The impact of Covid-19 on the port performance of Rotterdam and Piraeus

Sebastiaan Boon (448646)

Erasmus University Rotterdam - Erasmus School of Economics

Thesis Urban, Port and Transport Economics

Supervisor: Niels van Saase

Second assessor: Maurice Jansen

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Abstract

This thesis investigates the impact of Covid-19 on the port of Rotterdam and Piraeus. In this thesis, a combination of literature and data is used to answer the question of what the short and long term effect will be of this pandemic on the ports. Countries encounter lockdowns, which leads worldwide to demand shocks due to economic downturn. This subsequently effects port due to its position as a connecter of trade. In the short run it is inevitable that every port will experience a decrease in size, but in the long run there could be winners and losers from this crisis. The port of Rotterdam showed in the past, that it is very stable and resilient in a crisis. The port is constantly improving its operations and has proven to remain their size and competitive advantage. For this reason Covid-19 is expected to have a relatively low impact on throughput levels in ports in the long-run. The port of Piraeus showed the largest increase in throughputs of all ports in Europe in the last decade. Investments from the Cosco group have been of major influence in this increase. The port is expected to have a relatively large impact in the short run due to its high dependence on container trade but it is expected to recover quickly when Covid-19 is under control.

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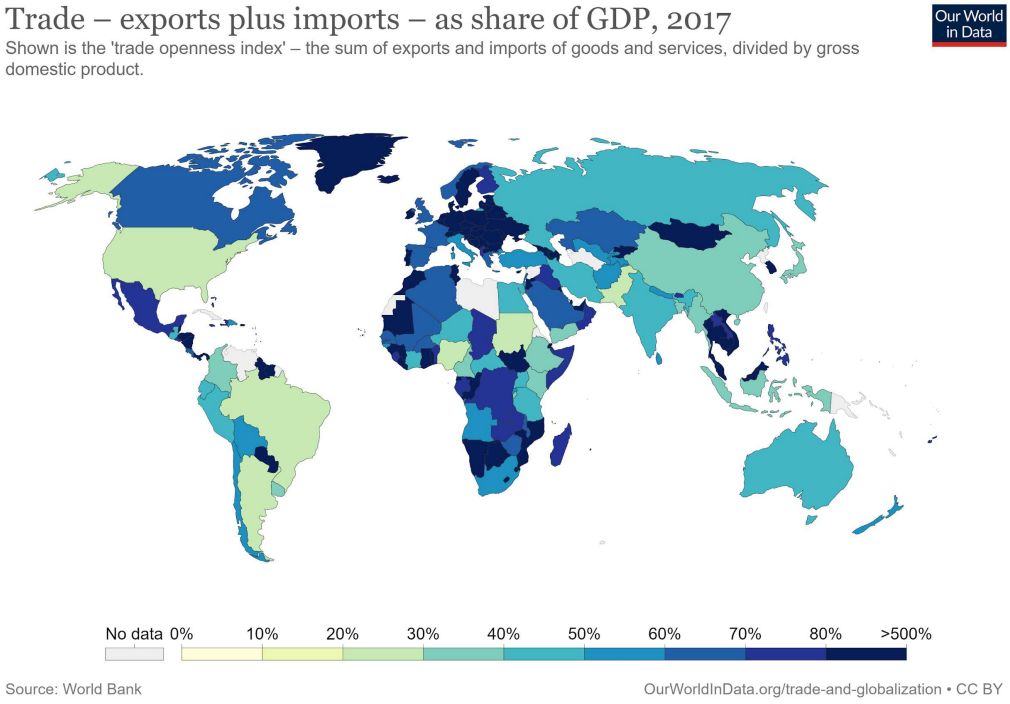
1. Introduction

The value of exported goods has increased substantially over the last 100 years (Our world in data, 2020). Countries became far more dependent on each other. Trade has become a crucial factor for the economy of every nation, the added value of trade worldwide is 25% of global GDP. Figure 1 shows the imports plus exports - as share of GDP in 2017. Trade is transported by sea, rail, road and air. The international shipping industry is responsible for about 90 percent of world trade (International Chamber of Shipping), this thesis discusses the trade that occurs in seaports.

Figure 1, sum of all imports plus exports divided by gross domestic product of the country.



In Europe, seaports are responsible for about half of the extra-EU transport in 2018 (Eurostat). This includes predominantly dry and liquid bulks, containers and wheeled cargo like cars and trucks. The biggest seaports in Europe are located in Rotterdam, Antwerp and Hamburg. These ports represent 19% of the gross weight of goods handled in all Seaports in Europe (Eurostat). The relevance of these locations is large, researchers of the section Urban Port Transport at the Erasmus University Rotterdam show that in 2017 seaports presented 5.8% of the Dutch GDP and directly employed 184,248 workers (Havenmonitor, 2018). Because of this, the performance of seaports is of major importance for the Dutch economy.

On the other hand, seaports rely on the economy. External shocks or developments play a large role in the performance of seaports. Past external shocks like the financial crisis in 2008/2009 (*hereafter:* financial crisis) and the oil crisis of the 1970s have diminished port performance (UNCTAD, 2018). The current Covid-19 crisis is expected to affect world trade substantially (Baldwin & Tamioura, 2020). In this thesis, the impact of Covid-19 will be discussed in the short and long run on two ports in Europe.

Furthermore world trade is expected to fall between 13 and 32 percent according to estimates. This shock will decline the gross weight of goods handled in Seaports in the short run, as it did in 2008, during the crash of the financial markets (McKinsey & Company, 2020). The impact on specific ports of Covid-19 depends on the function, performance and innovations in the port. In the short run it is inevitable that every port will experience a decrease in throughput levels, but in the long run there could be winners and losers from this crisis. This is due to the fact of the dependence on the pattern of world trade and demand and supply for goods, which is expected to experience a disruption due to Covid-19.

This thesis investigates moreover the impact of Covid-19 on the biggest port in Europe and the fastest growing port in Europe in terms of gross weight handled, the port of Rotterdam and Piraeus. This is done by identifying how the port performance is affected by a crisis. The thesis will combine literature, descriptive data and relations between world economy and port performance. With those three elements the following research question will be answered: ***How is the performance from the port of Rotterdam and Piraeus affected by Covid-19 in the short and long run?***

This thesis aims to investigate what the possible impacts of Covid-19 are on the port performance on the port of Rotterdam and Piraeus. In order to answer the research question, it is important to start with identifying the meaning of port performance. In this thesis port performance is based on three direct indicators: throughputs, added value and employment. To identify the possible effect, it is important to look at a comparable disruption which affected the port performance. For both ports, which I will investigate developments in the port sector in Europe are discussed. Next the methodology of how the research question is answered is explained. Finally, the results will be presented. The results will first show a data analysis that presents the effect of GDP, which is inevitably decreasing in the short run, due to the effect of Covid-19, on the port performance indicators. This is followed by a visualization and discussion of the financial crisis on ports in Europe. Next, both ports are individually analyzed, their effects on the external developments from the literature and their strategy towards it are discussed. The current impact of Covid-19 is analyzed and three possible scenarios are given of the long term effects. Finally, the results are connected in the discussion to answer the research question in the conclusion.

2. Literature review

This chapter gives a definition to port performance indicators and explains what happens to ports when an external disruption occurs. Next it explains how the financial crisis influenced the performance indicators. Finally, The influence of the energy transition and increasing role of China on port performance indicators will be discussed.

2.1 The impact of COVID-19 on the economy and world trade

Covid-19 triggers containment measures, which have large influences on labor mobility and transportation of passengers and freight. The tourism industry, entertainment and leisure sector are affected most by the measures. The closing of plants or reduced activity causes spinning into global supply chains (Boone, 2020). In the first quarter of 2020 GDP declined in the OECD area's by 1.8 percent (OECD, 2020). Spillovers occur during the decline of GDP of this size.

The spillovers identified could be identified in three main aggregates (Boone, 2020):

1. Supply
2. Demand
3. Confidence

Supply is defined as significant disruptions in global supply chains, factory shutdowns or reduced activities and cutbacks in service sector activities. Demand is defined as decline in business travel and tourism, education services, entertainment, consumption level and leisure services. Confidence involves the uncertainty for consumers and businesses leading to reduced or delayed consumption of goods, services or investment.

These three aggregates are of relevance for the port industry, The ports function as an industrial and distributional hub that relies on the continuance of global supply chains, factories, investments by businesses and demand for products, makes sure that a hitch in these factors, which Covid-19 creates, results in a decline in demand for industrial and distributional activity. This is also defined as transport being an indirect demand.

2.2 Port performance indicators

The performance of a port is originally defined as the annual gross weight handled in the port, also defined as throughput. According to Talley this originally is defined from an engineering perspective (Talley, 1994). Currently most researchers use the broader definition of port performance. The Havenmonitor of the Urban Port and Transport Economics section evaluates multiple performance indicators which are crucial to this research (Havenmonitor, 2018). In this thesis three performance indicators are taken into account which together represent the port performance. This consists of throughput levels, added value and employment statistics.

Throughput

Throughput is the most widely known indicator of performance of a port. It measures the amounts that pass the port. This indicator is of great relevance, but it is an engineering perspective. To understand the performance of a port in an economic way, more indicators are necessary (de Langen, 2007). However, economic throughput remains an important indicator of evidence of the performance of a port.

Added value of the port

Another important indicator for performance in this research is the added value of the port. Throughput might give an indication on the activity in the port, but it does not give an indication of the economic impact of the port itself and of the impact it had on the hinterland economy (de Langen, 2007). This is an important indicator because not all types of cargo generate the same amount of added value per ton. Separating the direct and indirect added value could give an understanding of the direct and indirect impact of the port. This thesis follows the same definition for direct and indirect effects as the Havenmonitor uses. The Havenmonitor calculates indirect effects by looking at economic effects which the port has on the suppliers of seaport related sectors.

Employment by the port

The third indicator used is direct and indirect employment, likewise as added value this gives an indication of the economic impact of the port. The difference with added value, is that this is a socio-economic statistic and not an economic statistic (de Langen, 2007).

2.3 Specialization and function of a port

The specialization of a port in this thesis is defined as the type of cargo the port handles. The types of cargo are split into four sorts: Liquid bulk, Dry bulk, containers and Mobile self-propelled units. This is the standard for reporting to Eurostat and a common way to measure throughputs in ports. This distinction is made because different types of cargo have different responses to a crisis and the differences between ports in the type of cargo that is handled differs substantially.

Besides specialization ports also differ in their function. This thesis makes a distinction between transshipment ports (Port of Piraeus) and gateway ports (Port of Rotterdam). A transshipment port is a port that is responsible for the transshipment of containers on big vessels to the mode of transport that brings the cargo to its end location. These ports compete with national ports because there function is to remove a link in a global or regional supply chain to gain efficiency (GOULIELMOS and PARDALI, 2002). These transshipment ports compete with gateway ports. Gateway ports are there to serve the hinterland of the port and be a literal gateway for the supply imports. The port of Rotterdam for instance operates as a gateway for over 500 million European inhabitants (van den Bosch et al, 2018). The different functions brings that the ports have different reactions the external disruptions.

2.4 The financial crisis

A financial crisis is often associated with a panic or a bank run during which investors sell off assets or withdraw money from savings accounts because they fear that the value of those assets will drop if they remain in a financial institution. Selling of assets, drives the price down due to a rise in supply. The financial crisis which started in the United States, soon became a global economic crisis. An economic crisis usually affects almost every sector in a country and leads to a recession or even a depression. A recession is a period of two or three month where the growth of GDP is negative. A depression is defined as a negative GDP level of at least 10 percent.

A relationship between GDP and throughput in ports is long discussed (Notteboom, 2013). Normally, when GDP rises, throughput rises, when GDP declines throughput falls. A regression model configured by (Tongzon, 1995) using a sample of 23 international ports, resulted in GDP being a significant determinant for throughput in ports. Added value of a port is highly dependent on the throughputs in the ports, since ports are industrial and distribution hubs and add their value by handling throughputs.

The function as distribution hubs makes the external effects of a shift in the trend high. Since distribution experiences an indirect demand, no-one is demanding distribution, a party is always demanding something that needs distribution (Introduction to Transport Economics, 2020). For this reason, with an

internal decrease in value added of a port, an external decrease is inevitable. This works in the case of ports in both ways, ports demand a high activity of the surrounding economy to experience a high demand for their services and companies are demanding a high activity from the port to not become short on the supply side. The local employment is highly correlated with the throughput by the port. In a sample of 560 regions located in ten West European countries, which includes 116 ports, they show that there is robust evidence of a positive and significant impact of seaport activities on employment levels in hinterland regions (Bottasso et al, 2013). For this reason, throughputs of a port could be a good indicator of the port performance.

Therefore this thesis shows a relation between GDP and port performance indicators and is focusing on throughputs afterwards, because of the high relation found in literature and data.

2.5 Developments in Europe

The energy transition will change the role of ports in the future. Ports are major hotspots for storage and transshipment of fossil fuels. Large amounts of throughputs depend on these activities, and in this way influence the port performance. The Paris agreement demands rapid reductions of the use of fossil fuels (Eurostat).

The Carbon lookout identifies the following major landscape pressures (Bosman et al, 2018):

1. Demand in Europe is stabilizing because its market is mature and the population is stable and ageing;
2. Increasing environmental concerns, in particular, climate change, challenge the future of fossil-based industries.

These pressures will have a direct effect on ports in Europe. The adaption to these changes will determine the future port performance (Bosman et al, 2018).

The increasing role of China in Europe is another development that will change the port performance of ports in Europe. China has invested 85 billion euros so far in the Belt and Road Initiative (*hereafter:* BRI) (China Daily, 2019) and 35 billion euros in European assets in 2016 (The Diplomat, 2019). The BRI is a national strategy from China to strengthen globalization and regional economic incorporation, connecting the country to the world. The BRI will expand connectivity of Chinese ports through construction and operation on the 21st-Century Maritime Silk Road. At the same time, port governance involves central, provincial and local governments engaging in overseas investment and financing in the context of the BRI (Chen et al 2019). It aims to connect China to Asia, Europe and Africa and with oceans and enhance and establish partnerships between countries along the routes (Chen et al 2019).

The BRI will have a substantial impact on ports in Europe. In 2019, China was the third largest partner for EU exports of goods with 9 percent and the largest partner for EU imports of goods 19 percent (Eurostat, 2020). The export-import rate in Europe is around 1.1, this holds that China is responsible for around 14% percent of the total European trade. The development of China Investments in the Port of Piraeus has already increased the importance of the Mediterranean Sea as an import and export hub for China. If the other planned investments in Algeria and Egypt are completed, Which occurrence will be magnified (Fardella & Prodi, 2017).

3. Research Methodology and Data

In this part the methodology of the research is explained. With the methodology the following research question is answered: *"How is the performance from the port of Rotterdam and Piraeus affected by Covid-19 in the short and long run?"*

The question is answered by *four* indicators, which are stated as followed:

1. The statistical relation between GDP and port performance indicators
2. The effect of the financial crisis on ports
3. The characteristics of the ports in question
4. The current effect of COVID-19 on ports

These *four* indicators will give a clear definition of the short and long term effects of COVID-19. By discussing these topics, the methodology combines general economic theory, statistical relevance, historical facts and past research. This will make it possible to properly answer the research question.

3.1 The statistical relation between GDP on port performance indicators

This indicator shows if there is a statistical relation between GDP and port throughout Europe. Second, there is investigated if there is a relation between GDP, direct and indirect employment and direct and indirect value added based on data in the period 2002-2017 in the Rijn- Maasmond region. Lastly, there is investigated if there is a relation between port throughput, direct and indirect employment and direct and indirect value added based on data in the period 2002-2017 in the Rijn- Maasmond region.

The data analysis starts with analyzing throughput of 26 ports in Europe and their relation to GDP between 2010 and 2018. This is done by using the linear regression method analysing the significance between the statistical relation between GDP and throughputs. The literature review discusses that Tongzon configured a model in 1995, that proved that GDP could be a significant indicator for port throughput (Tongzon, 1995). In this part there is investigated if GDP has been a significant indicator in ports throughputs in Europe over the past years.

Next a data analysis is configured between GDP, direct and indirect employment and direct and indirect value added in the region Rijn- en Maasmond. This is done with statistics between 2002 and 2017. This is done as well by using the linear regression method analyzing the significance between the relation between GDP, direct and indirect employment and direct and indirect value added. The same is done afterwards for port throughputs, direct and indirect employment and direct and indirect value added in the region Rijn- en Maasmond.

This part shows that Covid-19 is likely to have a downward impact on port performance indicators.

3.2 The impact of the financial crisis and the difference between Covid-19 and this financial crisis

The impact of the financial crisis on ports in Europe is discussed. Next the impact on different types of cargos is taken into account. In this way there is investigated which type of cargo is impacted the most in crisis time. Finally, there is looked at the recovery time of a crisis for all ports in Europe. The two topics standing central in the impact of a crisis are relative stability and resilience of a port. Stability and resilience gives us an indication of the dependence on the state of the economy, which will deteriorate due the Covid-19. The impact of different kinds of cargo could give us an indication of the cause of this stability and resilience.

3.3 Analysis of the ports

To go more in depth with the research it is crucial to analyze the ports in question. This is done because it is inevitable that ports will react in different ways on Covid-19. In this pillar the characteristics that distinguish the port of Rotterdam and Piraeus from other ports in Europe are discussed and there is explained why this results in different effects from Covid-19. Two important trends are involved which are a hot topic in the port industry and play a great role in the future of the ports in question. This is crucial for the research because it explains why our designated ports will react in a certain way.

3.4 The current effect of COVID-19 on ports

Because Covid-19 has been around for over eight months the first signs of the impact are already available in data. This is important to know, because this gives us a sign of the severity and actual situation. The current results of Q1 and Q2 of the port of Rotterdam, reported by the port authority, are discussed to present the first signs of the impact. This serves as a good indicator for ports over Europe because of the size and diversification of cargo handling of the port. Besides that it answers the part of the research question of the short-term effect on the port of Rotterdam.

4. Results

4.1 The statistical relation between GDP on port performance indicators

GDP and Throughputs in Europe

Table 1: Regression Throughput main ports over GDP per country

VARIABLES	*GDP Corresponding Country*		*Constant*		*Observations*	*R-squared*
BelgiumTP	*0.457****	*-0.0633*	*55,233**	*-25,891*	*9*	*0.882*
GermanyTP	*0.0143*	*-0.00968*	*253,439****	*-28,604*	*9*	*0.238*
GreeceTP	*-1.012****	*-0.248*	*353,666****	*-47,068*	*9*	*0.704*
SpainTP	*0.537****	*-0.136*	*-149,502*	*-147,581*	*9*	*0.691*
FranceTP	*-0.0372*	*-0.0268*	*385,591****	*-58,232*	*9*	*0.216*
ItalyTP	*0.123*	*-0.133*	*268,843*	*-220,702*	*9*	*0.11*
NetherlandsTP	*0.471****	*-0.0792*	*249,991****	*-54,547*	*9*	*0.834*
TurkeyTP	*0.372**	*-0.178*	*140,896*	*-123,637*	*9*	*0.385*

**** p<0.01, ** p<0.05, * p<0.1*

(Full results in the appendix)

Data: Eurostat

Table 1 shows a few of the outcomes of the regression of throughputs in a country over the GDP of that particular country over the period between 2005 and 2018. The regression uses the throughput of a country as independent variable and that country's GDP as dependent variable. The results are as followed: In 13 out of 26, there is a significant positive relation between GDP and throughputs. In the other 13 out of 26 cases this is not the case, which shows us that it is possible that GDP is an indicator, but not an accurate one.

Looking at the countries that are significantly negative: Estonia, Sweden, Greece and the UK, there are in most cases quite straight forward explanations. Greece shows a negative GDP in the data, but a positive throughput trend, the reason for this will be discussed in the "Analysis on Port of Piraeus". The inconsequential relation in the UK is expected to be the consequence of Brexit. The statistics and the explanation of the explanation suggest that there could be concluded that GDP is not a 1:1 indicator for port throughputs, but could be a helpful indicator, which will be more extensively discussed in the part "The effect of the financial crisis on ports".

GDP and Added value and Employment in Rijn- en Maasmond

Table 2: Regression port performance indicators Rijn- en Maasmond over GDP

VARIABLES	*Indirect Added Value*	*Indirect Employment*	*Direct Added Value*	*Direct Employment*
GDP	*0.0190****	*0.120****	*0.0239****	*0.0791****
	0	*0*	*0*	*0*
Constant	*-3,722***	*79,654****	*-167.9*	*59,112****
	-1,452	*-10,729*	*-2,387*	*-7,320*
Observations	*16*	*16*	*16*	*16*
R-squared	*0.828*	*0.779*	*0.737*	*0.767*
Standard errors in parentheses				
**** p<0.01, ** p<0.05, * p<0.1*				

Data: Havenmonitor

The regression shows four times a significance of 99 percent. The data shows that if GDP is increasing or declining in the Netherlands, the value added and employment by the Port of Rotterdam moves along. The statistics show that there could be concluded that GDP is an important indicator, but cannot solely decide if a port is going to perform better or worse, for that, there must be taken into account some more trends or statistics which explain the performance of a port. The direct and indirect added represents a share of the national GDP, In the Netherlands added value represent about six percent for the Dutch GDP were Rijn- en Maasmond is the largest contributor. For this reason the correlation is not surprising.

Port throughputs and Added value and Employment in Rijn- en Maasmond

Table 3: Regression port performance indicators Rijn- en Maasmond over Throughputs

VARIABLES	*Direct Employment*	*Indirect Employment*	*Direct Added Value*	*Indirect Added Value*
Throughputs	*0.157****	*0.170****	*0.0309***	*0.0294****
	-0.0333	*-0.0499*	*-0.0114*	*-0.00536*
Constant	*47,562****	*90,232****	*3,076*	*-3,001*
	-13,253	*-19,851*	*-4,543*	*-2,130*
Observations	*13*	*13*	*13*	*13*
R-squared	*0.669*	*0.515*	*0.4*	*0.732*
Standard errors in parentheses				
**** p<0.01, ** p<0.05, * p<0.1*				

Data: Havenmonitor

The regression shows four times a significance of 99 percent. The data shows that if throughputs is increasing or declining in The Netherlands, the value added and employment by the Port of Rotterdam moves with it.Looking at these statistics, it could be concluded that throughputs is an important indicator for port performance. The throughput levels are crucial for the added value that the port generates because it is the way the port earn its money. With high throughput levels more employment is necessary to handle the throughputs.

Both statistics are not surprising, however the statistics show the importance of the external economic situation to ports and the importance of throughputs for the port performance. This is valuable information to include in the research.

4.2 The impact of the financial crisis and the difference between Covid-19 and this financial crisis

Covid-19 and the financial crisis could be distinguished by three differences. First, during the financial crisis, the problem was within the system, the Covid-19 crisis is a fully external disruption for the entire economy. This means that during the financial crisis, the system had to be fixed after the recession, which takes a lot of time and effort to do. With Covid-19 everything is external, so if this external disruption is under control, the economy might be able to recover far more quickly than with a problem within the system.

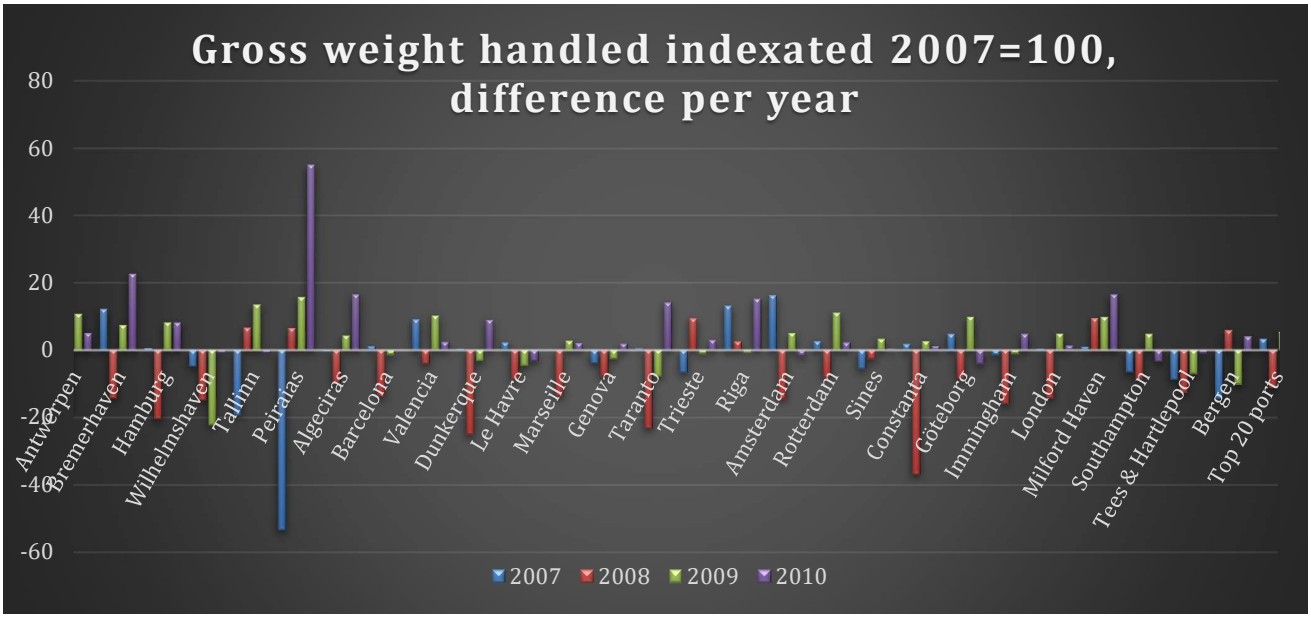
Second, Around March 2020 most nations went into lockdown for multiple months, the lockdown timeframe differed per country and state. This causes the world to stop moving, travel, consumption and investments activity declined and confidence levels went as low as they can get. This makes sense because during lockdowns people are uncertain of how long it is going to last, which causes confidence to decline substantially. During the financial crisis the world experienced a big hit in loans, where the problem spread over businesses eventually reaching consumers. Here the problem hits consumers and businesses at the same time.

Third, it is uncertain when the external disruption will stop. During the financial crisis it was important to find out the severity of the problem as fast as possible. When the problem was mapped, solutions could be thought of to fix the problem as fast as possible. The main question that is posed in the time this thesis (August 2020) is written is if the virus stopped by a vaccine or if there must be adapted to live under a new level of normality?

In the pre-financial crisis stage strong growth in maritime transportation mainly driven by the large container throughput in the period between 2000 and 2008. Average annual growth figures were reached of 10.4 percent in 2005-2008 (Notteboom, 2013). The growth ended due to the financial crisis, but every port was differently hit (Pallis and De Langen, 2010). Figure 2 shows the short term impact, in terms of throughput, of the financial crisis in the period between 2007 and 2011 on the 20 biggest ports in Europe (Eurostat). In the period year 2008, almost every port experienced a decline. Figure 3 shows that dry bulks

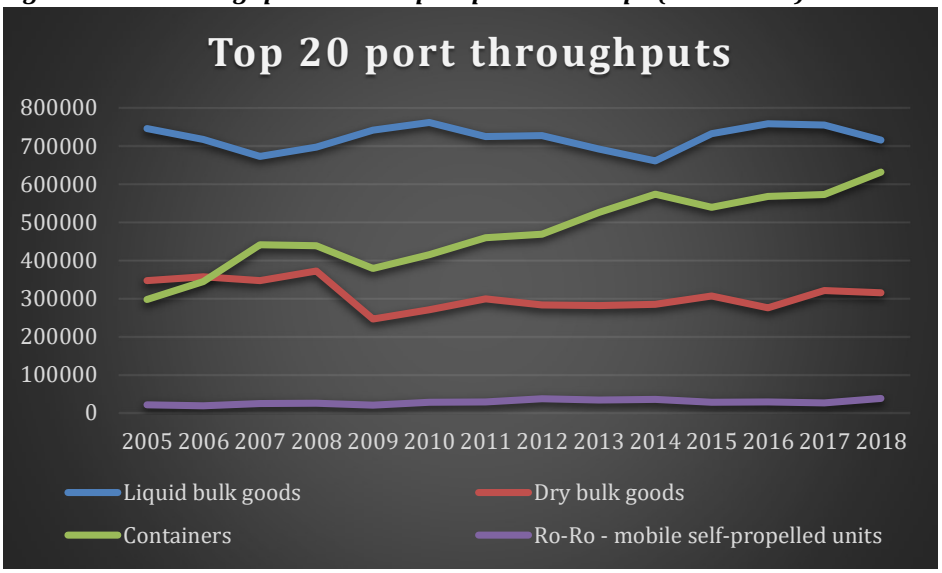
and containers decreased more in throughput levels then liquid bulks. Which suggests that it is possible that dry bulks and containers could be more vulnerable for Covid-19 than liquid bulks.

Figure 2: Indexation tonnes handled in all ports in Europe (2007-2011)



Data: Eurostat

Figure 3: Port throughputs in the top 20 ports in Europe (2005-2018)

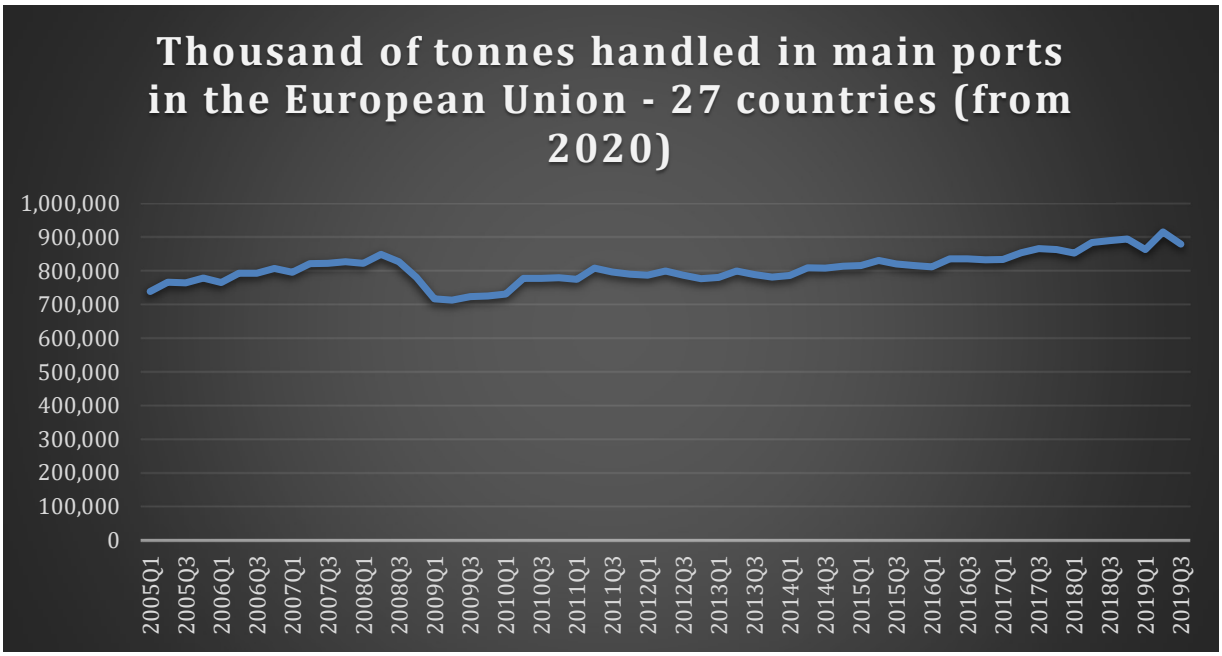


Data: Eurostat

Figure 4 shows us the tonnes handled in all European Union's main ports. Looking at the peak moment in pre-crisis time, the tonnes handled summed, was 849,249 thousand tonnes in 2008Q2, it took until

2017Q2 before this level was reached again. In other words, it took almost 10 years to recover for European ports overall, from the financial crisis.

Figure 4: Port throughputs by quarter in main ports in the European Union (2005-2019Q3)



Data: Eurostat

The data shows that the impact of the financial crisis on throughput in ports has been substantial. Looking at past developments, during and after crisis time, should give us an idea of how a global crisis, the topic Covid-19 and the financial crisis have in common that they affect ports. To analyze further we must know the effect on Rotterdam and Piraeus of the financial crisis and the characteristics of the ports.

4.3 Analysis on the Ports

The port of Rotterdam shows a stable growth pattern with no surprising decreases or increases. The experienced average growth of 2.16% a year still is substantial due to the size of the Port of Rotterdam (Eurostat, 2020). The throughputs show a slight decrease in 2008-2009, due to the financial crisis. The port of Piraeus shows a far more volatile pattern. The impact of the financial crash in 2008/2009 is more visible, but the recovery afterward is the highest in all of Europe (Eurostat 2020).

Analysis on Port of Piraeus

Due to the financial crisis, Greece entered a great recession, which boomed the debt to foreign countries (Vickstrom, 2012). After 2008, Chinese shipping rates collapsed, causing over-capacity by the Cosco shipping company. Because of this, the Cosco group invested heavily in the port of Piraeus. Due to the Chinese involvement, Piraeus is currently the fastest growing port in Europe, largely due to the shipping routes from and to Asia (van der Putten, 2014). For this reason the data about the port of Piraeus is largely explained.

In 2016 Cosco acquired a 51% stake in the Piraeus port CNBC. Since then the stock doubled in value in pre-covid-19 state. The stock took a hit of around 27 percent due to Covid-19 but is recovering since (Bloomberg, 2020). The share holds a current value of around 22 billion euros (Marketscreener, 2020). This hit was relatively small compared to one of its big competitors Maersk, which took a hit of around 41 percent.

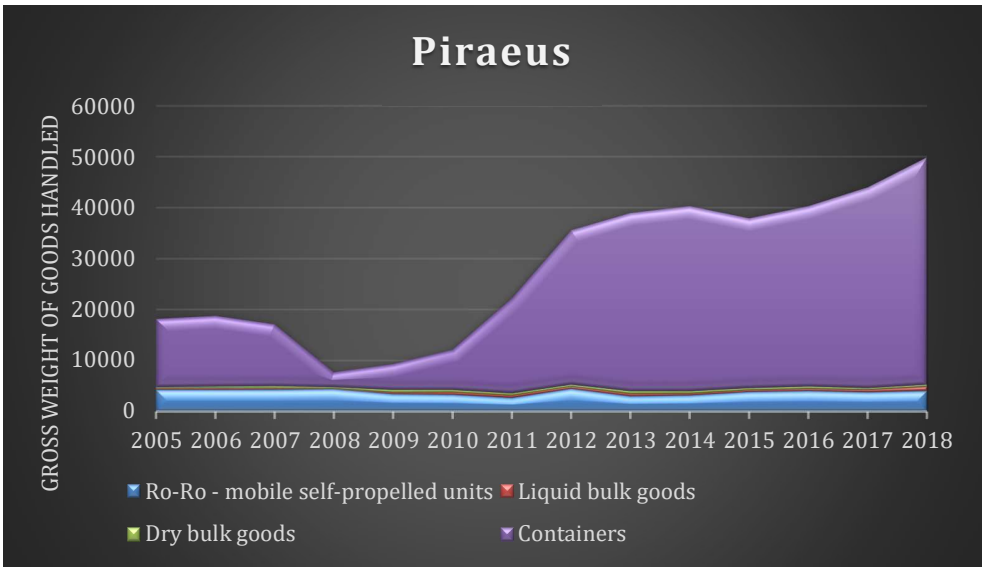
In 2019 COSCO announced that it is going to make the port of Piraeus the biggest port in all of Europe. They quoted the following in 2019: "The geographical advantages of Greek ports can be utilized for facilitating and increasing transfer flows from China and the Far East to the European Union, the Balkans and the Black Sea region, and vice versa," Fragogiannis told CNBC (Reuters, 2016). The port can serve the eastern European countries very well, due to its central location for this country, between China and the countries. This combined with increasing GDP in these areas could be a strategic long-term investment for COSCO. These long-term investments will increase the power of China in Europe (especially the southern European countries), in terms of world trade, politics and financial strength. These investments in the port are all part of China's Road Belt Initiative.

The market share of all Mediterranean ports together in Europe has been stable, and the growth was consequently greater than in Northern Europe over the last decades (van der Putten, 2014). While in 1990 they were responsible for 27 percent of the throughput, in 2011 this was 48 percent (van der Putten, 2014). The National Bank of Greece (*From now: NBG)* believes that international cargo flows in Piraeus will rise because of two reasons: global international container trade will increase and the Cosco will try to increase the market share in the port of Piraeus according to the NBG (2013). It is likely that Covid-19 will slow this increase down at least.

Piraeus is a specialized port, it almost exclusively handles containers as seen in figure 5. The reliance of fossil fuels is low. Due to this fact the energy transition will substantially less effect the port of Piraeus and

not much literature is known about this topic. The port of Rotterdam will indefinitely experience challenges from the energy transition (Hentschela et al, 2018).

Figure 5: Port throughputs by type of cargo in port of Piraeus (2005-2018)

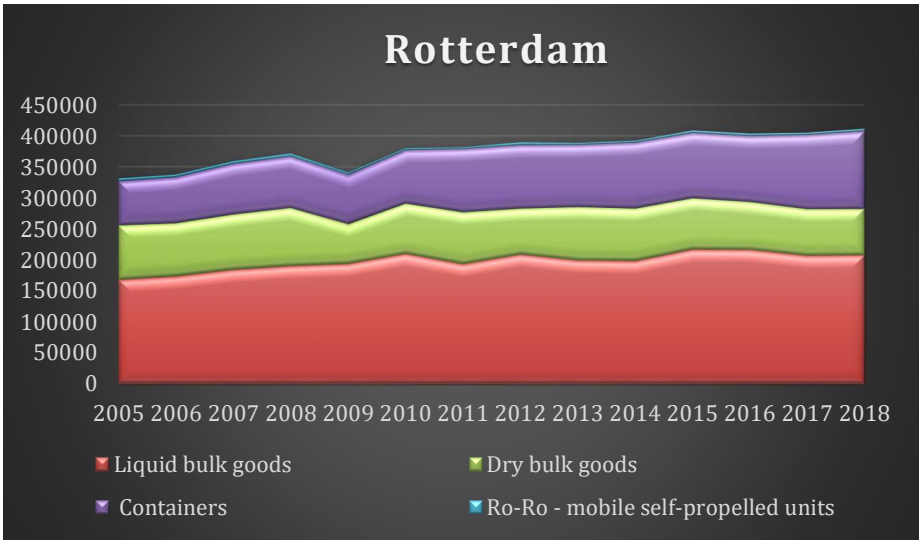


Data: Eurostat

Analysis on Port of Rotterdam

Figure 6 shows the handling in the port of Rotterdam between 2005 and 2018. According to Bosman et al, the port of Rotterdam could be considered a mature port that operates in a mature market (2018). Observing figure 6 this statement is in line with the figure.

Figure 6: Port throughputs by type of cargo in port of Rotterdam (2005-2018)



Data: Eurostat

The maturing European market and population could create a smaller growth of the port of Rotterdam in the future. The Port of Rotterdam is trying to prevent this from happening. The Port vision of the Port of Rotterdam states three major challenges in the next few years which are as followed: The economic transition, social transition and remaining to be an attractive region (Port of Rotterdam, 2020).

The economic transition focuses on a digital harbor and chain. The internal improvements in the operations of the port, which targets to increase the productivity are central in this subject. The social transition focuses on the improvement of education level. Which aims on the employment of viable and flexible employees by training the employees. The maintenance of being an attractive region includes the investments in infrastructure and improvement of public transport which promotes the live ability and accessibility to work. The strategies are important aggregates to include in the long-term impact of Covid-19. Ports react to external changes in demand, external shocks are important to include due to the fact that this can result in different outcomes for the port. The different outcomes in the long run are not solely dependent on the impact of Covid-19, it is also important to know which underlying trends there are that influence the port in general and the influences in a crisis.

Figure 7 shows signs of decreases in the relevance of dry and liquid bulks and increase of the containers. It shows that during the financial crisis, the share of liquid bulks increased, while the share of dry bulks decreased. Which tells us nothing about the long term trend, but it explains the relatively stable throughputs level during the financial crisis. It appears that liquid bulk was more resilient to the financial crisis than other cargo.

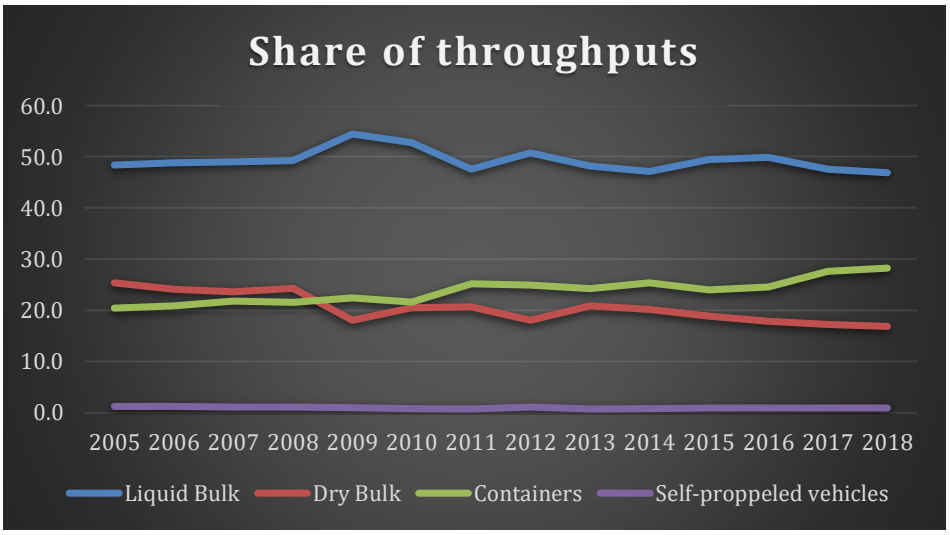
It is clear that the share of dry and liquid bulk dropped and the share of containers rose. This underlying trend is dedicated to the energy transition which diminishes the demand for fossil fuels, which presents a large amount of this type of cargo handled in the port of Rotterdam. Which is a pressure that is broadly discussed, Bosman identified these challenges for the port of Rotterdam and states these as landscape pressures.

Differences between the ports

There are three key differences between the port of Rotterdam and Piraeus, these differences cause a different form of leadership, strategy and impacts of external disruptions. The first one is that the port of Piraeus is for a large share in the hands of private companies (Marketscreener, 2020), the port of Rotterdam is 30 percent owned by the Dutch government and 70 percent by the Rotterdam Municipality. Second the port of Rotterdam is around 8 times bigger than the port of Piraeus. Finally the portfolio in the

type of cargo handled is far more diversified in the Port of Rotterdam than in the Port of Piraeus. For this reason different developments have different impacts on the ports. The increasing role of China is highly relevant for the port of Piraeus, but less relevant for the Port of Rotterdam and the energy transition is highly relevant for the port of Rotterdam, but less relevant for the port of Piraeus. Only the relevant impacts on the ports are in need to be discussed, so the impact of the increasing role of China is discussed for Piraeus, and the impact of the energy transition is discussed for the Port of Rotterdam.

Figure 7: Share of port throughputs in Europe by type of cargo indexed as 2005=100 (2005-2018)



Data: Eurostat

Landscape pressures

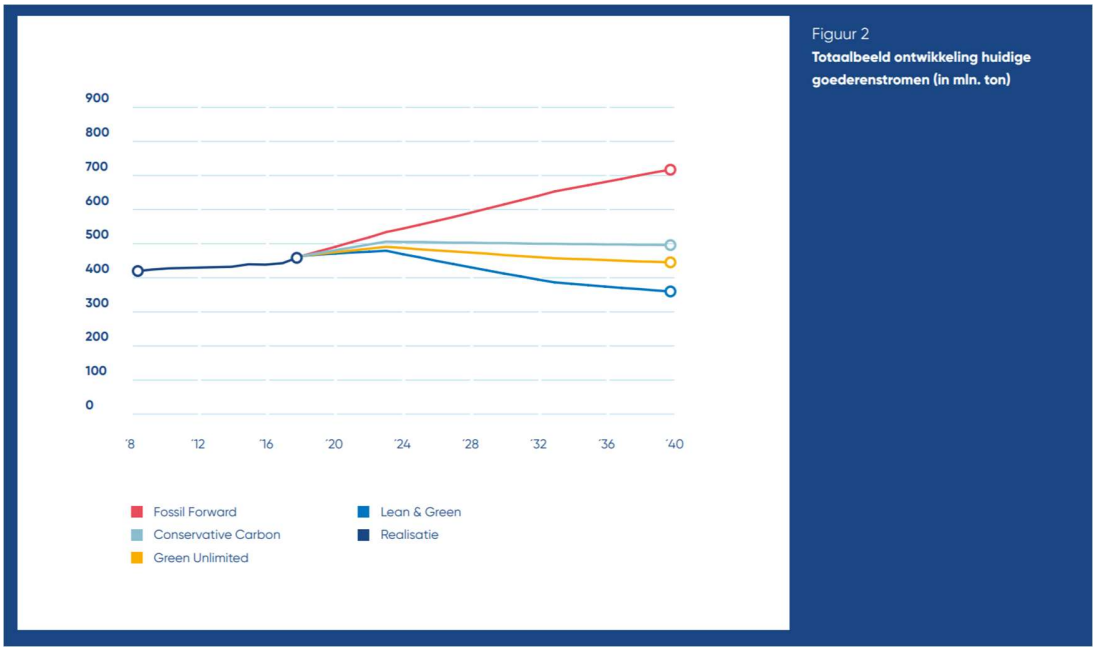
The Carbon lookout (Bosman et al, 2018) identified the five landscape pressures of which the following two are discussed in this thesis.

1. Demand in Europe stabilizes because its market is mature and the population is stable and ageing
2. Increasing environmental concerns, in particular, climate change, challenge the future of fossil-based industries.

The long term vision for port throughputs of the port of Rotterdam is directly linked to the energy transition in the port vision of Rotterdam (Port of Rotterdam, 2020). It shows four possible scenarios, fossil forward, conservative carbon, green unlimited and lean and green. Figure 8 shows the possible scenarios in a graph, these scenarios will all have different outcomes for the type of cargo that the port of Rotterdam will handle in the future. Fossil forward means a rise in the usage of fossil fuels in the next twenty years, which could be favorable for the throughput levels of these cargos. The other scenarios

show a flattening or decrease, which means that the port of Rotterdam has to reevaluate their type of cargo handling to continue growing.

Figure 8, scenarios for throughputs with different carbon usage levels, prognosed by the port authority of Rotterdam



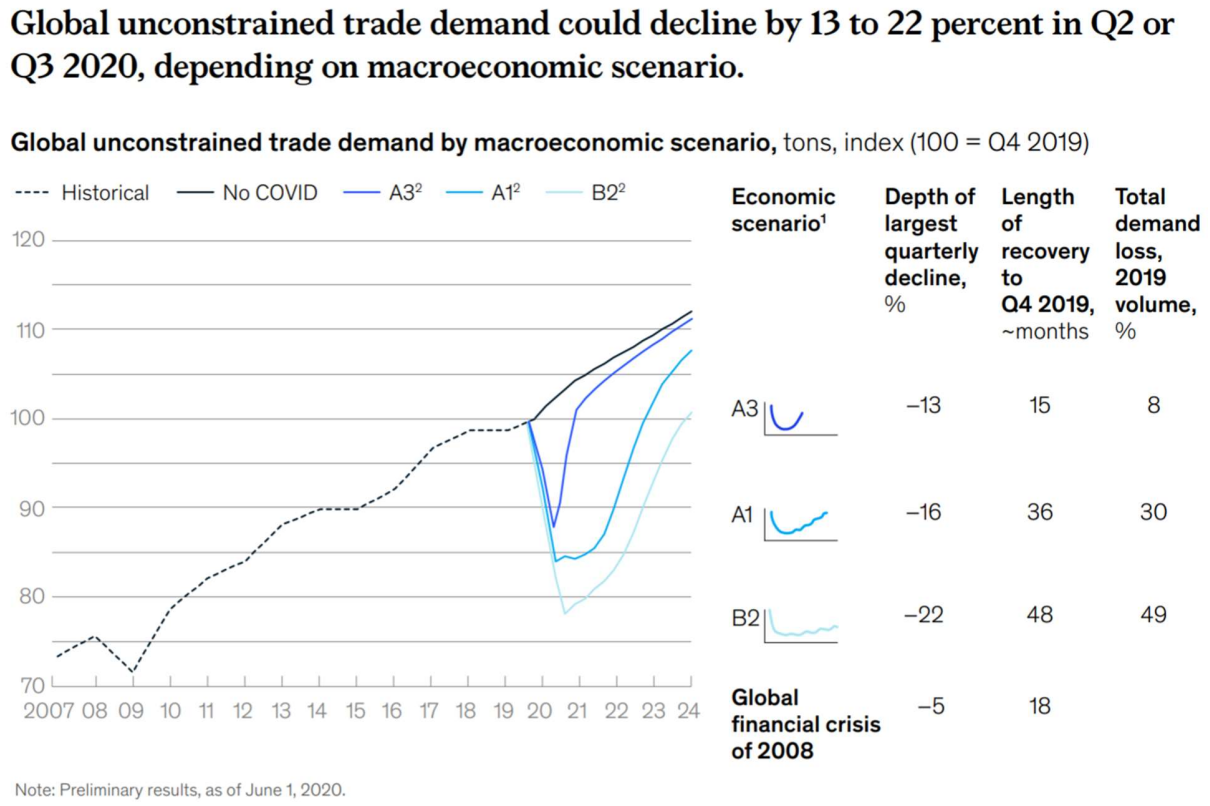
Source: Port of Rotterdam

4.4 Impact of Covid-19

Current impact on trade demand

Covid-19 will have more impact on world trade than any other recent crisis (McKinsey & Company, 2020). In every area McKinsey observes a reaction of innovation on the current challenges. The extent and disruption will vary by commodity, trade lane and mode of transport paired with local differences. World effect on trade will be far larger than on GDP, which is estimated at 3 to 8 percent. McKinsey modeled three potential scenarios of the impact of Covid-19 on trade demand.

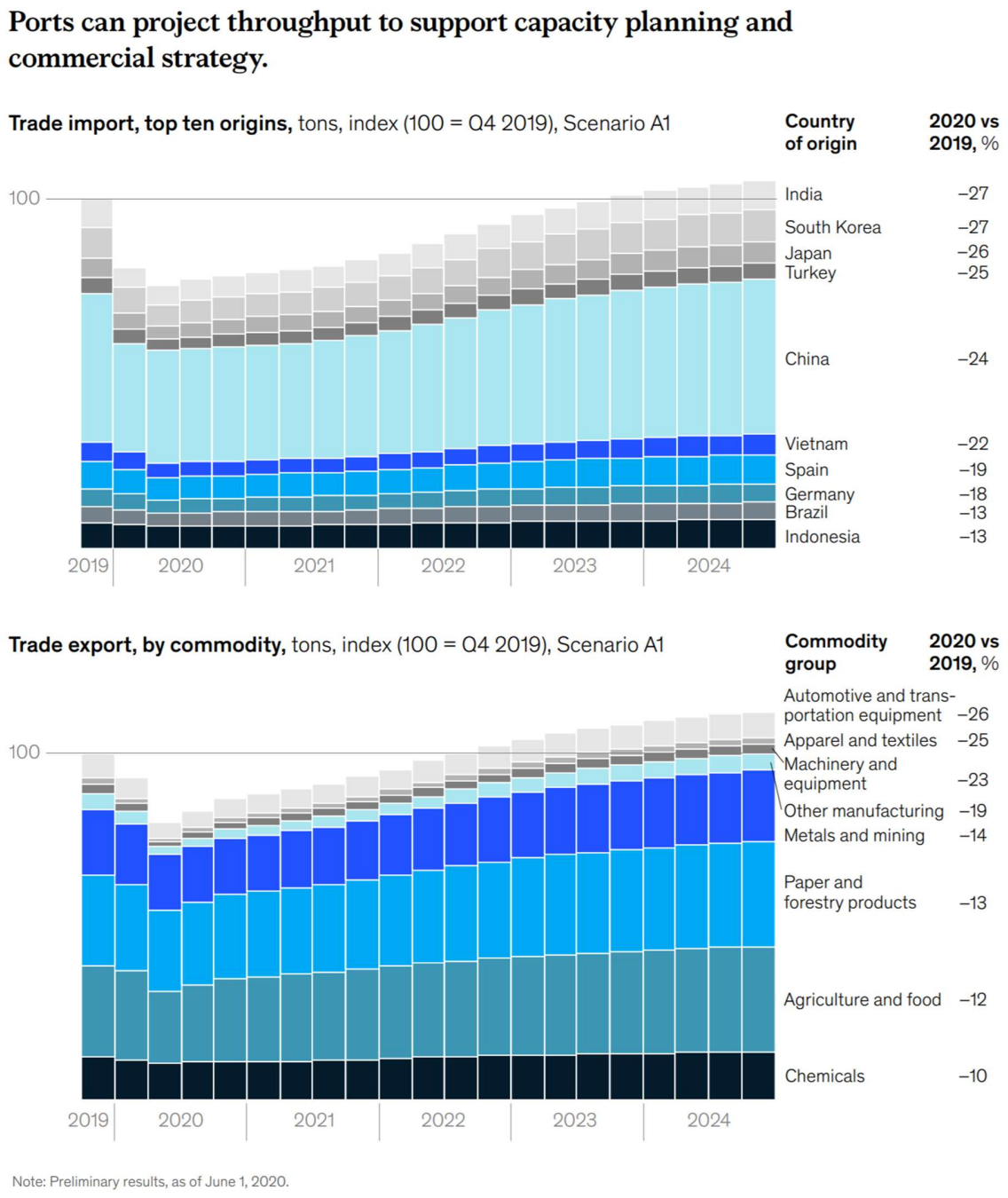
Figure 9: Scenarios McKinsey & Company about the impact of Covid-19 on trade demand



Source: McKinsey & Company

A3 represents quick public health responses with effective and rapid control of the virus and successful economic interventions. A1 holds partially effective interventions in health and partially effective economic interventions. B2 holds ineffective economic interventions and partially effective health interventions. Next they projected scenario A1 in figure (x) and split it per origin and commodity.

Figure 10: Scenario 1 impact per country of origin and commodity



Source: McKinsey & Company

Countries undergo lockdowns, which leads worldwide to demand shocks due to economic downturn. The impact of the crisis will vary significantly by commodity, shape and duration. Basic consumer goods are likely to decline less, then expensive, durable goods like automotive in the short run. Containers are

expected to take a bigger hit than dry bulk (McKinsey & Company, 2020). This suggests that the impact in the Port of Piraeus will be relatively larger than in the Port of Rotterdam.

Current impact on the port of Rotterdam and Piraeus

In the first six month of Covid-19 throughputs in The port of Rotterdam declined 9.1 percent. Which is lower than the 4.9 percent in the port of Antwerp (Port of Rotterdam, 2020). The reason for this difference has two explanations. The first one is that the port of Rotterdam had the highest throughputs ever in the period before and Antwerp did not experience this. Which gives a distorted image of the situation. The second reason is the high reliability of Asia compared to Antwerp of the port of Rotterdam. This cargo took the biggest hit in the first half. Due to the lockdown the demand for coal took a dive, but the demand for biomass and LNG increased (Port of Rotterdam, 2020).

The first prognoses expected between 10 and 20 percent decline in the first two quarters. Which shows that the stability observed in the data of 2008/2009 is again repeated. According to Castelein, CEO of the Rotterdam port authority, the funds of the port of Rotterdam are sufficient to invest in the port of Rotterdam out of the crisis (Port of Rotterdam, 2020). He also mentioned that according to the big shipping companies, the cargo of the ships incoming is already rising. Which suggests that the recovery of Covid-19 could be faster than first expected. Looking at the expected impacts of Covid-19 from McKinsey & Company, scenario A3 is currently of relevance in the Port of Rotterdam. The port of Rotterdam took a bigger dive than the port of Antwerp, this is because of its relatively higher volume in container trade, which took the biggest dive.

The results of Q1 and Q2 show a decrease in 6.2 percent of cargo throughputs (Notteboom, 2020). This is surprising because if you at the results from the EMSA in figure 11 you can see that the ship calls per week have substantially increased compared to 2019. The amount of ship calls were higher but throughputs decreased, this means that the occupancy rate of the ships were fare lower than the year before.

Table 4: Evolution in the number of ship calls per week by comparing data from 2019 and 2020

Port/Week	15	16	17	18	19	20	21	22	23	24	25	26	27	15-27
Piraeus	-18%	-26%	18%	61%	54%	87%	47%	62%	100%	136%	101%	91%	148%	69%
Rotterdam	-7%	-15%	-4%	-7%	-11%	-10%	-4%	2%	-13%	-12%	-9%	-12%	-2%	-8%
Top20ports	-23%	-21%	-22%	-21%	-19%	-18%	-19%	-16%	-17%	-14%	-16%	-14%	-13%	-18%

Data: EMSA

5. Discussion

Ports are industrial locations and transport hubs, these hubs have strong connections with external parties, Because of this instance ports experience an indirect demand. This indirect demand makes ports vulnerable for external disruptions. The demand is eventually never located in the ports, but at the parties they provide their service for (Introduction to Transport Economics, 2020). Lockdowns, uncertainty and measures taken by governments interrupt global supply chains, factories, investments by businesses and demand for products. These factors impact ports via a decline in demand for port activity.

Because of this high reliance on external events this thesis has found a statistical association between GDP and port throughputs. For most of the results that were not significant an explanation is given. In a country were the ports are handling throughputs mainly for the domestic economy, a higher statistical association between GDP and port throughputs is expected. When ports in the country are operating as transshipment ports and most of the throughputs are for the international market the statistical association is expected to be lower. An economic downturn like Covid-19 however is not a problem that stays between the borders of a particular country, so this will cause the throughput levels in ports to decline in the short run.

The two ports discussed differ most on three key elements: ownership, size, function and portfolio (Marketscreener, 2020). These four are crucial to the reaction they will experience from the external developments and Covid-19.

5.1 Piraeus

Over the last decade the Port of Piraeus boomed in the handling of containers. The port went from one of the minor players in Europe to the seventh biggest large container operator. The main reason for this is the investments by Cosco group in the port. The Cosco was able to increase their shares in the port easily due to the effect of the financial crisis on Greece. The debt to foreign countries was so high that they were forced to sell assets to the highest bidder (Vickstrom, 2012). After that the port of Piraeus became the fastest growing port in Europe handling predominantly containers from China (van der Putten, 2014). The investments were part of the larger story of the Belt Road Initiative where China aims to strengthen globalization and regional incorporation, connecting the country to the world. The central aim is to connect China to Asia, Europe and Africa and enhance and establish partnerships between the continents. Due to the central location and bad economy of Greece, the port of Piraeus was chosen to invest in.

Because Piraeus is a specialized port the energy transition will have relatively low effects on the operations of the port. For this reason the landscape pressures of Bosman et al are not relevant for the port of Piraeus. The flow of future investments by the Cosco and the trend in shipment of containers

however, are of great relevance for the Port of Piraeus. The function of Piraeus as a transshipment port could cause the port of Piraeus to be hit relatively limited by Covid-19. As a transshipment port, the port is more specialized and very cost efficient since their function is to be the most efficient link in the supply chain. It could even be that due to Covid-19, shipping lines will choose to move to Piraeus due to its high performance.

Although the energy transition will most likely have small effects on the port of Piraeus, the port is expected to face other challenges which are of the same severity. The high dependence on containers will most likely cause Covid-19 to be of relatively large impact in the short run. This effect is already measured in the port of Rotterdam that took a bigger dive than the port of Antwerp due to its relatively high volume of container throughputs. Since the port of Piraeus is almost fully specialized in container trade it is inevitable that the effect of Covid-19 in the short run will be most likely one of the biggest in Europe. In 2008/2009 the port of Piraeus took a big dive as well. The throughput levels declined by around 53 percent (Eurostat, 2020). In the ten years afterward, the port experienced a growth of 478 percent, the highest in all of Europe. Which shows that long and short term effect of a crisis could have two different outcomes.

The reason for the high vulnerability to crises of container trade could be found in the story of declining demand, supply and confidence spillovers. The demand for products handled in containers more volatile due to high dependence on consumption end products. External disruptions cause this consumption of end products to decline which causes a decline in the throughput level of containers in ports.

The effect of Covid-19 on the container trade is expected to be higher than during the financial crisis. This difference comes mainly from the fact of differences, in the terms of lockdown and duration of the external disruption. The lockdowns cause a great on the level of consumption of end products, which lowers the container trade throughput (Laurence Boone, 2020). The duration and intensity of the will be crucial for the throughput levels of the Port of Piraeus.

Another important factor is that the Covid-19 pandemic started in China. Which has negative consequences for the short run, but positive for the long run. The pandemic started in China, but was also afterward controlled first in China. Which will mean that in the first two quarters a decline in throughputs levels from China will be big, but due to its fast controlment of the virus quick recovery could be expected. For this reason quick recovery in the port of Piraeus would not be surprising.

5.2 Rotterdam

The port of Rotterdam is a mature port operating in a mature region. Which suggests that the challenges they face are an economic transition, social transition and remaining an attractive region. The main focuses are the internal operations, which benefits the productivity of the ports and the improvement of educational levels (Port of Rotterdam, 2020). My expectations are that this will contribute in ensuring the competitive advantage of the port in the future.

The port of Rotterdam operating as a gateway port could have two sides in the Covid-19 disruption. On one hand the large amount of European inhabitants cause a stable level of demand for throughputs in the port. On the other hand a decrease in local consumption could cause demand for some types of cargo to diminish intensively. Another threat, which could be the biggest on mid-long term is that more regional ports will gain market share from the port of Rotterdam because of their more direct supply chain, which is more cost-efficient. In other words, the diversified portfolio of the port of Rotterdam could be seen as an opportunity and as a threat. The share of fossil fuels could indefinitely be seen as a threat for the port.

The port highly depends on the throughputs of dry and liquid bulks, but is increasing their share in the trade in containers (Eurostat, 2020). Due to the potential effects of the energy transition this is a strategy which looks further than the operations of today and is making sure that the port of Rotterdam is keeping up with the developments in the world. If the Paris agreements are lived up to, which is a necessary renewal the port of Rotterdam has to make. The Paris agreement aims for a green unlimited to lean and green strategy which will change the operations in the port for good. It is crucial for the port of Rotterdam to implement the visions and gradually change its role worldwide.

Looking at the financial crisis the short term impact of the Port of Rotterdam was relatively small compared to the rest of Europe (Eurostat, 2020). The port has in that way proven to be a relatively stable port, which can handle external disruptions and adapts quickly. The port also proved to adapt to the increase in trade of containers by increasing its share of throughputs from 20 to almost 30 percent in the period between 2005 and 2018, decreasing their dependency on fossil fuels (Eurostat, 2020).

The differences between Covid-19 and the financial crisis are noticeable in the port of Rotterdam in all three factors. The non-system disruption creates that at the beginning of the crisis companies are stronger positioned than with a system error. Companies can more easily invest and use their buffers to financially bridge a period of lower revenues. The lockdowns cause the several commodities to decline heavily like containers and fuel for travelling, while dry bulks are affected less. Finally the confidence levels are

expected to be low. Transport is highly depended on the movement of cargo and people and when this declines, confidence levels decline, which decrease investments.

In a port like the port of Rotterdam investments are crucial to keep growing (Port of Rotterdam, 2020). CEO of port of Rotterdam has already mentioned that the wallets of the port are deep enough to invest themselves out of this crisis (Port of Rotterdam, 2020). The investments suggest a pro-active role of the port authority to recover from this crisis, historical data from the financial crisis in 2008 show that the port can operate stable even when there is a period of economic downturn.

Based on this knowledge, in the short run, the port of Rotterdam will and already is hit by Covid-19. Which will lower the port performance, decreasing throughputs, internal and external added value and direct and indirect employment. However, my expectations are that the effect will be relatively small, compared to the rest of Europe. Due to its stable function, constant adaptation to developments and constant improvement of their operations. The first results of Covid-19 confirm the stability of the port, although it took a hit of 9.1 percent. The first suggestions of recovery are already mentioned by Castelein, which suggests a rapid recovery, but 9.1 percent decrease is a substantial hit.

6. Conclusion

This thesis has investigated what the effect of Covid-19 will be on the port of Piraeus and Rotterdam. The main aggregates causing spillovers are identified as supply, demand and confidence. These factors impact ports because ports are industrial and distributional hub that rely on the continuance of global supply chains, factories, investments by businesses and demand for products. Because of this connections port throughput and GDP are responding statistically on eachother. Three major differences are identified between the financial crisis and Covid-19 are as followed: Lockdowns, external and internal cause and uncertainty of duration.

6.1 Piraeus

Comparing the financial crisis with the current Covid-19 crisis for the port of Piraeus are two different stories. The GDP and throughputs analysis shows significant results for Greece, but the port of Piraeus is a story on its own. The size of the port has increased so much that any comparison would by definition be invalid. In the short run it is inevitable that the port performance of the port of Piraeus will decline due to the high dependence on container trading and the severity of the disruption that Covid-19 is causing. However in the mid-long term there could be great opportunities for the port of Piraeus due to their function as a transshipment port which brings a relative high performance.

In the long run there should be looked at the potential for expansion. The Cosco group is planning to make Piraeus the biggest port in Europe, for this to become reality the Chinese investments need to continue and the port needs to adapt quickly to the new normal of the virus. The NBG and van der Putte both prognose a continuance of the growth of the port of Piraeus.As observed in the 20 biggest ports in Europe in 2008, the throughputs of containers will decline in the short run due to Covid-19 and it will most likely take a few years to recover from the disruption. This decline is already experienced in the port of Rotterdam in the first two quarters of 2020. In the following years the throughputs of containers will recover in the port of Piraeus. If the port of Piraeus adapts quickly, the port will start to resume its growth pattern, as soon as Covid-19 is under control.

6.2 Rotterdam

The port of Rotterdam has shown during the financial crisis that it is a very stable port. For this reason in the short run it is expected that the impact Covid-19, relative to other ports, is small. The port of Rotterdam already showed a decrease in throughputs of 9.1 percent, which was lower than expected. The main aggregate for the stable function is the constant improvements of operations, stated by the port of Rotterdam as the economic and social transition the port is working on daily. By the constant improvements of the processes in the port, Rotterdam remains its competitive position which is a contribution to the stable function.

In the long run the port of Rotterdam is expected to recover quickly as we saw during the financial crisis. The constant improvements of the processes are of major contribution in this case. The port showed resilience and a forward looking strategy. stabilizing demand in Europe and the increasing environmental concerns are challenges the has to deal with. The increase from 20 percent to 30 percent in the period between 2005 and 2018 of container share shows the adaptability of the port and decreases the dependency on fossil fuels. These steps show that the port is able to adapt to a changing world.

7. Limitations

Although, this research is executed to the best of my knowledge, my knowledge about port economics reaches no further than the investigation done for this thesis, the courses in my bachelor and live experience.

This thesis investigated the effect of Covid-19 on the short and long term performance in the port of Rotterdam and Piraeus. The analysis is based on four factors to demarcate the scope of the research. The future of the port sector is based on more factors than those four. Factors like international relations between countries, order in distribution of the vaccine, governmental support can very well have an impact on the recovery of the ports in question. In fact, no-one can tell for certain how the virus is going to impact the world in the next years. Further, the topic investigated is demarcated to the effect on the port of Rotterdam and Piraeus. Ports are mentioned in the thesis as industrial and distributional hub that reliy on the continuance of global supply chains, factories, investments by businesses and demand for products. The amount of factors they rely on, is a very broad spectrum. If even one factor is reacting different on the Covid-19 crisis, the forecasts not match the actual situation.

Identifying the factors that impact these ports and their size could be of great relevance and even this is hard due to the fact that there are probably will be more factors that could be identified which could be of major influence.

8. Suggestions for further research

Future research that could be helpful is the identification of the factors that influence the port of Piraeus and Rotterdam the most during crisis time. This could be done by investigating causal relations and analyzing their significance. The first steps that should be taken is the identification of the important factors. An analysis of Covid-19, the financial crisis in 2008/2009 and the internet bubble could show which factors show an causal relation with the throughputs in these ports. Ordering them by size could help to identify important factors that impact port performance for companies, port authorities and governments. In this way in an early stage the port performance can be predicted.

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Appendix

VARIABLES		GDP Corresponding Country			Constant			Observations	R-squared
BelgiumTP		0.457***	-0.0633		55,233*	-25,891		9	0.882
BulgariaTP		0.276**	-0.107		14,661**	-4,914		9	0.486
DenmarkTP		0.144***	-0.0389		53,413***	-10,485		9	0.663
GermanyTP		0.0143	-0.00968		253,439***	-28,604		9	0.238
EstoniaTP		-1.326***	-0.352		67,129***	-7,178		9	0.67
IrelandTP		0.0532***	-0.00435		36,880***	-1,024		9	0.955
GreeceTP		-1.012***	-0.248		353,666***	-47,068		9	0.704
SpainTP		0.537***	-0.136		-149,502	-147,581		9	0.691
FranceTP		-0.0372	-0.0268		385,591***	-58,232		9	0.216
CroatiaTP		0.216	-0.255		10,412	-11,701		9	0.093
ItalyTP		0.123	-0.133		268,843	-220,702		9	0.11
CyprusTP		-0.462	-0.443		16,538*	-8,483		9	0.134
LatviaTP		-0.217	-0.588		70,394***	-13,985		9	0.019
LithuaniaTP		0.817***	-0.142		14,025**	-5,233		9	0.825
MaltaTP		0.042	-0.0576		3,162***	-528.2		9	0.071
NetherlandsTP		0.471***	-0.0792		249,991***	-54,547		9	0.834
PolandTP		0.245***	-0.0248		-33,106**	-10,410		9	0.933
PortugalTP		0.645**	-0.244		-36,902	-44,378		9	0.5
RomaniaTP		0.132***	-0.0172		22,715***	-2,724		9	0.894
SloveniaTP		0.809***	-0.128		-12,807**	-5,016		9	0.851
FinlandTP		0.0939	-0.139		88,496**	-29,132		9	0.061
SwedenTP		-0.037	-0.0683		189,196***	-30,196		9	0.04
UK TP		-0.0391**	-0.0124		585,786***	-27,916		9	0.587
IcelandTP		0.118***	-0.0203		5,057***	-319.1		9	0.828
NorwayTP		0.149	-0.0941		149,432***	-34,043		9	0.263
TurkeyTP		0.372*	-0.178		140,896	-123,637		9	0.385
*** p<0.01, ** p<0.05, * p<0.1									