	2111	3.77	0.0070

Regression Equation

TEU = −12289437 + 7949 Railway Lines (Kms)

Simple Regression: TEU versus Railway Total Transport - Thous

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	3.81558E+12	3.81558E+12	8.34	0.0234
Error	7	3.20379E+12	4.57684E+11		
Total	8	7.01937E+12			

Model Summary

S	R-sq	R-sq(adj)
676524	54.36%	47.84%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	7752748	1176409	6.59	0.0003
Railway Total Transport - Thous	294.3	101.9	2.89	0.0234

Regression Equation

TEU = 7752748 + 294.3 Railway Total Transport - Thous

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
6	11877000	10605270	1271730	2.07	R

R Large residual

Simple Regression: TEU versus Naviable Canals (Kms)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.29857E+12	1.29857E+12	1.59	0.2479
Error	7	5.72080E+12	8.17257E+11		
Total	8	7.01937E+12			

Model Summary

S	R-sq	R-sq(adj)
904023	18.50%	6.86%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-242758125	201379469	-1.21	0.2672
Naviable Canals (Kms)	53946	42796	1.26	0.2479

Regression Equation

TEU = −242758125 + 53946 Naviable Canals (Kms)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
2	10791000	10193343	597657	1.26	X

X Unusual X

Simple Regression: TEU versus Navigable rivers (Kms)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.55214E+11	155214003307	0.16	0.7026
Error	7	6.86416E+12	980593745559		
Total	8	7.01937E+12			

Model Summary

S	R-sq	R-sq(adj)
990249	2.21%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	21785100	26893110	0.81	0.4446
Navigable rivers (Kms)	-7707	19372	-0.40	0.7026

Regression Equation

TEU = 21785100 − 7707 Navigable rivers (Kms)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
8	11621000	11449546	171454	0.87	X

X Unusual X

Simple Regression: TEU versus Inland Waterways Total Transpor

Method

Rows unused 1

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.38379E+12	4.38379E+12	80.39	0.0001
Error	6	3.27199E+11	5.45332E+10		
Total	7	4.71099E+12			

Model Summary

S	R-sq	R-sq(adj)
233523	93.05%	91.90%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	7462435	432130	17.27	<0.0001
Inland Waterways Total Transpor	107.23	11.96	8.97	0.0001

Regression Equation

TEU = 7462435 + 107.23 Inland Waterways Total Transpor

Simple Regression: TEU versus PoR Short Sea Shipping Total Tr

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.65195E+12	5.65195E+12	28.93	0.0010
Error	7	1.36742E+12	1.95345E+11		
Total	8	7.01937E+12			

Model Summary

S	R-sq	R-sq(adj)
441979	80.52%	77.74%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1764056	1739374	1.01	0.3443
PoR Short Sea Shipping Total Tr	299.71	55.72	5.38	0.0010

Regression Equation

TEU = 1764056 + 299.71 PoR Short Sea Shipping Total Tr

Simple Regression: TEU versus Investment in Port Infrastructu

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.19318E+13	1.19318E+13	4.24	0.0618
Error	12	3.37420E+13	2.81183E+12		
Total	13	4.56737E+13			

Model Summary

S	R-sq	R-sq(adj)
1676851	26.12%	19.97%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	8629663	897552	9.61	<0.0001
Investment in Port Infrastructu	0.006089	0.002956	2.06	0.0618

Regression Equation

TEU = 8629663 + 0.006089 Investment in Port Infrastructu

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
11	11862000	12439799	-577799	-0.48	X

X Unusual X

Port of Le Havre Minitab results

Simple Regression: TEU versus Labour Productivity Index

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.75204E+12	1.75204E+12	8.47	0.0093
Error	18	3.72224E+12	2.06791E+11		
Total	19	5.47427E+12			

Model Summary

S	R-sq	R-sq(adj)
454743	32.00%	28.23%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2228003	149892	14.86	<0.0001
Labour Productivity Index	-239041	82123	-2.91	0.0093

Regression Equation

TEU = 2228003 – 239041 Labour Productivity Index

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
2	1020000	2055894	-1035894	-2.35	R

R Large residual

Simple Regression: TEU versus FRA GDP (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.78894E+12	4.78894E+12	125.78	<0.0001
Error	18	6.85335E+11	3.80741E+10		
Total	19	5.47427E+12			

Model Summary

S	R-sq	R-sq(adj)
195126	87.48%	86.79%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-217203	194405	-1.12	0.2786
FRA GDP (MLN EUR)	1.2297	0.1096	11.22	<0.0001

Regression Equation

TEU = −217203 + 1.2297 FRA GDP (MLN EUR)

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
13	2638000	2194024	443976	2.36	R

R Large residual

Simple Regression: TEU versus FRA Export (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.60343E+12	4.60343E+12	95.15	<0.0001
Error	18	8.70846E+11	4.83803E+10		
Total	19	5.47427E+12			

Model Summary

S	R-sq	R-sq(adj)
219955	84.09%	83.21%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	213634	180475	1.18	0.2519
FRA Export (MLN EUR)	4.4747	0.4587	9.75	<0.0001

Regression Equation

TEU = 213634 + 4.4747 FRA Export (MLN EUR)

Simple Regression: TEU versus FRA Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4.49679E+12	4.49679E+12	82.81	<0.0001
Error	18	9.77487E+11	5.43048E+10		
Total	19	5.47427E+12			

Model Summary

S	R-sq	R-sq(adj)
233034	82.14%	81.15%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	589970	153873	3.83	0.0012
FRA Import (MLN EUR)	3.1655	0.3479	9.10	<0.0001

Regression Equation

TEU = 589970 + 3.1655 FRA Import (MLN EUR)

Simple Regression: TEU versus Investment in Sea Infrastructur

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.34492E+12	2.34492E+12	13.49	0.0017
Error	18	3.12936E+12	1.73853E+11		
Total	19	5.47427E+12			

Model Summary

S	R-sq	R-sq(adj)
416957	42.84%	39.66%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	920946	284333	3.24	0.0046
Investment in Sea Infrastructur	0.0031680	0.0008626	3.67	0.0017

Regression Equation

TEU = 920946 + 0.0031680 Investment in Sea Infrastructur

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
13	2638000	1636906	1001094	2.50	R

R Large residual

Simple Regression: TEU versus FRA Motorways (Kms)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	4251486465	4251486465	0.14	0.7236
Error	7	219510735757	31358676537		
Total	8	223762222222			

Model Summary

S	R-sq	R-sq(adj)
177084	1.90%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1347635	2792018	0.48	0.6441
FRA Motorways (Kms)	91.4	248.1	0.37	0.7236

Regression Equation

TEU = 1347635 + 91.4 FRA Motorways (Kms)

Simple Regression: TEU versus FRA Motorways Total Transport -

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	8986839471	8986839471	0.29	0.6052
Error	7	214775382751	30682197536		
Total	8	223762222222			

Model Summary

S	R-sq	R-sq(adj)
175163	4.02%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2579912	382287	6.75	0.0003
FRA Motorways Total Transport -	-6.99	12.92	-0.54	0.6052

Regression Equation

TEU = 2579912 – 6.99 FRA Motorways Total Transport -

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
2	2638000	2336015	301985	2.04	R

R Large residual

Simple Regression: TEU versus FRA Railway Lines (Kms)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2811154210	2811154210	0.09	0.7740
Error	7	220951068012	31564438287		
Total	8	223762222222			

Model Summary

S	R-sq	R-sq(adj)
177664	1.26%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	1724477	2182107	0.79	0.4553
FRA Railway Lines (Kms)	21.64	72.51	0.30	0.7740

Regression Equation

TEU = 1724477 + 21.64 FRA Railway Lines (Kms)

Simple Regression: TEU versus FRA Railways Total Transport -

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	22732836785	22732836785	0.79	0.4032
Error	7	201029385437	28718483634		
Total	8	223762222222			

Model Summary

S	R-sq	R-sq(adj)
169465	10.16%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2061991	356812	5.78	0.0007
FRA Railways Total Transport -	26.59	29.89	0.89	0.4032

Regression Equation

TEU = 2061991 + 26.59 FRA Railways Total Transport -

Simple Regression: TEU versus FRA Inland Watwerways Total Tr

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	196086462	196086462	0.01	0.9397
Error	7	223566135761	31938019394		
Total	8	223762222222			

Model Summary

S	R-sq	R-sq(adj)
178712	0.09%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	2414441	501236	4.82	0.0019
FRA Inland Watwerways Total Tr	-10.4	132.1	-0.08	0.9397

Regression Equation

TEU = 2414441 − 10.4 FRA Inland Watwerways Total Tr

Simple Regression: TEU versus Container Traffic Calling

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.29474E+11	229473857770	1.58	0.2486
Error	7	1.01418E+12	144883448890		
Total	8	1.24366E+12			

Model Summary

S	R-sq	R-sq(adj)
380636	18.45%	6.80%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	-289582	1834529	-0.16	0.8790
Container Traffic Calling	969.7	770.5	1.26	0.2486

Regression Equation

TEU = −289582 + 969.7 Container Traffic Calling

Appendix 5

Port of Antwerp Minitab Multi regression model results

Multiple Regression: TEU versus Quay length (meter), Terminal Area (ha), Labour Productivity Index, BEL GDP (MLN EUR), CHE Export (MLN EUR), CHE Import (MLN EUR), FRA Export (MLN EUR), FRA Import (MLN EUR), Container Traffic (calling), Sea Infra Invest (EUR)

Regression Equation

TEU = −6972662 − 399.2 Quay length (meter) + 6569 Terminal Area (ha)
+ 112344 Labour Productivity Index + 20.204 BEL GDP (MLN EUR)
− 16.288 CHE Export (MLN EUR) + 11.919 CHE Import (MLN EUR)
+ 33.455 FRA Export (MLN EUR) − 18.884 FRA Import (MLN EUR)
+ 614.7 Container Traffic (calling) + 0.001572 Sea Infra Invest (EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	10	6.14535E+13	6.14535E+12	625.02	<0.0001
Error	6	5.89938E+10	9.83230E+09		
Total	16	6.15125E+13			

Model Summary

S	R-sq	R-sq(adj)
99157.9	99.90%	99.74%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	-6972662	667830	(-8606784, -5338539)	-10.44	<0.0001
Quay length (meter)	-399.2	257.8	(-1030.0, 231.6)	-1.55	0.1725
Terminal Area (ha)	6569	4021	(-3270, 16408)	1.63	0.1534
Labour Productivity Index	112344	34200	(28660, 196028)	3.28	0.0167
BEL GDP (MLN EUR)	20.204	2.821	(13.301, 27.107)	7.16	0.0004
CHE Export (MLN EUR)	-16.288	8.102	(-36.113, 3.537)	-2.01	0.0911
CHE Import (MLN EUR)	11.919	7.747	(-7.038, 30.876)	1.54	0.1749
FRA Export (MLN EUR)	33.455	4.275	(22.994, 43.916)	7.83	0.0002
FRA Import (MLN EUR)	-18.884	3.666	(-27.854, -9.914)	-5.15	0.0021
Container Traffic (calling)	614.7	169.8	(199.1, 1030.2)	3.62	0.0111
Sea Infra Invest (EUR)	0.001572	0.001064	(-0.001030, 0.004175)	1.48	0.1898

Multiple Regression: BEL TEU versus BEL Road TT - Ttonne, BEL IW TT - Ttonne, PoAtwp SSS TT-Ttonne

Regression Equation

BEL TEU = −456490 + 252.95 BEL Road TT - Ttonne + 7.96 BEL IW TT - Ttonne
+ 78.62 PoAtwp SSS TT-Ttonne

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	3	3.14111E+12	1.04704E+12	12.12	0.0099
Error	5	4.31953E+11	8.63907E+10		
Total	8	3.57306E+12			

Model Summary

S	R-sq	R-sq(adj)
293923	87.91%	80.66%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	-456490	1811402	(-5112846, 4199866)	-0.25	0.8111
BEL Road TT - Ttonne	252.95	75.26	(59.49, 446.41)	3.36	0.0201
BEL IW TT - Ttonne	7.96	15.39	(-31.60, 47.51)	0.52	0.6271
PoAtwp SSS TT-Ttonne	78.62	19.42	(28.70, 128.55)	4.05	0.0098

Appendix 6

Port of Hamburg Minitab multi regression model results

Multiple Regression: TEU versus Quay Length (meter), Terminal Area (ha), Labour Productivity Index, DEU GDP (MLN EUR), DEU Export (MLN EUR), DEU Import (MLN EUR), Container Traffic (calling), Investment in Sea Infrastructur, SVK Rep Export (MLN EUR), CZK Import (MLN EUR)

Regression Equation

TEU = −156426 − 4321 Quay Length (meter) + 71138 Terminal Area (ha)
− 55196 Labour Productivity Index + 0.8318 DEU GDP (MLN EUR)
+ 33.168 DEU Export (MLN EUR) − 6.943 DEU Import (MLN EUR)
− 463.4 Container Traffic (calling) + 0.0005157 Investment in Sea Infrastructur
− 179.19 SVK Rep Export (MLN EUR) − 90.37 CZK Import (MLN EUR)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	10	4.92112E+13	4.92112E+12	190.91	<0.0001
Error	5	1.28884E+11	2.57768E+10		
Total	15	4.93401E+13			

Model Summary

S	R-sq	R-sq(adj)
160551	99.74%	99.22%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	-156426	2389119	(-6297852, 5985000)	-0.07	0.9503
Quay Length (meter)	-4321	1778	(-8893, 250)	-2.43	0.0594
Terminal Area (ha)	71138	27524	(385, 141890)	2.58	0.0492
Labour Productivity Index	-55196	67737	(-229320, 118927)	-0.81	0.4522
DEU GDP (MLN EUR)	0.8318	0.9644	(-1.6473, 3.3108)	0.86	0.4278
DEU Export (MLN EUR)	33.168	4.063	(22.725, 43.612)	8.16	0.0004
DEU Import (MLN EUR)	-6.943	4.308	(-18.018, 4.132)	-1.61	0.1680
Container Traffic (calling)	-463.4	108.6	(-742.5, -184.3)	-4.27	0.0079
Investment in Sea Infrastructur	0.0005157	0.0004481	(-0.0006361, 0.0016676)	1.15	0.3018
SVK Rep Export (MLN EUR)	-179.19	32.61	(-263.01, -95.37)	-5.50	0.0027
CZK Import (MLN EUR)	-90.37	32.79	(-174.65, -6.10)	-2.76	0.0400

Multiple Regression: TEU versus DEU MW TT TTonnes, DEU RLY TT TTonnes, DEU IW TT TTonnes, PoHmbg SSS TT TTonnes

Regression Equation

TEU = 5774914 – 1.275 DEU MW TT TTonnes + 65.61 DEU RLY TT TTonnes
– 229.85 DEU IW TT TTonnes + 157.58 PoHmbg SSS TT TTonnes

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	4	6.88656E+12	1.72164E+12	32.88	0.0026
Error	4	2.09472E+11	5.23680E+10		
Total	8	7.09604E+12			

Model Summary

S	R-sq	R-sq(adj)
228841	97.05%	94.10%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	5774914	2170230	(-250611, 11800440)	2.66	0.0563
DEU MW TT TTonnes	-1.275	2.175	(-7.314, 4.764)	-0.59	0.5892
DEU RLY TT TTonnes	65.61	25.83	(-6.10, 137.33)	2.54	0.0640
DEU IW TT TTonnes	-229.85	89.64	(-478.74, 19.04)	-2.56	0.0624
PoHmbg SSS TT TTonnes	157.58	34.88	(60.73, 254.43)	4.52	0.0107

Appendix 7

Port of Le Havre Minitab multi regression model results

Multiple Regression: TEU versus Labour Productivity Index, FRA GDP (MLN EUR), FRA Export (MLN EUR), FRA Import (MLN EUR), Investment in Sea Infrastructur

Regression Equation

TEU = −1778291 − 29253 Labour Productivity Index + 1.3850 FRA GDP (MLN EUR)
+ 18.743 FRA Export (MLN EUR) − 13.874 FRA Import (MLN EUR)
+ 0.0000376 Investment in Sea Infrastructur

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	5	5.20864E+12	1.04173E+12	54.90	<0.0001
Error	14	2.65632E+11	1.89737E+10		
Total	19	5.47427E+12			

Model Summary

S	R-sq	R-sq(adj)
137745	95.15%	93.41%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	-1778291	468510	(-2783144, -773438)	-3.80	0.0020
Labour Productivity Index	-29253	35357	(-105087, 46581)	-0.83	0.4219
FRA GDP (MLN EUR)	1.3850	0.3381	(0.6598, 2.1102)	4.10	0.0011
FRA Export (MLN EUR)	18.743	4.367	(9.378, 28.109)	4.29	0.0007
FRA Import (MLN EUR)	-13.874	3.458	(-21.292, -6.457)	-4.01	0.0013
Investment in Sea Infrastructur	0.0000376	0.0004592	(-0.0009472, 0.0010225)	0.08	0.9359

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
13	2638000	2420941	217059	2.13	R
20	2551000	2817341	-266341	-2.33	R

R Large residual

Multiple Regression: TEU versus FRA Motorways Total Transport -, FRA Railways Total Transport -, FRA Inland Watwerways Total Tr

Regression Equation

TEU = 2686252 − 9.11 FRA Motorways Total Transport - + 18.73 FRA Railways Total Transport -
− 70.4 FRA Inland Watwerways Total Tr

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	3	29063090161	9687696720	0.25	0.8592
Error	5	194699132061	38939826412		
Total	8	223762222222			

Model Summary

S	R-sq	R-sq(adj)
197332	12.99%	0.00%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	2686252	1645757	(-1544300, 6916805)	1.63	0.1636
FRA Motorways Total Transport -	-9.11	22.78	(-67.66, 49.44)	-0.40	0.7056
FRA Railways Total Transport -	18.73	39.92	(-83.87, 121.34)	0.47	0.6586
FRA Inland Watwerways Total Tr	-70.4	214.9	(-622.7, 481.9)	-0.33	0.7565

Appendix 8

Port of Rotterdam Minitab multi regression model results

Multiple Regression: TEU versus Quay Length (meter) Cumulative, Terminal Area Cumulative (ha), No of Quayside Cranes cumulativ, Cumulative Capacity Increase, NLD GDP (MLN EUR), NLD Export (MLN EUR), NLD Import (MLN EUR), Container Traffic (calling)

Regression Equation

TEU = 24384971 + 3469 Quay Length (meter) Cumulative + 177099 Terminal Area Cumulative (ha)
– 2616561 No of Quayside Cranes cumulativ + 4.528 Cumulative Capacity Increase
+ 24.218 NLD GDP (MLN EUR) – 14.94 NLD Export (MLN EUR)
+ 20.86 NLD Import (MLN EUR) + 543.6 Container Traffic (calling)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	8	4.52398E+13	5.65497E+12	65.15	0.0001
Error	5	4.33975E+11	8.67949E+10		
Total	13	4.56737E+13			

Model Summary

S	R-sq	R-sq(adj)
294610	99.05%	97.53%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	24384971	9522769	(-94086, 48864029)	2.56	0.0506
Quay Length (meter) Cumulative	3469	1821	(-1213, 8151)	1.90	0.1152
Terminal Area Cumulative (ha)	177099	53213	(40310, 313888)	3.33	0.0208
No of Quayside Cranes cumulativ	-2616561	910855	(-4957989, -275132)	-2.87	0.0349
Cumulative Capacity Increase	4.528	1.536	(0.580, 8.476)	2.95	0.0320
NLD GDP (MLN EUR)	24.218	8.978	(1.139, 47.297)	2.70	0.0429
NLD Export (MLN EUR)	-14.94	18.41	(-62.26, 32.37)	-0.81	0.4539
NLD Import (MLN EUR)	20.86	17.83	(-24.96, 66.68)	1.17	0.2947
Container Traffic (calling)	543.6	220.6	(-23.6, 1110.7)	2.46	0.0570

Fits and Diagnostics for Unusual Observations

Obs	TEU	Fit	Resid	Std Resid	
14	12234535	12234351	184.262	0.98	X

X Unusual X

Multiple Regression: TEU versus Motorways Total Transport - Tho, Railway Total Transport - Thous, Inland Waterways Total Transpor, PoR Short Sea Shipping Total Tr

Method

Rows unused 1

Regression Equation

TEU = 8035009 + 8.506 Motorways Total Transport - Tho + 27.78 Railway Total Transport - Thous
+ 143.80 Inland Waterways Total Transpor – 81.3 PoR Short Sea Shipping Total Tr

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	4	4.49131E+12	1.12283E+12	15.33	0.0245
Error	3	2.19677E+11	7.32256E+10		
Total	7	4.71099E+12			

Model Summary

S	R-sq	R-sq(adj)
270602	95.34%	89.12%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value
Constant	8035009	2669342	(-460029, 16530048)	3.01	0.0572
Motorways Total Transport - Tho	8.506	7.941	(-16.765, 33.778)	1.07	0.3626
Railway Total Transport - Thous	27.78	67.83	(-188.08, 243.63)	0.41	0.7096
Inland Waterways Total Transpor	143.80	53.86	(-27.60, 315.20)	2.67	0.0757
PoR Short Sea Shipping Total Tr	-81.3	140.6	(-528.7, 366.0)	-0.58	0.6034

Appendix 9

Port related data

Port of Antwerp

Year	TEU	Maximum Draught (meters)	Quay length (meter)	Terminal Area (ha)	Number of cranes	Container Capacity (TEU)	Labour Productivity Index	BEL GDP (MLN EUR)	BEL Export (MLN EUR)	BEL Import (MLN EUR)	BEL GDP (MLN EUR)	BEL Export (MLN EUR)	BEL Import (MLN EUR)
1999	3614000	17.75	3005	168	21	4100000	2.20	238588	160980	148143	238588	160980	148143
2000	4082000	17.75	3005	168	21	4100000	0.80	260899	169055	159292	260899	169055	159292
2001	4218000	17.75	3005	168	21	4100000	-0.15	270313	171279	160828	270313	171279	160828
2002	4777000	17.75	3005	168	21	4100000	2.34	286121	194223	178285	286121	194223	178285
2003	5445000	17.75	3005	168	21	4100000	1.17	289983	229998	211430	289983	229998	211430
2004	6064000	17.75	7775	439	49	10100000	2.94	299900	276921	257830	299900	276921	257830
2005	6482000	17.75	10375	639	70	14700000	1.13	311619	302123	287177	311619	302123	287177
2006	7019000	17.75	10375	639	70	14700000	0.92	332938	330152	317784	332938	330152	317784
2007	8177000	17.75	10375	639	70	14700000	1.43	349816	388569	371732	349816	388569	371732
2008	8663000	17.75	10375	639	70	14700000	-0.62	364806	424618	419704	364806	424618	419704
2009	7310000	17.75	10375	639	70	14700000	-0.74	365639	333791	319128	365639	333791	319128
2010	8468000	17.75	10375	639	70	14700000	2.19	384963	366836	352130	384963	366836	352130
2011	8664000	17.75	10375	639	70	14700000	-0.47	406257	428362	419714	406257	428362	419714
2012	8635000	17.75	10375	639	70	14700000	-0.22	419953	402169	394094	419953	402169	394094
2013	8578000	17.75	10375	639	70	14700000	0.52	433351	460355	439674	433351	460355	439674
2014	8978000	17.75	10375	639	70	14700000	0.82	438785	424981	407495	438785	424981	407495
2015	9654000	17.75	10375	639	70	14700000	0.82	446830	357965	333923	446830	357965	333923

NLD GDP (MLN EUR)	NLD Export (MLN EUR)	NLD Import (MLN EUR)	DEU GDP (MLN EUR)	DEU Export (MLN EUR)	DEU Import (MLN EUR)	CHE GDP (MLN EUR)	CHE Export (MLN EUR)	CHE Import (MLN EUR)	FRA GDP (MLN EUR)	FRA Export (MLN EUR)	FRA Import (MLN EUR)	Container Traffic (calling)	Sea Infrastructure Investment (Euro)
411627	153484	151088	1906241	488552	426151	209335	72270	71871	1320325	266423	257934	2708	164155092
451891	192082	179034	1970400	494646	450747	223071	72420	74238	1423828	265811	273382	3302	167129814
473742	194542	176006	2054846	514284	437420	230221	73888	75692	1514598	260639	264479	3478	186267195
493436	197838	174703	2111070	554398	441405	238496	82793	78594	1585503	274403	273448	3352	157110000
492695	238317	210597	2181064	673678	541585	240554	94475	90317	1573804	322319	326266	3217	188990000
518766	286236	255613	2279546	820568	646335	251135	110709	104372	1638188	372338	390818	3229	232500000
547951	314832	279532	2388779	879419	701837	262066	117837	113916	1727198	390919	428271	3416	260290000
600456	360617	322659	2571901	1009767	829992	291991	133071	127260	1847585	431112	476912	3503	184440000
643690	429876	379231	2723018	1195957	953377	322162	155053	145212	1960878	485758	550228	4099	158570000
682925	491268	445443	2840589	1319524	1083788	347165	180553	165164	2036030	535054	625504	4617	202510000
660353	388352	343971	2735667	1015056	844527	347798	155432	140015	2026477	417702	486452	4268	219200000
669542	443381	395988	2917436	1143987	960135	361677	176048	158653	2100530	460486	539254	4379	230000000
696927	477518	443554	3102444	1333982	1134268	388464	211337	187398	2195046	527151	642308	4587	241000000
700424	499210	451021	3155916	1269117	1045092	411717	281054	265564	2213791	502614	600008	4341	236000000
725264	514122	455546	3266119	1305856	1068583	432103	322115	288945	2324982	511189	604128	4064	197000000
732413	514213	457230	3381384	1348342	1093460	438766	280031	247549	2352033	509991	593885	3864	150000000
738653	424762	377169	3463443	1198074	950706	451488	262763	227837	2382935	515750	586346	4182	198447631

Belgium								
BEL TEU	BEL Roadways		BEL Railway		BEL Inland Waterways			Short Sea-Shipping **[PoAtwp]**
BEL TEU	BEL Motorways (Kms)	BEL Road TT - Ttonne	BEL Railway Lines (Kms)	BEL Rail TT - Ttonne	BEL Naviable Canals (Kms)	BEL Navigable rivers (Kms)	BEL IW TT - Ttonne	PoAtwp SSS TT-Ttonne
7019000	1763	22029	3500	17644	875	641	14754	23822
8177000	1763	23719	3374	17696	875	641	12225	30482
8663000	1763	23304	3578	17673	875	641	15261	37244
7310000	1763	20085	3578	14836			18685	36313
8468000	1763	20684	3582				19993	43617
8664000	1763	22318					33470	39967
8635000	1763	21571					29650	38341
8578000	1763	23543					32346	39215
8978000	1763	23914					21655	43464
9654000	1763	20769						

Port of Hamburg

Year	TEU	Maximum Draught (meters)	Quay Length (meter)	Terminal Area (ha)	No of Quayside Cranes	Container Capacity (TEU)	Labour Productivity Index	DEU GDP (MLN EUR)	DEU Export (MLN EUR)	DEU Import (MLN EUR)	DEU GDP (MLN EUR)	DEU Export (MLN EUR)	DEU Import (MLN EUR)
2000	4248000	16.70	4090	195	42	6150000	2.53	1970400	494646	450747	1970400	494646	450747
2001	4869000	16.70	4090	195	42	6150000	2.69	2054846	514284	437420	2054846	514284	437420
2002	5374000	16.70	5490	275	57	9150000	1.23	2111070	554398	441405	2111070	554398	441405
2003	6318000	16.70	5490	275	57	9150000	0.81	2181064	673678	541585	2181064	673678	541585
2004	7003000	16.70	5490	275	57	9150000	1.00	2279546	820568	646335	2279546	820568	646335
2005	8088000	16.70	5490	275	57	9150000	1.52	2388779	879419	701837	2388779	879419	701837
2006	8862000	16.70	5490	275	57	9150000	1.92	2571901	1009767	829992	2571901	1009767	829992
2007	9890000	16.70	5490	275	57	9150000	1.52	2723018	1195957	953377	2723018	1195957	953377
2008	9737000	16.70	5490	275	57	9150000	0.19	2840589	1319524	1083788	2840589	1319524	1083788
2009	7008000	16.70	5490	275	57	9150000	-2.56	2735667	1015056	844527	2735667	1015056	844527
2010	7896000	16.70	5490	275	57	9150000	2.47	2917436	1143987	960135	2917436	1143987	960135
2011	9014000	16.70	5490	275	57	9150000	2.06	3102444	1333982	1134268	3102444	1333982	1134268
2012	8864000	16.70	7590	415	80	13250000	0.52	3155916	1269117	1045092	3155916	1269117	1045092
2013	9257000	16.70	7590	415	80	13250000	0.66	3266119	1305856	1068583	3266119	1305856	1068583
2014	9729000	16.70	7590	415	80	13250000	0.36	3381384	1348342	1093460	3381384	1348342	1093460
2015	8800000	16.70	7590	415	80	13250000	0.57	3463443	1198074	950706	3463443	1198074	950706

CHE Export (MLN EUR)	CHE Import (MLN EUR)	AUT Export (MLN EUR)	AUT Import (MLN EUR)	SVK Rep Export (MLN EUR)	SVK Rep Import (MLN EUR)	HUN GDP (MLN EUR)	HUN Export (MLN EUR)	HUN Import (MLN EUR)	CZK Export (MLN EUR)	CZK Import (MLN EUR)	POL GDP (MLN EUR)	POL Export (MLN EUR)	POL Import (MLN EUR)	Container Traffic (calling)	Investment in Sea Infrastructure (EUR)
72420	74238	57307	61537	10696	11497	111063	25283	28872	17686	23015	365259	27860	43315	5808	562000000
73888	75692	59843	63442	11372	13293	125123	27448	30314	20554	25897	377530	31830	44503	6061	506000000
82793	78594	65801	65517	13030	14965	136395	30903	33850	24145	28927	398859	36229	48840	6148	1020000000
94475	90317	80331	82436	19725	20341	142596	38703	42907	31673	37040	414158	47480	60432	6584	440000000
110709	104372	99747	100135	25078	26511	149745	49921	54224	50181	52557	448434	66401	79339	9017	430000000
117837	113916	105950	107955	28667	30803	157187	56045	59328	64473	63731	474249	80440	91385	6985	570000000
133071	127260	120753	120921	37518	40283	169072	66650	69281	77025	76054	519837	98626	113081	7357	580000000
155053	145212	140930	140450	52232	53287	175005	85132	85194	95822	95362	579482	124906	147755	7276	640000000
180553	165164	155005	157523	63170	65350	188012	97390	97906	112716	112949	619221	154674	189431	6933	630000000
155432	140015	118249	122777	49998	49644	188170	74315	69545	90287	87219	657182	122977	134613	5360	685000000

176048	158653	130394	135533	57599	57944	194191	85274	78689	103496	101590	715005	141358	156715	5088	965000000
211337	187398	152560	164115	70639	69021	202854	100095	91233	124140	120296	771466	169295	188272	5270	925000000
281054	265564	142939	152697	71880	69173	202686	92705	84840	120876	115173	808412	161643	172287	4985	890000000
322115	288945	149644	156022	76666	73166	214022	96957	88796	123375	115693	838572	183463	185052	4793	780000000
280031	247549	152743	155203	77379	73219	222533	100977	92800	131794	122275	864237	193029	195019	4407	450000000
262763	227837	130750	133142	67731	65832	226658	90150	81337	117982	110270	893816	175015	170727	4111	671533333

		Germany							
Year	TEU	Roadways		Railway		Inland Waterways			Short Sea-Shipping [**PoHmbg]**
Year	TEU	DEU Motorways (Kms)	DEU MW TT - TTonnes	DEU Railway Lines (Kms)	DEU RLY TT - TTonnes	DEU Naviable Canals (Kms)	DEU Navigable rivers (Kms)	DEU IW TT - TTonnes	PoHmbg SSS TT - TTonnes
2006.00	8862000.00	12531.00	90805.00	38165.00	51898.00	1962.00	5514.00	18673.00	26450.00
2007.00	9890000.00	12594.00	85389.00	38005.00	60258.00	1962.00	5514.00	17585.00	26843.00
2008.00	9737000.00	12645.00	262305.00	37798.00	66022.00	1967.00	6160.00	17490.00	26200.00
2009.00	7008000.00	12813.00	227370.00	37934.00	55421.00	1967.00	6160.00	20729.00	17680.00
2010.00	7896000.00	12819.00	225037.00	37669.00	60524.00	2163.00	5565.00	20327.00	18859.00
2011.00	9014000.00	12845.00	247920.00	37846.00	64301.00	2163.00	5565.00	19388.00	22648.00
2012.00	8864000.00	12879.00	244339.00	37941.00	66230.00	2163.00	5565.00	19714.00	23357.00
2013.00	9257000.00	12917.00	257805.00	37860.00	71094.00	2163.00	5565.00	20610.00	25885.00
2014.00	9729000.00	12949.00	272822.00	37775.00	66458.00	2163.00	5565.00	20078.00	27619.00

Port of Le Havre

Year	TEU	Quay Length (meter) Cumulative	Terminal Area Cumulative (ha)	No of Quayside Cranes cumulative	Cumulative Capacity Increase (TEU)	Maximum Draught (meters)	Labour Productivity Index	FRA GDP (MLN EUR)	FRA Export (MLN EUR)	FRA Import (MLN EUR)	Investment in Sea Infrastructure (EUR)
1995	970000	2384	210	14	3000000	15.50	2.67	1108504	255641	246049	235000000
1996	1020000	2384	210	14	3000000	15.50	0.72	1144837	255511	247422	195000000
1997	1185000	2384	210	14	3000000	15.50	2.16	1199179	255011	239918	178000000
1998	1319000	2384	210	14	3000000	15.50	2.62	1263249	270514	257432	189000000
1999	1378000	2384	210	14	3000000	15.50	1.65	1320325	266423	257934	174000000
2000	1464000	2384	210	14	3000000	15.50	3.73	1423828	265811	273382	197000000
2001	1525000	2384	210	14	3000000	15.50	1.10	1514598	260639	264479	296000000
2002	1721000	2384	210	14	3000000	15.50	3.26	1585503	274403	273448	320000000
2003	1980000	2384	210	14	3000000	15.50	1.01	1573804	322319	326266	483000000
2004	2150000	2384	210	14	3000000	15.50	0.70	1638188	372338	390818	377000000
2005	2058000	2384	210	14	3000000	15.50	1.29	1727198	390919	428271	283000000
2006	2137000	2384	210	14	3000000	15.50	2.86	1847585	431112	476912	261000000
2007	2638000	2384	210	14	3000000	15.50	-0.15	1960878	485758	550228	226000000
2008	2450000	2384	210	14	3000000	15.50	-0.73	2036030	535054	625504	436000000
2009	2241000	2384	210	14	3000000	15.50	-0.64	2026477	417702	486452	532000000
2010	2358000	2384	210	14	3000000	15.50	1.52	2100530	460486	539254	328000000
2011	2215000	2384	210	14	3000000	15.50	1.12	2195046	527151	642308	299000000
2012	2303000	2384	210	14	3000000	15.50	0.25	2213791	502614	600008	313000000
2013	2486000	2384	210	14	3000000	15.50	1.74	2324982	511189	604128	446000000
2014	2551000	2384	210	14	3000000	15.50	-0.06	2352033	509991	593885	460000000

Port of Le Havre

Year	TEU	Number of Container Companies
2000	1464000	2204
2001	1525000	2331
2002	1721000	2463
2003	1980000	2568
2004	2150000	2415
2005	2058000	2137
2006	2137000	2235
2007	2638000	2674
2008	2450000	2350

	France							
	Roadways		Railway		Inland Waterways			Short Sea-Shipping [**PoLH] - Data not available**
Year	FRA Motorways (Kms)	FRA Motorways Total Transport - Thousand Tonnes	FRA Railway Lines (Kms)	FRA Railways Total Transport - Thousand Tonnes	FRA Naviable Canals (Kms)	FRA Navigable rivers (Kms)	FRA Inland Watwerways Total Transport - Thousand Tonnes	Total Transport - Thousand Tonnes
2006.00	10849	31648	31076	11704	5607	2894	3265	
2007.00	10958	34887	31349	10970	5607	2894	3270	
2008.00	11042	32681	31234	14902	5607	2894	3057	
2009.00	11163	28506	29699	9240	5607	2894	3632	
2010.00	11392	31640	29503	8769	5607	2894	3903	
2011.00	11413	33386	29671	11057	5607	2894	4080	
2012.00	11413	26039	29588	13031	5607	2894	4356	
2013.00	11552	23217	29243	13379	5607	2894	4074	
2014.00	11469	21219	29386	13036	5607	2894	4268	
		22041					3871	

Port of Rotterdam

Year	TEU	Draught (meters)	Quay Length (meter) Cumulative	Terminal Area Cumulative (ha)	No of Quayside Cranes cumulative	Cumulative Capacity Increase	Labour Productivity Index	NLD GDP (MLN EUR)	NLD Export (MLN EUR)	NLD Import (MLN EUR)	DEU GDP (MLN EUR)	DEU Export (MLN EUR)	DEU Import (MLN EUR)
1997	5495000	22.55	8025	378	63	7840000	2.16	360413	165990	146124	1785525	461196	400946
1998	5995000	22.55	8025	378	63	7840000	2.36	386369	150836	141055	1836553	489200	424104
1999	6354000	22.55	8025	378	63	7840000	2.19	411627	153484	151088	1906241	488552	426151
2000	6290000	22.55	9625	478	77	11190000	3.30	451891	192082	179034	1970400	494646	450747
2001	6120000	22.55	9625	478	77	11190000	0.86	473742	194542	176006	2054846	514284	437420
2002	6506000	22.55	9885	481	78	11340000	0.61	493436	197838	174703	2111070	554398	441405
2003	7144000	22.55	9885	481	78	11340000	1.43	492695	238317	210597	2181064	673678	541585
2004	8292000	22.55	9885	481	78	11340000	1.74	518766	286236	255613	2279546	820568	646335
2005	9288000	22.55	9885	481	78	11340000	2.46	547951	314832	279532	2388779	879419	701837
2006	9654000	22.55	10035	486	79	11490000	1.55	600456	360617	322659	2571901	1009767	829992
2007	10791000	22.55	11325	511	85	12870000	0.77	643690	429876	379231	2723018	1195957	953377
2008	10784000	22.55	11625	521	87	13070000	0.05	682925	491268	445443	2840589	1319524	1083788
2009	9743000	22.55	11625	521	87	13070000	-2.39	660353	388352	343971	2735667	1015056	844527
2010	11148000	22.55	13125	605	103	18070000	2.14	669542	443381	395988	2917436	1143987	960135
2011	11877000	22.55	13125	605	103	18070000	0.71	696927	477518	443554	3102444	1333982	1134268
2012	11862000	22.55	13125	605	103	18070000	-0.20	700424	499210	451021	3155916	1269117	1045092
2013	11621000	22.55	13125	605	103	18070000	0.33	725264	514122	455546	3266119	1305856	1068583
2014	12298000	22.55	13125	605	103	18070000	0.83	732413	514213	457230	3381384	1348342	1093460
2015	12234535	22.55	16325	799	129	23120000	1.14	738653	424762	377169	3463443	1198074	950706

CHE GDP (MLN EUR)	CHE Export (MLN EUR)	CHE Import (MLN EUR)	AUT GDP (MLN EUR)	AUT Export (MLN EUR)	AUT Import (MLN EUR)	SVK Rep GDP (MLN EUR)	SVK Rep Export (MLN EUR)	SVK Rep Import (MLN EUR)	HUN GDP (MLN EUR)	HUN Export (MLN EUR)	HUN Import (MLN EUR)	GDP CZK (MLN EUR)	CZK Export (MLN EUR)	CZK Import (MLN EUR)	Container Traffic (calling)
197269	68535	68310	183097	51042	57268	48233	8671	10554	93055	17189	19111	138110	14871	20029	4793
204670	70970	72085	191887	54771	60388	50977	9646	11763	99520	20705	23136	138689	16915	20475	5029
209335	72270	71871	199628	53344	59403	51326	9051	10017	103541	22511	25207	142417	16239	20254	5410
223071	72420	74238	213185	57307	61537	54117	10696	11497	111063	25283	28872	150280	17686	23015	5372
230221	73888	75692	216104	59843	63442	59237	11372	13293	125123	27448	30314	162293	20554	25897	4942
238496	82793	78594	227389	65801	65517	63572	13030	14965	136395	30903	33850	168112	24145	28927	5426
240554	94475	90317	235377	80331	82436	67251	19725	20341	142596	38703	42907	179907	31673	37040	5886
251135	110709	104372	248596	99747	100135	72471	25078	26511	149745	49921	54224	192584	50181	52557	6685
262066	117837	113916	256890	105950	107955	79910	28667	30803	157187	56045	59328	204815	64473	63731	6292
291991	133071	127260	280005	120753	120921	90964	37518	40283	169072	66650	69281	224853	77025	76054	6154
322162	155053	145212	292921	140930	140450	103705	52232	53287	175005	85132	85194	247300	95822	95362	6864
347165	180553	165164	308199	155005	157523	115441	63170	65350	188012	97390	97906	253388	112716	112949	7203
347798	155432	140015	305018	118249	122777	112334	49998	49644	188170	74315	69545	253870	90287	87219	6749
361677	176048	158653	315329	130394	135533	118957	57599	57944	194191	85274	78689	255185	103496	101590	7386
388464	211337	187398	332478	152560	164115	122277	70639	69021	202854	100095	91233	270964	124140	120296	6476
411717	281054	265564	347993	142939	152697	126982	71880	69173	202686	92705	84840	272988	120876	115173	6175
432103	322115	288945	361474	149644	156022	133563	76666	73166	214022	96957	88796	285763	123375	115693	5813
438766	280031	247549	367989	152743	155203	138142	77379	73219	222533	100977	92800	299086	131794	122275	5814
451488	262763	227837	373504	130750	133142	140969	67731	65832	226658	90150	81337	311082	117982	110270	5814

Year	TEU	Investment in Port Infrastructure (EUR)
2002	6506000	156000000
2003	7144000	112000000
2004	8292000	115000000
2005	9288000	135000000
2006	9654000	231000000
2007	10791000	235000000
2008	10784000	190000000
2009	9743000	340800000
2010	11148000	444700000
2011	11877000	494400000
2012	11862000	625700000
2013	11621000	262900000
2014	12298000	189400000
2015	12234535	151100000

Netherlands									
Year	TEU	Roadways		Railway		Inland Waterways			Short Sea-Shipping **[PoR]**
Year	TEU	Motorways (Kms)	Motorways Total Transport - Thousand Tonnes	Railway Lines (Kms)	Railway Total Transport - Thousand Tonnes	Naviable Canals (Kms)	Navigable rivers (Kms)	Inland Waterways Total Transport - Thousand Tonnes	PoR Short Sea Shipping Total Transport - Thousand Tonnes
2006	9654000	2603	51316	2796	7343	4705	1391		28611
2007	10791000	2582	56775	2801	10680	4689	1385	33151	30157
2008	10784000	2583	56585	2889	10937	4706	1396	29449	28772
2009	9743000	2631	53325	2896	10617	4705	1396	20899	26250
2010	11148000	2646	37041	3013	10451	4707	1397	36858	32840
2011	11877000	2651	40283	3013	9694	4708	1396	38814	31826
2012	11862000	2658	40489	3013	13554	4712	1396	40273	34474
2013	11621000	2666	7122	3013	13830	4702	1341	41125	33068
2014	12298000	2678	44390	3032	14857	4716	1395	43161	33943
2015	12234535		54896					42245	