MASTER THESIS

THE PORT – CITY RELATIONSHIP

The Success of Urban Maritime Ports

Student:
D.P. Veenboer
303826DV

Supervisor:
M.H. Nijdam
Co-reader:
M.R. Van der Horst

MSc Thesis
Urban, Port and Transport Economics

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Erasmus University Rotterdam

PREFACE

I am hereby proud to present to you my Master Thesis "*The Port – City Relationship: The Success of Urban Maritime Ports".* This thesis is the final part of the Master's Program Urban, Port and Transport Economics at the Erasmus University Rotterdam. The thesis is at the same time the final part of my student life.

When I was deciding on what the subject of my thesis would be, I wanted it to be a good representation of my career as a student. I was seeking for a subject where I was able to include both the Urban and the Port aspect into my study. As in my opinion both ports and cities are fascinating and interesting units of analysis. This thesis further reunites with my economic geography background of my Bachelor's Program at the University of Utrecht.

As a proud resident of the city of Rotterdam I can say that my Interest in urban dynamics and ports is partly to be explained by growing up in my hometown. The city underwent some astonishing redevelopment since the bombardment in the Second World War, and in my opinion especially the last decade. It is not without a reason that the city of Rotterdam is currently getting so much international attention, as a city that is worth visiting. The city is constantly evolving; there are cranes rising everywhere, just as the one inspiring real estate project after the other. As a kid the port always fascinated me. I cherish a special memory of driving through the port at night with my mother. I was so impressed by all of these lights, the flames coming out of the pipes and the sheer scale of the port.

I would like to thank my family, especially my parents Paul and Bertje. They have supported me all these years, through the good and bad times. I would like to thank my loving girlfriend Anouk and her family, who I truly appreciate. Joran and Joren, though our study careers separated a little early, we had the best time. Further I would like to thank my thesis supervisor dr. Nijdam for his support and advice in writing my thesis and finally my co-reader drs. Van der Horst.

I hope you enjoy reading my master thesis.

Daan Veenboer

Rotterdam, December 2014

"…it is precisely the urban challenges and constraints faced by ports located in densely populated metropolitan areas today that provide them with the competitive edge as they are forced to innovate and rely upon dynamic urbanization externalities."

Hall and Jacobs (2012, p. 190)

MANAGEMENT SUMMARY

The relationship between ports and cities is put into question, it is said to have disappeared. Especially technological and globalizing forces have changed the interaction between ports – cities. Ports tend to move downstream and away from cities, some even claiming to be able to function on Greenfield locations. Thereby, the links between the ports and cities are said to have been reduced to the bare minimum. What can be observed from looking at ports in this present day, is that despite the numerous negative aspects accompanying an urban character, most of the world's leading ports are still located in and closely connected with their hosting urban environment. This research is aimed at getting a better understanding of the inner workings of the port – city relationship. The contradiction between the leitmotiv in the literature of a separating relationship and the main observations to be found when studying port locations today led to the following research question:

> ***Do both ports and cities still profit, after decades of major technological and globalization changes and the numerous bilateral negative externalities, from being in close proximity?***

Historically, ports were at the heart of the development of many cities, eventually to become among the largest metropolitan areas we know today. Having a port created the possibility to interact in international trade, allowing to trade over far greater distances than via traditional land transportation. The relationship between ports and cities was self-reinforcing, where growth in port activity led urban growth and vice versa. The last century the maritime port and shipping industry underwent some profound changes, especially technological and globalizing forces changed the relationship between ports and cities. First, industrialization and new container terminals led to great scale increases of the port cluster, resulting in conflicts with the urban environment. A second important change in the port and shipping industry was the internationalization and globalization of operations and actors. The internationalization had some serious impacts, where for example throughput experienced enormous growth or the displacement of local port operators by large international operators. These developments have considerably affected the port – city relationship and the interaction between ports and cities.

The empirical research, studying 21 European port cities, created evidence to believe that ports and cities do still profit from being in close proximity. The city can profit from employment and value added creation in the port cluster. Where the port can profit predominantly from knowledge and business services that are concentrated within the city. The most striking result is to be found in the results on geographical separation. Where ports benefit from being in close proximity, for the urban environment it is more beneficial if the spatial separation is somewhat larger. To be explained by the negative externalities that will strike the city more when the port is directly located within the urban environment.

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INTRODUCTION

Ports and cities are historically strongly tied and have developed in close relationship. Especially the opportunities for and enabling of international trade benefited the development of many port cities significantly (Fujita and Mori, 1996). The relationship between ports and cities is self-reinforcing, where increased port activity led to more urban activity and increased urban activity led to the growth in port activity (Hall and Jacobs, 2012). Ports still find the support of local and national governments, port authorities and port business communities, who stress the importance of ports for the development of local economies (Musso, Benacchio, Ferrari and Haralambides, 2000). Many of the world's most important ports are still to be found in urban environments (Hall and Jacobs, 2012). However, the leitmotiv in the literature is that of a weakening port – city relationship. The traditional mutual beneficial relationship between ports and their hosting cities is put into question in the literature. The debate, starting in the 1960s and getting more fierce since the 1980s, discussing a broad selection of factors affecting the relationship between port and city. The main focus in the literature is on the separation of ports and cities, thereby fading the direct relationship between ports and cities. It can't be denied that the relationship between ports and cities have been affected considerably during the second half of the twentieth century (Levinson 2006). Ports have become increasingly disconnected from cities, in spatial, institutional as well as economical terms (Hall and Jacobs, 2012). Spatially, developments such as intensified port-industrial activity and containerization, in combination with urban growth, the lack of available land and environmental constraints have led to the move downstream of port facilities away from city centers (e.g. Bird, 1963; Hoyle 1989; Hall 2007). Institutionally, the devolution of local government control on the port's management has led to a further weakening port – city relationships. Accompanied by the internationalization of port actors and the rise of megacarriers, displacing many local port operators (e.g. Brooks and Cullinane 2007; Jacobs 2007; Hall and Jacobs, 2012). Economically, the port – city relationship was affected by reduced dependence of ports on the urban labor market as well as the reduced dependence of cities on ports for local economic growth (e.g. Jacobs, Ducruet and De Langen, 2010; Hall and Jacobs, 2012). These developments have eroded the close relationship between ports and cities, the port and city are even described as becoming two separate identities (Pesquera and Ruiz, 1996).

The separation of ports and cities can to a large extent be explained by two important factors of change. First, the port – city relationship was at first heavily affected by technological changes and the development of the container. Second, the internationalization of the port and shipping industry and other globalizing forces have had important impacts in the port – city relationship. Together with

many negative externalities concerning urban ports; pollution, congestion and scarcity and mixed interests of (urban) land, the urban character of ports is seen as an important impediment. Despite these developments in the maritime shipping industry the last decades and the negative externalities, most of the world's most important ports retain an urban character and are still closely involved with the urban environment. Most ports are still located within the urban environment, attract labor from the city's labor pool, make use of the local knowledge and service sector and are bound to local politics and policies. Being adjacent to the urban environment thus seems to provide urban ports some kind of an advantage over non-urban ports in attracting throughput (Hall and Jacobs, 2012).

RESEARCH AIM

This study will examine the relationship between ports and cities. Starting with the initial development of port cities and how they have evolved over time. The study will focus on the impact of technological developments and the globalization process on the port – city relationship. Despite the leitmotiv of a separating port – city relationship, many ports are still to be found in urban environments. I will explore if and how ports and cities can profit from being in close proximity. In this study the effect of port performance indicators on urban performance indicators is empirically tested and vice versa. Ultimately in an attempt to answer the following main research question:

> ***Do both ports and cities still profit, despite decades of major technological and globalization changes and the numerous bilateral negative externalities, from being in close proximity?***

In order to answer the main research question, five sub questions have been formulated. These sub questions will provide guidance in this study aimed at explaining the observed pattern of remaining proximity between ports and cities.

How did port cities develop historically?
How did technological advancements affect the relationship between ports and cities?
How did globalization forces affect the relationship between ports and cities?
How did the technological advancements and globalization forces affect the port – city relationship spatially?
Why would maritime ports remain an urban character?

In order to answer the main research question, I will first look at several sub questions concerning the port – city relationship by providing a literature review and subsequently an empirical research. We will first look at how port cities have developed historically in section 1. This will be followed by an overview of the factors that have changed the port – city relationship over time, especially in the last century. I will look at the technological developments and in particular the influence of the

development and adaptation of the container in the maritime shipping industry. We will further look at the internationalization in the industry and the globalizing forces that have affected the port – city relationship. I will thereby examine how the factors of change have affected the port – city relationship. Section 3 will give an overview of the spatial transformation of port – cities, by studying the Anyport model by Bird (1963) and the port-city interface by Hoyle (1989). This will be done in order to get an understanding how the factors of change have affected the port – city relationship spatially. As mentioned, many of the world's leading ports still operate in an urban environment. In section 4 we will investigate why so many ports retain an urban character, and how the ports and cities can profit from being in close proximity. Section 5 will include an empirical research into the bilateral effects of port and city performance. The empirical research will include investigate the bilateral relationship of port and city performance concerning 21 European port cities. This will be followed by the conclusion, a discussion and recommendations for future research.

PART I: LITERATURE REVIEW

Ports have played an important role in the early development of many cities. However, the relationship between city performance and the importance of the ports is put into question in the literature. The urban environment hosting port activities was seen to be essential to the success of many (port) cities, where the urban character of a port nowadays is mainly considered to be a major drawback. Due to factors like the scarcity of urban space, negative externalities, congestion etc., ports tend to move away from the urban environment. The development and adaptation of the container and the globalization process have significantly changed the environments in which port-cities operate today (Notteboom, 2004). Since the need for labor (e.g. due to automation) declined and the footloose character of ports nowadays, scholars and policy-makers argue that the ports should be and are developing separated from the urban environment. It is even claimed that the port and city now can be seen as two separate identities. The port and city are both seen to be independent and to be able to function without the presence of its counterpart (Pesquera and Ruiz, 1996). The historical closely integrated development of ports and cities is now considered to be over (Hall and Jacobs, 2012).

The literature review will start with an exploration on the initial relationship between ports and cities, their coherent development and evolution over time. As said, the maritime port and shipping industry experienced significant changes due to technological developments and the globalization process. In the second section we will be looking at the technological changes and in particular the development of the container and the effects on the port – city relationship. In the third section we will discuss the influence of the globalization process and the internationalization of the maritime port and shipping industry. In the last section of the literature review we will explore how the technological changes and globalization process have affected the port – city relationship spatially.

1. PORT CITY DEVELOPMENT OVER TIME

To get a better understanding of the relation between ports and cities, we will look at the joint development of ports and cities from a historical perspective. Most of the important and large cities in the world have developed in coastal regions, or in areas with well-established water connections, led by the possibility to interact over larger distances. The transportation opportunities led to the rudimental development of many large metropolitan regions (Norcliffe, Bassett and Hoare, 1996). Many cities in the world, in fact, exist due to their port functions in earlier times (Hoyle, 1989). Ports initiated the growth of many cities, where the cities started as trading links between land and

maritime connections. Ports allowed small towns to grow into large cities, stimulating urban development related to the prosperity of trade (Merk, 2013). Where ports created cities and large ports have created big cities (Norcliffe et al., 1996). The development of a city was closely tied to the prosperity of the port, the port and city would either develop together or decline together (Hoyle, 1989). There are examples of large non-coastal metropolitan regions, however many of these regions depended on well-established water connections to maritime ports in earlier times. Historically, every coastal city had a port and the port sustained the city (Hall and Jacobs, 2012).

The world we live in today is characterized by a vast number of people living in cities, creating areas of large economic activity. Some locations are more likely to develop into cities than others, predominantly explained by spatial inhomogeneities and transportation possibilities (Bosker and Buringh, 2010). Traditionally, the development of cities is based on comparative advantages. Each region has different technological conditions (e.g. climate or soil) or immobility of production factors (capital, human capital and resources like minerals). Each region is supposed to have their own comparative advantage in the production of a certain set of goods, to be traded with other regions (Fujita and Mori, 1996). Attractive city locations are those close to natural resources and with good access to the main trade routes. Given that a city relies on the exchange with other regions, location on a transport route offers substantial advantages in terms of transportation possibilities (Bosker and Buringh, 2010). Historically, the growth of cities was mainly limited by the cost of transportation of agricultural goods. Food is costly to be transported and the larger the city the higher the cost of transportation. This element was the first major impediment to urban growth. In this context the high costs of transporting agricultural supplies is also referred to as ‘the tyranny of distance’ (Duranton, 1999). Transportation costs together with scale economies are seen as fundamental elements in the development of cities (Bosker and Buringh, 2010).

Many of the largest and most important cities in the world have developed at ports, being situated in coastal regions or connected via rivers (Fujita and Mori, 1996). With the tyranny of distance in mind, it is no big surprise that the more prosperous cities tend to be found in fertile areas and in locations with specific advantages that reduce shipping costs, such as being located at a river delta or in a coastal area (Duranton, 1999). As said, the theory not only applies for port cities adjacent to the sea, but also applies to the development of cities at inland port locations. The structure and location of cities in the United States gives a good reflection on the influence of transportation costs. Where transportation costs were high prior to 1900 and roads and railways were scarce, people moved by foot and goods were transported by making use of waterway connections. In 1900 every large city in the U.S. was connected via waterways. Being located at sea, or at an inland location exploring the riches of the U.S. hinterland (Glaeser and Kohlhase, 2004). For example take Chicago, a city that is

being surrounded by fertile lands. Crops were collected in Chicago and from there shipped to New York with less prosperous in farming land. In this manner, cities likewise developed at inland locations, being connected to a port and the possibility to trade as dominant factors in the growth and prosperity of these cities (Konishi, 2000). At that time New York was the United States' largest city and hosted the leading port, especially in the trade with Europe (Glaeser and Kohlhase, 2004). There are many examples of world cities where the port has lost its importance in the economic environment of the city, but has evolved due to good water connections in the early stages in the development of the city. The advantage of having good water access initiated the growth of these cities in the past, which enabled them to profit from its accessibility and trade potential (Fujita and Mori, 1996).

The explanation for the initial development of cities around port locations can be explained by the convenience of exporting and importing when being located near a port (Fujita and Mori, 1996). Ports can be seen as the gateways to the outside world, supporting the search for new export markets and natural resources. In colonial times the ports played an essential role as a trading place and allowed technological transfers to occur (Lee, Song and Ducruet, 2008). The port cities started to act as transportation hubs for the local area. Products were brought to these transportation hubs, from the surroundings of the city, to be traded and shipped to other regions. The port allowed for better and easier access to other regions, offering lower transportation costs (Konishi, 2000). The improvements in transport reduced the strong effects connected to the tyranny of distance, leading to strong urban growth (Duranton, 1999). Trade amongst different regions took place between the different transportation hubs (Konishi, 2000). Production activities in regions concentrated around ports, profiting from the convenience of exporting to and importing of goods from other regions, ultimately leading to the formation of port cities (Fujita and Mori, 1996). As the volume of the transported goods between these transportation hubs started to increase, the demand for labor to handle the shipped goods likewise became greater. This resulted in the formation of large agglomerations of people at these transportation hubs (Konishi, 2000). Historically, port cities were more likely to develop into major agglomerations than non-port cites. However, enough examples exist of non-port cities that have developed into large urban agglomerations, and continue to thrive today. This is to be explained by the lock-in effect and self-reinforcing agglomeration forces. Where these agglomeration forces are also to be found in former port cities, which still prosper today even now they no longer rely on their initial advantage of water transportation possibilities (Fujita and Mori, 1996).

Ports have played a vital role in the development of cities. Geographical location, in relation to waterway connections, fertile lands and near transportation routes, has thereby played an important role in the growth and success of the development of cities, at least in the past. Though, there are examples where port activity today, led to the creation of new and large cities. This is especially to be found in emerging markets, for example in China there are several examples (e.g. Shenzhen) where due to the export driven industries, small fishing towns turned into one of the largest metropolitan regions and biggest ports in the world (Merk, 2013).

1.1 BASIC MODEL OF THE PORT – CITY RELATIONSHIP

To get a better understanding of the workings in the port – city relationship, we will take a look at the model created by Hall and Jacobs (2012). The main focus will be on the port – city relationship over time and the various factors that have an effect on this relationship. Hall and Jacobs (2012) have created a model from an evolutionary perspective on the coherent development of ports and cities (Figure 1). The model is primarily based on the Anyport model of Bird (1963) and port – city models based on the Central Place Theory (Bird, 1973). The model is rather basic in its nature and the elements that are included, but it does present a good foundation for a better understanding of the relationship between port and city performance. The model is based around four possible relationships between port and city development. The four relationships are, the port either has a positive or negative effect on the city and the city either has a positive or negative effect on the port. The different relationships can occur in random order and each city will encounter them in some way.

The first possible relationship between port and city, as described by Hall and Jacobs (2012), is the growth of port activity having a positive effect on urban development. Based on the fact that the growth in port activity will create a greater need in local employment, provide tax revenues and increase economic activity. This relationship is not only built upon firms handling cargo, but also firms profiting from being located in the port area, for example producer firms benefiting from inputs arriving in the port. The second possible relationship is the growth of urban activity having a positive effect on the development of port growth. As the city develops into a larger agglomeration and thereby accompanied economic activity, the city will have an effect on growing cargo attracted to the port. Urban ports would have an advantage over non-urban ports, due to factors such as the presence of infrastructure or labor pool.

The growth of the port or urban activity is not necessarily an advantage in the port – city relationship. The following two possible relationships explain how the growth of either the port or city could as well lead to a separation in the port – city relationship. The third possible relationship, the growth of the port can drive off urban activities, based on externalities created by port activity. Externalities, such as pollution and congestion, worsen the urban living and working environment and may lead to the relocation of urban activity (Merk, 2013). Another factor is the growth of port activity, created by the growth of imports. This will eventually lead to the displacement of local production and local activity (Hall and Jacobs, 2012).

The last possible relationship between port and city Hall and Jacobs (2012) describe is that the growth of urban activity can have a negative effect on the development of the adjacent port activity. The growth of the urban environment and accompanied by urban activity can eventually drive off port activity to downstream or Greenfield locations. Predominantly land competition issues can force the port to move away from their formerly urban core port sites. Hall and Jacobs (2012) however, mention port actors seeking new urban locations and the displacement is mostly concerning other activities such as warehousing and production and other supportive facilities.

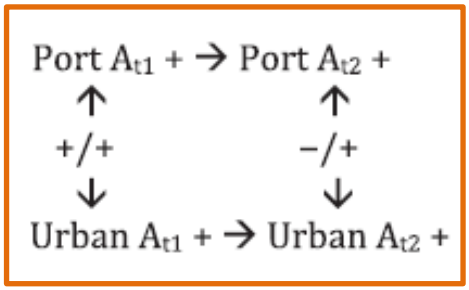


Figure 1: Basic Model Port – City Relationship (Hall and Jacobs, 2012)

The model describes the idea that both port and city will develop separately and in relation with one another. In the initial setting (t1), the port – city relationship will always be positive, as we have seen in the previous section. Ports initiated the growth of many cities and the prosperity of the city was closely tied to the development of the port (Merk, 2013; Hoyle, 1989). Over time the port – city relationship will experience different developments, effected by the four possible relationships between port and city. The model presented by Hall and Jacobs (2012), however, does not give a good indication how the port – city relationship evolves over time, nor does it give a plausible explanation why we see in practice that most ports retain an urban character. The four possible relationships between port and city are too basic in their nature to explain the close development of the entities.

2. CHANGING PERSPECTIVE: TECHNOLOGICAL DEVELOPMENTS AND GLOBALIZATION

In the previous chapter we have seen the mutual and close development of ports and cities over time. The relationship between ports and cities was self-reinforcing, where port growth led to increased urban activity and vice versa. Until the Second World War, all major ports were also important cities and most cities had a significant port function (Norcliffe, 1981). The maritime shipping industry, however, have undergone some profound changes the last couple of decades. This has resulted in significant changes in the port – city relationship. Following the logics of economic globalization, ports changed due to developments like industrialization, containerization, the emergence of global supply chain systems and principles of mega-carriers, transnational terminal operators and extended hinterlands (e.g. Robinson, 2002; Levinson, 2006; Hall and Jacobs, 2012). The port city relationship was initially disrupted by developments of industrialization and later by containerization (Hall and Jacobs, 2012). Especially the introduction of the container revolutionized the shipping industry, and can be seen as one of the most important technological developments in the maritime shipping industry (Levinson, 2006; Notteboom, 2007). The development of the container can be seen as an important technological change, which also had a major influence on the organizational structure in the shipping industry and enhanced the globalization process (Cullinane and Khanna, 2000). Ports today are seen as strategic nodes in international trade and shipping networks, disentangled from their original hosting city. The cities' dependence on ports for economic growth has decreased significantly and ports have become of less importance in local economies and labor markets, especially due to the automation of port operations (Hall and Jacobs, 2012). The 1990s were characterized by an increase in the pace of changes in the maritime port and shipping industry, with the internationalization of the management of operations (Olivier and Slack, 2006). In an era of globalization, international companies were gradually taking control over local port functions and firms. The new companies drove out the locally embedded companies, thereby displacing many local business ties for international ones. The port and city were institutionally disconnected as port authorities were privatized in many countries and limited governmental control over port activity (Hall and Jacobs, 2012). The technological developments, globalization and the internationalization of port operations have had a large effect on the port – city relationship. Some scholars are claiming that the interdependence between port and city has been obliterated. The new footloose character of ports allows it to function almost anywhere, even on Greenfield locations, and is no longer bound to the urban environment (Notteboom, 2007; Ducruet and Lee, 2006).

In this section we will look at the changes that occurred in the maritime shipping industry, that have had a major impact on the port – city relationship. The changes will be grouped into two categories, that of technological changes and globalization forces. However, the two groups overlap to certain extents and have both led to the major changes in the maritime shipping industry and the port – city relationship. I will first look at the technological developments, including the industrialization and containerization process. This will be followed by the developments and impacts of globalization and the internationalization of port operations and the shipping companies. This section will focus on the factors that led to the assumed separation in the port – city relationship.

2.1 TECHNOLOGICAL DEVELOPMENTS

The port – city relationship was initially disrupted by developments of industrialization and later by the adaptation and introduction of the container (Hall and Jacobs, 2012). Historically, port operations took place at the waterfronts at the heart of the urban environment. The industrial revolution in the late eighteenth century brought enormous changes to the maritime shipping industry. Prior to the major technological changes, no forms of motorized transportation existed. Land transportation was a slow, costly and labor intensive business, only capable of transporting low quantities. As we have seen in the previous section, in earlier times waterways were the most efficient way of transporting goods over larger distances. Thereby most cities historically developed at waterways or in coastal regions. Trade was however mainly local in scope, and city size remained fairly constant over time (Rodrigue, Comtois and Slack, 2006; Norcliffe, 1981). Obvious changes took place in all of these activities, driven by industrialization and mechanization processes. Sailing ships were replaced by motorized vessels, leading to major changes in ship sizes, tonnage shipped, port activities and port layouts. To give an example, the largest ship in 1871 could ship 3,800 tons, the largest ship in 1914 was able to ship an amount of 47,000 tons and ships today are able to ship over 500.000 tons (Rodrigue et al., 2006, p. 21; Rodrigue, Comtois and Slack, 2013d). This enormous growth in the size of ships led to the need of large investments in port infrastructure to be able to accommodate these large ships and cargo carried. Ports further transformed into large industrial complexes, by integrating production facilities processing all kinds of raw materials (Rodrigue et al., 2006). The introduction of the container further accelerated the growth of ships and volumes traded internationally. The container also needed whole new facilities and techniques to accommodate. These developments thereby had a substantial influence on the developments of port cities globally.

2.1.1 Industrialization, Fordism and Post-Fordism

The market environment in which seaports operate have changed significantly since the early 1970s. A driving force in this process of change is the shift from Fordism to Post-Fordism (Notteboom and Winkelmans, 2001). The Fordist production system arose in the 1930s, based on the principles of the assembly line mass production system pioneered by Henry Ford (De Langen, Nijdam and Van der Lugt, 2012; Norcliffe et al., 1996). At the heart of the Fordist system is the standardization of production, thereby achieving large economies of scale and creating a market for mass consumption (Notteboom and Winkelmans, 2001). By the 1970s the Fordist system entered a period of recurring crisis and appeared to be losing ground (Norcliffe et al., 1996). Fordism faced structural limitations, as increases in productivity reached the limits of economies of scale and growing individualism began to reflect in the consumers' demand (Notteboom and Winkelmans, 2001). Higher welfare led to a change in consumer behavior and preferences, where consumers started to demand differentiated products (De Langen et al., 2012). Another important change was the rise of international manufacturers, taking a substantial share in global trade. As international agreements reduced tariff barriers and opened up world markets to international trade (King, 1997). Goods produced in East-Asia started to push western manufacturers out of their traditional export markets, even penetrating their home markets grasping a substantial share (Norcliffe et al., 1996). The globalization process, accompanying the post-Fordist principles, will be discussed in section 2.2.

The shifts in production and consumption patterns initiated the Post-Fordism era. Where the Fordist production system focuses on scale economies, in contrast the post-Fordist system is organized around economies of scope (De Langen et al., 2012). In order to fulfil the needs of the economies of scope, the Post-Fordist are organized more flexible and making use of cooperative economic networks. The Post-Fordist system is accompanied by social changes, where consumers demand greater product variety, availability, quality and reliability (Notteboom and Winkelmans, 2001). The shift from Fordism to Post-Fordism occurred round major structural changes in time, space, function and organizational forms of production. The post-Fordist system is arranged around the just-in-time practice, instead of mass production, enabling to adapt to consumer preferences and allowing more flexibility. Traditionally, goods were produced in western countries, due to global segmentation and regionalization of production, in the Post-Fordist system production erupted in many low-wage countries. Goods in the Post-Fordist system are produced demand-driven, by the 'invisible hand', contrary to the Fordist system. The Post-Fordist era thereby underwent organizational changes of lean management, intensified networks and alliances, smaller corporations and vertical disintegration of production, to cope with the demand for differentiated goods (Olivier and Slack, 2006; De Langen et al., 2012).

The shift towards Fordism, followed by the Post-Fordism system, both had great influences in multiple ways on ports and the relationship with their traditional hosting cities. The shift towards Fordism had especially locational consequences, as the focus on economies of scale changed the way Fordist industries organized their activities. In order to realize the greatest scale economies, the Fordist manufacturing industries located at the places with the lowest costs of primary factors of production (De langen et al., 2012). Many port activities, such as pilotage, stevedoring and warehousing, are mandatory in every port as they are part of the daily operations. However, ship-related industries are of special interest as they display locational flexibility. Shipbuilding and repairing and other related industries were commonly located within the port area, though they are not mandatory for the daily port operations. With the rise of Fordism they started to move to locations with abundant low-wage labor; in their strive for cost minimization (Norcliffe, 1981). This led to serious reforms in the port – city relationship, resulting in decreasing port related functions being located within the port or surrounding city (Lee et al., 2008). With the withdrawal of the labor intensive activities of shipbuilding and repairing, the city labor pool became less important for the port sector. The rise of the Fordist system not only influenced the port related activities, but also the port operations itself became distinctly Fordist in nature. In the Fordist era port operations tended to incorporate into integral systems (Norcliffe et al., 1996). Container terminal operations are Fordist in nature, as they handle standardized containers making use of highly mechanized operational systems. The focus of the Terminal Operating Companies is to realize large scale economies and cost reductions. The port as a whole is largely arranged following the principles of Fordism (De Langen et al., 2012). The Fordist port operations can be characterized by five principles: mechanization for higher efficiency; reducing the role of labor; focusing on maximization of throughput; development of land as a competitive asset and local orientation (De Langen et al., 2012). The Fordist ports, with the industrialization of the port, led to an enormous growth in the size of the port area. Due to the internationalization of production, global trade increased immense in amplitude. Leading to a large growth in throughput handled in ports and expanding port operations. The emerging port size led to the move downstream, at first without discarding the old city ports. This resulted in a vast port-industrial area stretching from the old city to the outskirts of the urban area (Norcliffe et al., 1996).

The Fordist principles were not sufficient in the Post-Fordist era. Especially the lack of flexibility of the Fordist approach was seen as a serious drawback of the system. Post-Fordistic industries base their location decision on other factors; they give more weight to factors that are important for innovation and quality. The presence of competitors, suppliers, consumers, training centers and other facilities are important factors that give an advantage in the Post-Fordistic era (De Langen et al., 2012). In the Post-Fordian era, new patterns of global production arose. The change included an

expanded international division of (human) capital and the rise of global corporations (Norcliffe et al., 1996). Production companies started to adopt flexible multi-firm organization structures on a global scale, as the capabilities of their own resources are often exceeded (Notteboom and Winkelmans, 2001; King, 1997). These new global corporations gave rise to the upcoming of the globalization process, which will be further discussed in section 2.2. Due to shorter life-cycles and the needed short time to markets, the frequency and number of products shipped increased. Though, the batch sizes of the shipments became smaller (Notteboom and Winkelmans, 2001). The impact of the larger amounts of throughput and the increase in ship size, have affected the location of the port operations. The increasing need for depth and large open space forced the port operations to move downstream, withdrawing from the urban environment. The move out of the urban environment was enhanced by growing concerns on environmental issues, especially from governments and independent associations seeking to preserve a high standard of living for the city's residents (Lee et al., 2008). Where the Fordist industrialization and scale economies led to the move downstream, adapting to the post-Fordist characteristics of containerization and flexible markets forced ports to let go of their traditionally urban roots (Olivier and Slack, 2006). Thereby, they are selling the abandoned port sites on the central waterfronts, in order to raise capital for the needed downstream infrastructure (Norcliffe et al., 1996). Other than the revolutionary upcoming of Fordism, the Post-Fordist principles are mainly complementing the Fordist principles in the port industries. Opposed to the Fordist approach, the Post-Fordist approach of economies of scope, flexibility and networking created the need for more interaction between firms and to certain extent revert the contact with the city and its service providers. What we see in port operations today is the use of both practices from the Fordist as well as the Post-Fordist system (De Langen et al., 2012). Table 1 gives an overview of the ideal combination of characteristics of the Fordist and Post-Fordist in port operations. The Fordist and Post-Fordist principles are complementary, as the Fordist scale economies are a necessary condition to give rise to the Post-Fordist scope economies. As well as the Fordist port profits from the efficiency and growth of the Post-Fordist system (De Langen et al., 2012).

Table 1: Ideal Combination Fordist and Post-Fordist Port Characteristics (De Langen et al., 2012)

Aspect	Fordist Port	Post-Fordist Port
Goal	High transport efficiency	Flexible and dedicated services
Function	Node for cargo flows	Node for cargo, capital, information, knowledge and networks
Company structure	Large capital-intensive firms	Networks and clusters
Culture and orientation	Port as national and regional engine	Port as international arena
Investments	Government as investor	Flexible market driven investments

2.1.2 Containerization

The development of the container can be seen as the most revolutionary technological development in the maritime shipping industry, with an impact that affected the whole global transportation system. Before the introduction of the container, transporting goods was extremely costly. Where we today consume goods that are produced from various countries across the globe, prior to the container, it did not even pay to ship goods halfway across Europe or the United states (Levinson, 2006). The awareness started to rise in the 1960s that relying on the vessels' equipment and manual cargo handling methods was constraining the growth of world trade. This encouraged the international adaptation and standardization of containerization, to improve efficiency and productivity in the maritime shipping industry (Martin and Thomas, 2001). The introduction of the container formed the basis of a highly automated transportation system for moving goods on a global scale. The container led to an enormous reduction in the costs and complications in the transportation of goods, thereby the container has changed the shape of the world economy (Levinson, 2006).

The container was introduced by Malcolm McLean, an American entrepreneur owning a trucking company. The container was thereby originally applied to improve land transportation. However, it became soon clear that the container had great potential, especially with the relative ease of changing between different modes of transport, mainly between maritime, rail and road transportation (Levinson, 2006). One of the reasons of the swift diffusion of the standard container was the fact that McLean did not applied for a patent on his container. Thereby all actors in the transport sector had access to the standard (Rodrigue et al., 2006). The first container ship set sail in 1956 between Ney York and Houston and started the revolution of the container. In 1960 the port authority of New York and New Jersey built the first specialized container facility, believing in the true potential of containerization. In 1966 the first containership crossed the Atlantic, shipping containers from New York to Rotterdam. By the 1980s, the container was becoming the dominant way of shipping goods in international trade (Rodrigue et al., 2006). Of the cargo that can be shipped in a container, up to 95 percent are shipped in containers today (Cullinane and Khanna, 2000). The success of containerization can be explained by several factors. First of all, the standardization of the container (ISO standard), needed to become introduced and accepted in international trade. Container throughput is measured in TEUs (Twenty foot Equivalent Units), reflecting the standard dimensions of a container. The standard size of a container is 20 feet long, 8 feet high and 8 feet wide. Though, there exist some slight variations in the size and specifications of a container, of which the 40 foot container is the most prevailing and accounts as 2 TEU. The standardization allows the container to be handled globally with specialized equipment, and can be moved onto other forms of

transportation at relative ease. Second, the flexibility of usage is an important factor in explaining the success of the container. The container can be used to ship a wide variety of goods, ranging from manufactured goods, raw materials, cars and refrigerated products. As mentioned above there are all kinds of specialized containers, for example adapted refrigerated containers to transport perishable food products (also known as reefers) or adapted containers to enable the transportation of liquids. Third, the introduction of the container led to major improvements in the speed of transshipment. The container allowed for massive improvements in port turnaround times, reducing them from 3 weeks to about 24 hours (Rodrigue et al., 2006). The handling of a container also requires 25 times less labor than its equivalent in bulk freight (Levinson, 2006). This is mainly realized by the standardization of the container and the specialized ships and port facilities. Due to the operational efficiency improvements by containerization, the costs of maritime shipping have declined significantly (Rodrigue et al., 2006). Where the reduction of costs is one of the main improvements that containerization brought to the maritime shipping industry, the container enabled to realize major economies of scale. By building larger vessels, specially designed to ship containers, the cost of transporting a container declined drastically (Martin and Thomas, 2001). For example, before the introduction of the container maritime transport costs could account for up to 10 percent of the retail price of any manufactured goods; whereas this percentage have dropped to not higher than 1.5 percent today (Rodrigue et al., 2006 p. 116). The main success factors behind the significant cost reductions are the improvements in speed and flexibility provided by containerization and scale economies due to the use of larger ships (Rodrigue et al., 2006). The evolution of container vessels is shown in box 1, giving an indication of the serious economies of scale that have been realized in the maritime shipping industry as a result of the introduction of the container.

Containerization created the need for innovative practices for the handling of the container cargo, including new ship design, new loading and unloading methods, new specialized handling facilities, employment and working practices, information and communication systems, customs procedures, and predominantly the modification and integration of the transportation system for moving commodities from their origin to the final destination (Hayuth, 1981; Norcliffe et al., 1996; Martin and Thomas, 2001). The introduction of the container has had a much bigger impact than solely the technical development in the cargo handling. The container also has left a major impact on the organizational and operational structure in transportation systems (Hayuth, 1981). According to Hayuth (1987) the transformation occurred by containerization can be divided into two distinct phases. The first phase is predominantly based on the technological developments the container brought to the maritime shipping industry, e.g. the substantial increase in ship size and terminal facilities. The second phase is driven by innovative changes in the design of organizational practices

(Cullinane and Khanna, 2000). The organizational changes in the maritime shipping industry will be discussed in the next section 2.2.

Box 1. Containership Evolution

The development and adaptation of the container revolutionized the maritime shipping industry. Drawn by ever greater scale economies, vessel size and capacity have experienced major growth (Figure 2). The first container ships were converted bulk and tanker vessels that had a capacity of 500 to 800 TEU, where the largest container vessels today can carry up to 18.000 TEU. Pushed by economies of scale the size and capacity kept increasing, as an increase in vessel capacity lowers the costs per TEU. The first restriction faced in the scale increases was limited size of the Panama Canal (Rodrigue et al., 2013a). When the maximum size able to cross the Panama Canal was reached, the maximum vessel size remained stable for almost 10 years. Until in 1988 the first post-panamax containership was introduced, leading to a return in designing ever bigger vessels (Rodrigue et al., 2006). Where scale increases in containerships will most likely be pushed to the limits of technical and economic feasibility (Notteboom and Rodrigue, 2008). There are three bottlenecks in maritime shipping routes restricting the size of containerships: the Panama Canal, the Suez Canal and the Strait of Malacca. Where today the limit of the Panama is surpassed, the maximum of the Suez Canal is reached and there are development plans of vessels that reach the maximum of the Malacca Strait with a capacity reaching up to 30.000 TEU (Rodrigue, 2013a). The size of the vessels affected the port industry heavily, it is either develop and adapt the port to be able to handle future ultra-large vessels or lose its importance logistical chains (Wijnolst and Wergeland, 2009).

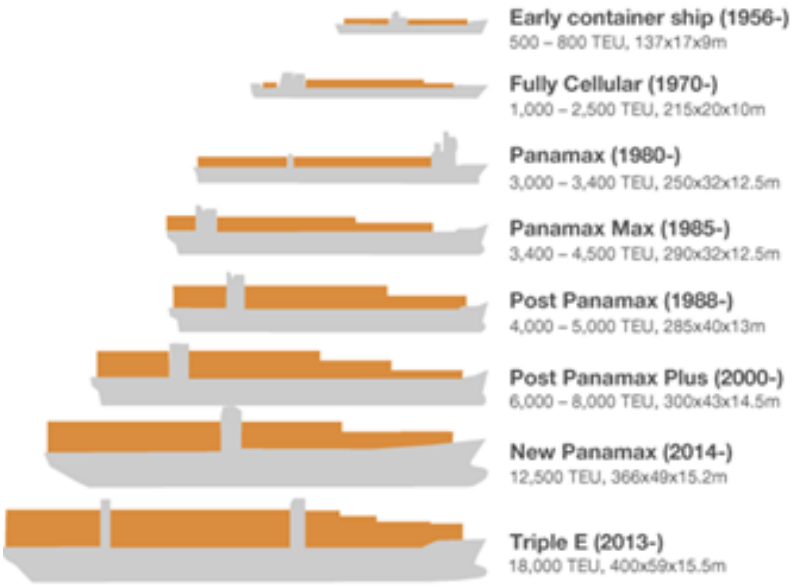


Figure 2: Containership Evolution (adapted from Ashar and Rodrigue, 2012)

2.1.3 Technological Developments and the Port – City Relationship

Until the 1960s, the port was at the heart of most of the important centers of commerce globally, employing millions of workers. Port activity clustered around the port quays and the areas surrounding the port cluster were used for the housing of workers (Levinson, 2006). The adaptation of the container in the maritime shipping industry has led to some profound changes, influencing the port – city relationship. First of all, the introduction of the container led to an enormous growth in the size of vessels and freight volumes handled in ports. In search of available land to accommodate new container terminals and deeper drafts to encompass the large vessels, new port areas were developed away from the conventional urban port sites to peripheral locations (Lee et al., 2008; Rodrigue et al., 2013b). Port expansions to facilitate new port functions might have been very difficult to achieve due to numerous reasons. For example, there may be no land available for an expansion or the new port facility lacks societal support. These factors have contributed to the creation of satellite ports or terminals (De Langen et al., 2012). The satellite ports tend to be located near the original seaport, but at the periphery of the urban environment (Rodrigue and Notteboom, 2013). The established satellite ports benefit from the proximity of the seaport, but are able to overcome the mentioned difficulties due to their sufficiently far location from the city (De Langen et al., 2012). Intermodal transport and improved hinterland accessibility have eased the possibilities of inland ports. It further led to a majority of port related and manufacturing activities to have moved away from the port locations. Due to intermodal transport possibilities and satellite ports, the city can profit less from the throughput passing through the seaport. With the development of the container, port operations have become less labor intensive and thereby require less labor from the adjacent urban environment (Rodrigue et al., 2013b). The impact of the introduction and adaptation of the container thus has impacted the port – city relationship in several ways, both positive as well as in a negative manner. The container has led to a major growth in throughput and accompanied port activity. Though, the container also led to a great decline in requisite port employment, due to greater complexity the need for skilled workers however did increase. With the ease of intermodal transport the importance of inland shipping and rail became strategic factors in port competition. The container and the ease of intermodal transportation have contributed to a reduction of congestion in the urban environment (De Langen et al., 2012).

2.2 GLOBALIZATION AND INTERNATIONALIZATION

> *"…maritime business itself is probably the most globalized industry… A Greek-owned vessel, built in Korea, may be chartered to a Danish operator, who employs Philippine seafarers via a Cypriot crewing agent, is registered in Panama, insured in the UK, and transports German made cargo in the name of a Swiss freight forwarder from a Dutch port to Argentina, through terminals that are concessioned to port operators from Hong Kong and Dubai."* - Hoffmann and Kumar (2010, p. 36)

The quote of Hoffmann and Kumar (2010) gives an indication how globalized the maritime shipping industry itself has become. However, the effects of globalization have had a much larger effect than just the internationalization in the maritime shipping industry, having affected the port – city relationship in some rigorous manners. As we have seen in the previous section, technological developments significantly changed the maritime shipping industry and significantly affected the port – city relationship. Especially the standardization of port practices and introduction of the container eased global trade. . Driven by the technological developments of standardization of transport systems and scale economies, transportation costs declined substantial and international trade volumes experienced major growth (De Langen et al., 2012). The rise of global production firms, stimulated by the steep decline in transportation and trade costs together with improved communication technologies, enhanced the globalization process. Where the production firms aim at taking advantage of differences in factor endowments, factor prices and differences in technologies across various geographical locations (Fujita and Thisse, 2006). Globalization in its simplest form could be described as the increasing geographical scale in which economic, social and political interactions take place. The rise of global corporations can be classified as one of the most characteristic aspects of the globalization process (Janelle and Beuthe, 1997). There are several factors that have stimulated the globalization process and the emergence of the global corporations, by creating a favorable international economic climate (King, 1997). The factors include gradual deregulation of government control on private corporations, the privatization of former public services and more efficient operating international capital markets (Notteboom and Winkelmans, 2001; Janelle and Beuthe, 1997; King, 1997). The process was further enhanced by the removal of trade barriers and the liberalization of markets. Where trade liberalization accelerated during the 1980s, fueled by liberalizing initiatives of organizations like NAFTA, ASEAN, EU, GATT or WTO (De Langen et al., 2012; Notteboom and Winkelmans, 2001). The coherent rise of multinational corporations has also had a big impact on the port environment. Where large international corporations invested in or have taken control over port operations and port companies, effecting the development of many ports worldwide. Loosening up the relationship between the port and the

local environment, as locally embedded firms are being displaced by international corporations (De Langen et al., 2012; Hall and Jacobs, 2012). The globalization process induced all kinds of new practices and attitudes in business environments, leading to all new organizational structures, relationships, environments and opportunities (King 1997). Together with the technological developments, the globalization process has had a major impact on the maritime shipping industry and the port – city relationship. The globalization process led to vast port growth and had a big influence on urban structures, by revolutionary changes in transportation and communication. Globalization not only led to the growth of ports and related industrial activities, it also allowed urban economies to thrive (Lee and Ducruet, 2006). In this section we will explore the effects of globalization and internationalization strategies on the changing port – city relationship. By looking at the effects of the internationalization of the shipping industry, the integration of supply chains, the rise of transnational terminal operators and intensified international port competition.

2.2.1 Transnational Terminal Operators

Ports globally have experienced important changes in the operation and management of container terminals since the 1990s, with the emergence of transnational container terminal operating corporations as an essential characteristic (Olivier and Slack, 2006). These international corporations facilitate the operation for a selection of container terminals in multiple ports, spread over different regions and countries (Olivier, 2005). Traditionally, the management of container terminals was either provided directly by the port authority or leased to third parties. The management always tend to have a local character, being obviously inevitable concerning the direct management (Slack and Frémont, 2005). However, global port operating corporations are increasingly taking control over the management and operations of container terminals. In the late 1980s the first terminal operators shifted their focus from a national to an international level, and the port industry experienced the first wave of international private investments in container terminals (Midoro, Musso and Parola, 2005). Where the 1990s were characterized by comprehensive institutional reformations of privatization and trade liberalization, providing opportunities for the transnational terminal operators to enter new markets accelerated the internationalization process (Olivier, Parola, Slack and Wang, 2007). The privatization was mainly driven in order to improve port efficiency and performance and to reduce public expenses in this extreme costly industry (Cullinane and Song, 2002).

The international terminal operators can be classified into four different categories of actors involved in the internationalization of operations: global terminal operators, port authorities, ocean carriers and other private investors (Olivier and Slack, 2006; Notteboom and Rodrigue, 2012). Global terminal operators have the largest share in international port container terminal operations today (Olivier and Slack, 2006). These global operators are former local terminal operators that have extended their business by geographical diversification (Song, 2003). Traditionally operating on a regional scale, or even from a single port, several port terminal operators have extended their scope to an international level. Thereby, replicating their expertise in terminal operations to new markets and upsurge their revenues (Notteboom and Rodrigue, 2012). Similar to the expansion of the former local terminal operators is the expansion of port authorities in global terminal operations. Prior to the privatization of terminal operations, most of the container terminals in ports were managed by port authorities. Some of these port authorities, supported by their expertise gained in the home market, expanded their port operations internationally. Most of these port authorities were never fully privatized, however they do function as independent private corporations (Olivier and Slack, 2006). The internationalization of container terminals further involved the entrance of leading ocean carries in terminal operations, especially in the transpacific routes (Olivier et al., 2007). The ocean carriers broadened their scope to terminal operations in order for them to secure stevedoring costs and schedule reliability (Midoro et al., 2005). Of the total costs of container transportation, halve is generated in terminal operations. Making it attractive to the ocean carriers to have control over the terminal operations (Slack and Frémont, 2005). Via mergers, joint ventures and alliances the ocean carries extended their geographic operations and allowed for better control over the supply chain management (Haralambides, Cariou and Benacchio, 2002). The vertical integration of the ocean carriers into terminal operations follows their commitment to offer total logistics services to their customers, following a door-to-door strategy. The ocean carriers often have created subsidiaries that manage the terminal operations serving the carrier's shipping networks (Olivier et al., 2007). Maritime shipping is the core business of the ocean carries and the investments are mainly to support and secure their main operations. Last, there are other private investors, predominantly owned for profit generation. The private investors include various actors with different financial interests, being for example investment banks or retirement funds. Most of the private investors manage the port terminal operations in an indirect manner, leaving the management in the hands of the original operator. The other strategy is to have a subsidiary company to control over the terminal operations directly (Notteboom and Rodrigue, 2012).

2.2.2 Supply Chain Integration

In an era of globalization, the maritime shipping industry underwent some profound changes in corporate structures and the organization of businesses. With the emergence of large multinational corporations that have affected the whole global industry. The globalization process is accompanied by the rise international terminal operators and mega ocean carries – involved in the formation of dominant shipping alliances. The expansion strategy of many actors in the shipping industry was encompassed by vertical and horizontal integration of corporations. The entrance of global terminal operators and ocean carriers in local markets involved a process of heavy horizontal and vertical integration. The internationalization of the shipping industry involved the formation of alliances, predominantly between leading ocean carriers. These developments have changed the maritime shipping industry and the port environment significantly, thereby significantly affecting the port city relationship.

Horizontal Integration

In a globalizing world, the stevedoring industry experienced substantial expansion in activity. This was accompanied by the rise of global terminal operators, nowadays controlling over large multinational portfolios of terminal operations (Notteboom and Rodrigue, 2012). The rise of global corporations in port operations is to a large extent effectuated via mergers and acquisitions, involving horizontal integration of former local terminal operators and port authorities (Notteboom, 2004). Where conventional port actors, of which port terminal operations is their core business, expanded geographically into new markets (Notteboom and Rodrigue, 2012). Port reforms globally created a unique opportunity for many local terminal operators to expand their operations on an international scale (Olivier and Slack, 2006). The rise of the international terminal operators is to a large extent facilitated by the privatization of ports activities (Notteboom, 2004). Where former local terminal operators started to take over port management and operations (Song, 2003).The expansion into new geographical locations of terminal operators involved the creation of new terminal facilities, however in most cases the expansion rather went through mergers and acquisitions of existing local facilities (Notteboom and Rodrigue, 2012). The port operators further decided for the expansion of their activities and horizontal integration as a reaction to the growing consolidation trend in the shipping line industry. Confronted by larger and less shipping lines, who are exploiting their power to extract better service at a lower cost (Notteboom and Rodrigue, 2012; Notteboom, 2004).

As said, the maritime shipping industry is further characterized by horizontal integration of shipping lines, resulting in the rise of mega ocean carries, driven by the globalization process. The horizontal integration of shipping lines is based on many different motives; however one of the main reasons

the shipping line industry experienced huge horizontal integration is the ability to realize major scale economies. Where owning more ships creates the ability to extend the shipping lines' network, serving more ports and increases the service level offered. Thereby, a larger shipping line can realize substantial cost advantages and increase its market power (De Langen et al., 2012). The main economies of scale are realized by the shipping line, by employing of larger vessels and the use of efficient terminals (Heaver, 2001). The shipping lines further engaged into horizontal integration to obtain instant access to new markets, networks and technologies. Horizontal integration further offers shipping lines a slight advantage, as opposed to setting up a new venture, in expanding their network. Where entry barriers are often relatively high, the existence of cultural differences and the construction of complete new facilities involves extensive investment costs. Acquisitions become a good alternative if the shipping line considers the risks and costs of a new venture as too precarious (Notteboom, 2004). The shipping line industry is therefore characterized by a relative high concentration, especially in the container market (De Langen et al., 2012).

Another important form of horizontal integration by shipping companies in extending their business is the formation of alliances and operating agreements with other shipping lines. The formation of strategic alliances allows shipping lines to improve their schedules, add geographical extensions to their network and to achieve greater economies of scale (Notteboom, 2007; Heaver, 2001; Ryoo and Thanopoulou, 1999). By participating in an alliance the shipping lines can agree to cooperate both at sea as well as ashore, by sharing vessel capacity and terminal slots (Notteboom 2007). Enabling shipping lines to extend their network at a relatively low costs, with minimum costs of investing in new vessels (Heaver, 2001).The members of the alliances can further cooperate in the negotiation process with their suppliers, joining forces to exert even more pressure to gain favorable service charges and conditions (Song, 2003).

Vertical Integration

In an era of globalization the maritime shipping industry experienced many corporations involved in vertical integration, including both port operators as well as shipping lines. Especially among the shipping lines there is a clear tendency to gain greater control over the different parts of the transportation supply chain (Heaver, Meersman, Moglia and Van de Voorde, 2000). Shipping lines are exploring the potential benefits and costs of integrating vertically, in order to meet the changing interests of shippers (Heaver, 2001). A shift can be witnessed in the core business of shipping lines, as they gradually are functioning more and more as integrated logistic suppliers. In order to meet the demand of shippers, shipping lines are increasingly integrating along the supply chain. By including sea, port and hinterland operations into their business, to be able to offer higher customer value (Notteboom, 2007). Containerization and standardization have paved the way for the inclusive door-

to-door strategies of the shipping companies, allowing for intermodality (Frémont, 2009). The shipping lines are changing their strategies from providing basic port-to-port services into inclusive door-to-door services. With a port-to-port strategy the logistics supply chain depends on many different firms. However, this strategy may lead to an inefficient logistic supply chain, where the involvement of many firms may lead to high costs and possible coordination problems. These problems led many shipping lines to provide inclusive door-to-door strategies, by integrating hinterland transportation and additional logistics services in to their business strategy (De Langen et al., 2012). Furthermore, the shipping companies entered into port operations, as we have seen in the previous section, in order to secure stevedoring costs and schedule reliability (Midoro et al., 2005). The vertical integration of the ocean carriers into port operations follows their commitment to offer total logistics services to their customers, following the door-to-door strategy (Olivier et al., 2007). Some shipping lines are thereby even bypassing freight forwarders, by building direct relationships with the shippers (Notteboom, 2004). Thereby, the shipping lines have become the sole partner of the shippers, offering 'one-stop shopping' to their clients (Notteboom and Winkelmans, 2001).

With the increasingly integrating of shipping companies, many steps in the logistics supply chain have been removed. The mergers and acquisitions have changed some of the shipping lines into mega-carriers, controlling over most links in the logistics chain (Notteboom, 2007). Robinson (2002) has depicted the change in the port value chain, see figure 3. Focusing on the logistics channel within the port environment and the impact of the mega-carriers have on the logistical organization and relationships within ports. Ranging from many individual operations, to fully functionally integrated systems controlled by the mega-carriers (Bichou and Gray, 2004).

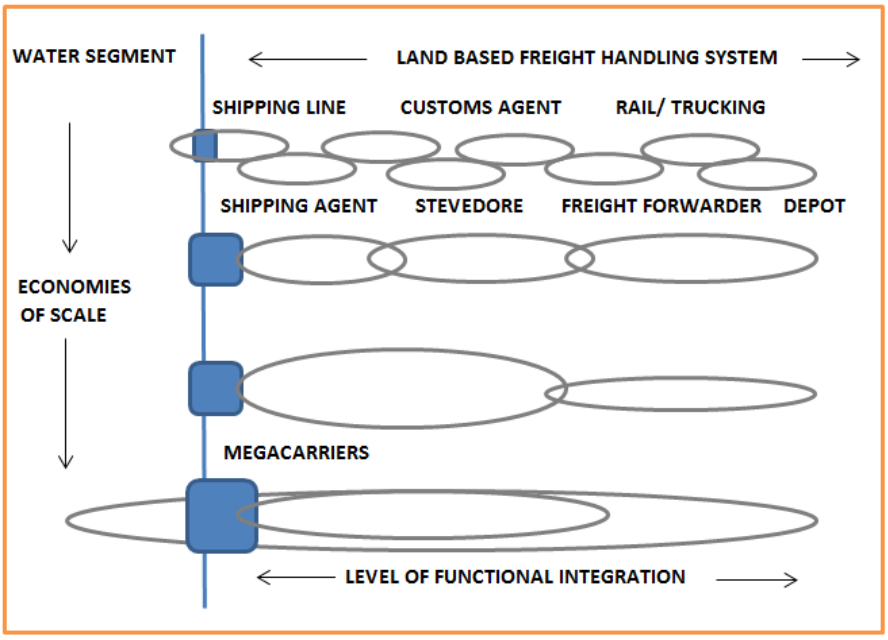


Figure 3: Functional Integration Port Sector (Robinson, 2002)

Until recently terminal operators were mainly focusing on extending their business geographically into new markets, exploiting opportunities offered in a globalizing world. They are predominantly looking for opportunities to increase the scale of their operations (Notteboom, 2007). Due to competitive forces the terminal operators are exploring new opportunities to extend their services. Most of the terminal operators already do offer some additional services, such as temporarily storage and eventual value-adding activities such as the assembly or re-packaging of goods (De Langen et al., 2012). However, the terminal operators are aware that the shipping lines and shippers are looking at the efficiency of the total logistics chain. In order to remain competitive the terminal operators have developed diverging strategies, striving for more control over larger parts of the total logistics chain (Notteboom, 2004). The terminal operators are getting increasingly involved in connecting the port terminal to the hinterland, creating linkages between the port and inland terminals or even directly to the shippers' end destination (Veenstra, Zuidwijk and Van Asperen, 2012). In order to create a higher service level for their customers, the port operators have integrated into road haulage and feeder services. The operators further created inland terminals, functioning as extended gates of the seaport (Notteboom, 2004). Thereby, the port operators are anticipating on the growing demand for sustainable multimodal transport services by shippers, and the growing dominance of shipping lines (Veenstra et al., 2012).

2.2.3 Port Competition

The port environment in this day and age can be defined as globalized, corporatized, privatized and highly competitive (Robinson, 2002). This has had major impacts on the operations, management, ownership and growth potential of each individual port (Jacobs, 2007). The maritime shipping industry is characterized by horizontal and vertical integration and the rise of large conglomerate organizations, in the ongoing process of a globalizing world. Testing the limits of vessel size, less port calls, shared utilization of capacity, cargo concentration and cargo handling efficiency, all in order to enjoy large economies of scale and cost efficiency (Notteboom, 2002). These developments had a significant effect on the functioning and positioning of ports, increasing port competition, and thereby effecting the development of port cities. Traditionally, ports only competed with neighboring ports of similar size over a shared hinterland. The globalized shipping industry, accompanied by new network structures of ocean carriers and increased vessel sizes, led to and expansion in the span of ports competing for throughput. Former non competing ports are now forced to engage in the intensified port competition (Notteboom, 2007). Some ports are unable to handle the ever growing vessel size and draft, or lost their position due to the concentration of cargo and less port calls. Ports

continuously face physical and organizational challenges in order to stay competitive and remain a dominant position within maritime shipping networks (Notteboom, 2002). Ports can no longer rely on the fact that they are natural gateways to rich hinterlands, and for that reason simply will attract cargo to the port (Notteboom and Winkelmans, 2001; Notteboom, 2007). Intensified port competition and scale economies, due to growing vessel size and utilization of capacity of the vessels together with the formation of alliances, will favor the largest and most efficient ports. Thereby, leaving other ports in decline and the need for these port cities to diversify their economic structure.

It is not the cities or ports who choose to handle cargo; the position of a port rather depends on decisions made by the shippers and movers of cargo. Ocean carries and shippers make use of the ports that offer them the best reliability and offer the lowest costs to their shipping networks (Hall and Jacobs, 2012). The vertical and horizontal integration of actors in the maritime shipping industry have resulted in a concentration of power. Ports face extensive port customers with strong bargaining power versus the port operators (Notteboom and Winkelmans, 2001). The formation of alliances led to the bundling of services and increased power into the hands of only a few actors, creating a dominant role for the highly integrated ocean carriers in particular. Thereby, they are exerting their power on ports to improve their productivity and the creation of new port facilities (Martin and Thomas, 2001). The competitive pressures further allowed the ocean carriers to levy the costs of the tremendous increase in vessel size to the port authorities, imposing dredging and port infrastructure adaptations. The footloose monopolistic ocean carriers have developed the ability to almost instantly alternate between ports, having considerable impact on the throughput and activity in a port (Merk, 2013). The loss or the acquirement of a port user can lead up to a 20 percent decline or increase in the port's throughput (Notteboom, 2007). Port authorities try to optimize the port environment to meet the new requirements, as far as their influence reaches, in order to provide the best possible environment for the port actors. The port authorities try to minimize the costs of the handling of goods and improve the maritime accessibility of the port. However, they are not able to fully effect another important factor in port competition, time, in the form of turnaround time (Heaver et al., 2000). In a landscape where the port authorities did their best to create the best environment, local port operators were put under high internationalization and standardization pressures. The need to install expensive information technology systems, invest in the ports infrastructure and the ability to handle more throughput on tight schedules was a real burden to many local terminal operators (Notteboom, 2002). Many of the local terminal operators were not able to compete successfully with the global operators' efficiency and capital available to invest (Midoro et al., 2005). The international terminal operators, however, were capable to put up to these pressures and made a steady entrance into most ports globally (Notteboom, 2002).

Nonetheless, ports solely focusing on the provision of port infrastructure and improving the performance of the port will not be able to attract the footloose actors to their port and to maintain a sustainable relationship (Nottboom and Winkelmans, 2001). The integration in the maritime shipping industry and the formation of alliances favor the ports that can contribute to the most cost efficient network structure of the global actors. Ports are chosen in order to minimize the total network costs of sea, port and inland costs. A port continuously faces the risk of losing important clients, as loyalty is absolutely no guarantee in the industry. Ports can lose their clients, not because of infrastructure or operational deficits, but because their clients have found more cost efficient network arrangements or engaged in new partnerships (Notteboom and Winkelmans, 2001).

Due to the globalized transport activities, port clients no longer only look at the functioning of ports, but rather look at the quality and reliability of an entire transportation chain (Magala and Sammons, 2008). This development is giving an advantage to the new large inclusive transportation corporations, and their door-to-door strategies. Due to the mergers and acquisitions combined with the formation of alliances, ocean carriers have become more and more monopolist actors in the maritime shipping industry (Lee et al., 2008). The ocean carriers and shippers enjoy power to extract the most value out of the port and its place-bound actors, such as terminal operators, labor and port authorities (Hall and Jacobs, 2010). The ocean carriers have the advantage of having vessels that are able to move freely, whereas ports are static and bound to its geographical location (Lee et al., 2008). According to Slack (1993), ports have become merely a “pawn in the game” of global actors. Being dependent on the interests and network strategies of the dominant ocean carriers, who tend to concentrate their services to only a few ports based on time and cost motives (Lee et al., 2008).

2.2.4 Globalization and the Port – City Relationship

The globalization process has significantly left its mark in the port – city relationship. First of all, globalization of production and trade have affected urban structures alongside the growth of ports, due to increased international trade and the advancements made in port operations and technology (Lee and Ducruet, 2006). The globalization process changed the balance of power between on the one hand port clients and on the other hand port operators and port authorities. Port operations are traditionally a public and local activity; however the entrance of global players (both terminal operators as well as ocean carriers) changed this perspective (Merk, 2013). As we have seen in the previous sections, global corporations started to heavily expand their operations into other ports worldwide. Their expansion strategies included the creation of new facilities, however most expansions were executed through mergers and acquisitions of existing port operators. The globalization process led to significant changes in port operations, management and ownership

(Jacobs, 2007). The rise of the international actors, that are taking control over local port operations and port actors, led to the displacement of local operators. Thereby displacing the strong local business connections of the former locally embedded operators, replacing them by international connections (Hall and Jacobs, 2012). The rise of the global terminal operators went in most cases at the cost of the former local and public terminal operators, and to be found in all large world ports. Where these global terminal operators tent to be less inclined to take local beneficial impacts in mind (Merk, 2013). The rise of the mega ocean carriers and global terminal operators also led to decreased participation of the actors within the local port environment (Martin and Thomas, 2001). The internationalization of management and operational control of the ports actors led to a decreased possibility of port authorities to control over the destiny of the port. Especially as the international actors took control over berths, leaving port authorities with minimal influence to control over the fate of the port (Slack and Frémont, 2005). The port authority and port actors will need to ensure that their port will be integrated in the business networks by improving their position by investing in efficient infrastructure and hinterland connectivity. Though the direct influence of port authorities is limited, they could operate as a catalyst between the different actors involved (Notteboom, 2007). The developments of globalization and integration have put high pressure on the account of port authorities to defend the interests of the port (Notteboom, De Langen and Jacobs, 2013). Where the ability to correctly respond to challenges is to a large extend dependent on the support of the local government and local community and the financial resources they are able to secure (Notteboom and Winkelmans, 2001). This supports reminding on the importance of a well-balanced relationship between a port and city. Though cooperation in the transportation chain has increased, the relationship between port operators and its clients have become increasingly uncertain. Increased bargaining power of port clients, strengthened by the formation of alliances, led to intensified port competition. By playing different ports of against each other, searching for the most cost effective port for the inclusion in their shipping networks (Notteboom, 2007). Port clients seized the prospect to be able to almost immediately switch between ports, with severe consequences for the performance and existence of a port (Merk, 2013). Thereby, form a threat to all the related port activities, of which many service activities being located in or near the city. The rise of the international port operators has raised questions in the local environment, fearing the fate of the port and economic rents will bypass the local environment. As in most ports the international corporations have established very strategic positions, where they have built substantial abilities that can heavily impact the future of the port (Notteboom, 2007). Where the port authorities have ceded the management and operational control into the hands of the international actors, thereby the control over the ports fate have shifted from the local to international actors (Slack and Frémont, 2005).

3. THE SPATIAL TRANSFORMATION OF PORT CITIES

In the previous section we have seen that the shipping industry have changed significantly the last century. These various developments have changed the relationship between port and city and thereby led to a spatial transformation. It is claimed that the port and city are separated in their development and have become separate identities, and ports are being able to function at Greenfield locations parted from urban environments (Pesquera and Ruiz, 1996; Lee et al., 2008). The developments in the shipping industry definitely changed the spatial planning of ports. It is claimed in the literature that thereby also the symbiosis between port and city has disappeared. It is impossible to deny the fact that many port activities moved downstream, away from the city. However, there are also many activities that remained within the urban perimeters. There are multiple studies that have translated the effects of the changes in the shipping industry to the spatial transformation of ports and cities. Although the different models all have a slightly different approach, the main finding of the studies can be summarized as a retreat from the urban environment. The studies on the spatial structure of ports and cities are focused on a broad range of grounds on which the port city relationship has changed in its organization and spatial structure. In this section we will look at the spatial transformations that have occurred at ports and cities and the accompanying spatial models that influenced the perception of the spatial relationship between ports and cities. The following sections describe the different models that have studied the spatial transformations of ports.

3.1 THE ANYPORT MODEL

As we have seen the shipping industry has experienced some profound changes in the last century, thereby changing the spatial characteristics of the ports. One of the first models portraying the effects of the changes in the shipping industry on the spatial structure of ports and cities is the fundamental work of Bird (1963) and his 'Anyport Model'. By studying the evolution of British ports, Bird (1963) created a model with five stages to demonstrate how ports facilities have changed over time (Rodrigue et al., 2006). The Anyport Model describes how simple city ports located adjacent to the city center have evolved into specialized and spatially defined entities downstream, spatially distanced from the city and the oldest port facilities (De Langen et al., 2012; Rodrigue et al., 2006). Resulting predominantly from land pressures at the upstream port city and increasing ship sizes (Lee et al., 2008). In the process of change in port infrastructure and facilities, three major steps can be identified. These three steps occurred following five stages of port development, represented in Figure 4.

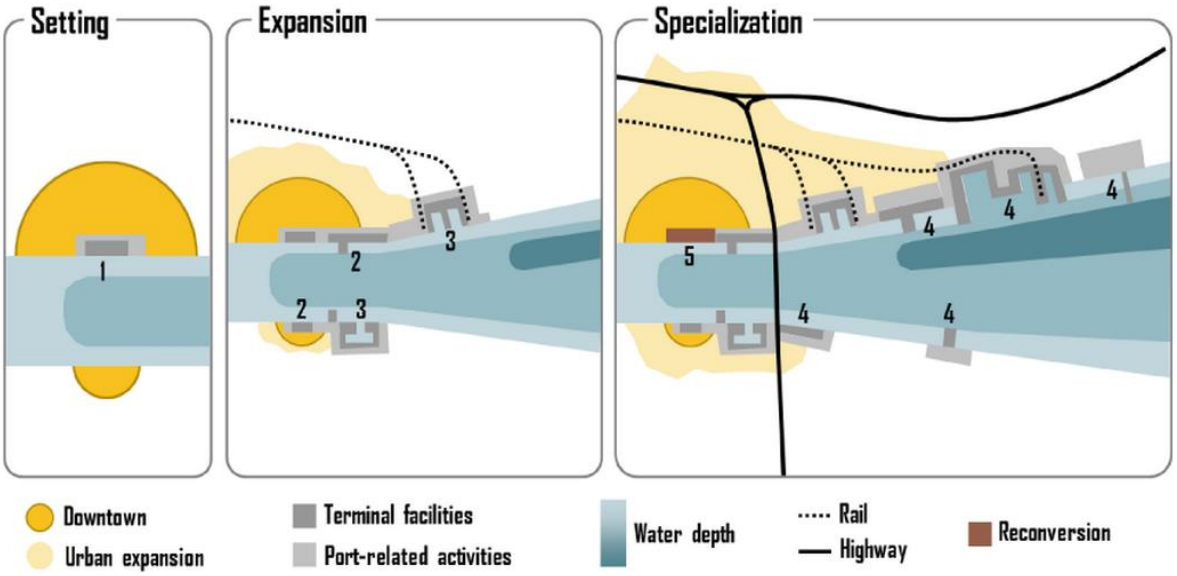


Figure 4: The Anyport Model (Bird, 1963 adapted by Rodrigue et al., 2006)

The first step in the Anyport Model, is the initial setting of a port based on geographical considerations. The location is the furthest a sailing ship could navigate on the river and adjacent to the city center. The main port-related activities were warehousing and wholesaling, located directly in between the port and city (stage 1). For centuries the port facilities and port-related activities remained very basic and simple (Rodrigue et al., 2006; Rodrigue et al., 2013c). The second major step in the spatial development of ports was forced by the industrial revolution. The port facilities started to expand their activities, mainly downstream, due to growing amounts of freight and passengers. Quays were expanded to fulfill the growing maritime traffic and larger ships (stage 2). As ship sizes started to increase, the shipbuilding industry started to need docks (stage 3). Railroad tracks were constructed for better access to a larger hinterland, leading to a further growth in maritime traffic. Port activities also started to include industrial activities. Most of these activities were planned downstream towards deeper draft areas (Rodrigue et al., 2006; Rodrigue, 2013c).

The last major step that changed the spatial structure of ports and the relationship between port and city is the phase of specialization. Due to growing ships, shipping bulk, and the invention of the container, led to the construction of specialized piers to handle the specific goods, as containers, ore, grain, petroleum and coal (stage 4). This required the port activities to expand their warehousing significantly. The increase in ship sizes required an even larger depth and dredging of the waterways. The port activities thereby moved further downstream. Accompanying the downstream movement of port activities is the retreat from the original sites at the city waterfront (stage 5). Whereby, the old facilities are converted to make use for other practices, as housing, waterfront parks and other commercial activities (Rodrigue et al., 2006; Rodrigue, 2013c).

3.2 THE PORT-CITY INTERFACE

Another important model in the spatial dimension of port cities is the port-city interface (Hayuth, 1982; Hoyle, 1989). The port-city interface shows similarity to the Anyport Model, with the focus on the port moving downstream and thereby the retreat from the urban environment by ports. The port-city interface tries to explain growth patterns in western port cities, due to spatial and functional conflicts between ports and cities (Lee et al., 2008). As we have seen in the previous section, ports formed the basis for many cities to flourish and develop into large agglomerations of people and economic activity in earlier times. However, the relationship between ports and cities has undergone some profound changes the last couple of decades. Where the port and city in earlier times developed together in close spatial proximity, the urban character is now considered to be a drawback in both the development of the port as well as the progress of a city. The port-city interface and waterfront renewal studies (e.g. Hayuth, 1982; Hoyle, 1989; Norcliffe et al., 1996) describe the changing relationships between port and city. Although these studies are in particularly formed round the problems occurring at the city waterfronts with the port activities moving downstream away from the city, leaving large space available in the city with no occupancy. The theories also give a good indication of the problems that ascended with the port in the urban landscape, over time. The port-city interface describes how the port seemed to have lost its urban character. The port-city interface and waterfront renewal studies where one of the first studies that were really claiming the retreat of ports from the urban environment.

One of the first to mention the port-city interface has been Hayuth (1982), describing the changing relationship between ports and cities. Hayuth mentions, as we also have seen in the previous section, the development of ports and cities have been closely tied since the early days of shipping. Many ports and cities grew on the basis of mutual benefit. The spatial proximity of ports and cities was a matter of necessity, due to the traditional shipping technology, the nature of trade and the size of cities. Historically, ports were located within an urban area, most often next to the commercial center (market) of the city. Many cities were situated at sites that were conducive to the establishment of a port. The port, in turn, served primarily the local area and maintained close ties with the manufacturing industry in the city (Hayuth, 1982). However, as cities grew in size and ports expanded their facilities, an initial spatial and functional segregation between ports and cities emerged. Ports started to abandon the urban areas, moving downstream with more space available to fit the needs of the growing ports. Developments in the shipping industry such as technological changes, modernization of port operations and increasing public concern over coastal areas, have greatly accelerated the phenomenon, loosening the spatial and functional relationship between

cities and ports and subverting the traditional land-use characteristics of the urban waterfront (Hayuth, 1982).

In the classic work of Hoyle (1989) on the port-city interface, he finds similar observations. Throughout most recorded history a close association existed between city and port. The prosperity of the city largely depended on the fortunes of the port: either the two developed together, or they declined together. Hoyle (1989) however, mentions this is no longer necessarily the case today. There is no law which states that coastal cities and ports must be geographically associated. In recent decades the port function has become dissociated from city functions. Economically and geographically, ports and cities are said to have grown apart (Hoyle, 1989). The separation of port and city-encapsulated in the phrase 'the retreat from the waterfront'-is today a commonplace world-wide phenomenon: a fact and a process of port geography that can be illustrated from most countries with a seaboard. The basis of the change in the port city relation is derived from four developments happening in the port industry. Hoyle (1989) mentions the evolution of maritime technology, the scale of modern ports and industries, a decline in port related employment and environmental perspectives are said to have changed the closely tied relationship between port and city development.

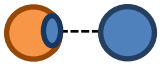
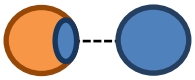
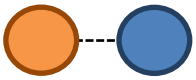
STAGE	SYMBOL City Port	PERIOD	CHARACHTERISTICS
I Primitive port/city		Ancient/medieval to 19th century	Close spatial and functional association between city and port
II Expanding port/city		19th- early 20th century	Rapid commercial / industrial growth forces port to develop beyond city confines
III Modern industrial port/city		Mid-20th century	Industrial growth and introduction of containers / ro-ro require separation / space
IV Retreat from the waterfront		1960s – 1980s	Changes in maritime technology induce growth of separate maritime industrial development areas
V Redevelopment of the waterfront		1970s – 1990s	Large-scale modern port consumes large areas of land / water space, urban renewal of original core
VI Renewal of port/city links		1980s – 2000+	Globalization and intermodalism transform port roles, port-city associations renewed; urban redevelopment enhances integration

Table 2: Evolution of the port city interface (Hoyle, 1989; 1998)

In his work, Hoyle (1989) describes the evolution of the port city interface in a five stage model, see Table 2. The first stage depicts the primitive ancient and medieval city port, where the interdependence between port and city is at its highest and spatially very close to each other. The

second stage depicts the expansion of the port activities beyond the urban boundaries in the nineteenth and early twentieth century, due to technological and industrial developments. In the third stage the spatial separation between port and city is accelerated, led by the increased space consuming activities (e.g. oil-refinery and container terminals) in the mid twentieth century. The fourth stage represents the developments in the 1960s-1980s, where according to Hoyle (1989) the ports started to develop at individual locations downstream and separated from the formerly host city. The fifth stage represents the problems since the 1970s with problems occurring at the waterfront in cities, as the port industries left the urban area. The model was extended by Hoyle in 1998, with a sixth stage. In the last stage the links between the port and city are renewed, at least from a cultural perspective in remembrance to the port heritage (Daamen, 2007).

3.3 PORT REGIONALIZATION

In 2005 Notteboom and Rodrigue introduced a new phase in the development of port cities, that of port regionalization. The first three stages of the model, setting, expansion and specialization, are the same steps as in the Anyport model of Bird (1963). The extension is constructed around the growing importance of hinterland connections in port competitiveness. As for the shipping industry is concerned, they try to optimize the supply chain from the origin as far as the customer. This includes the optimization of the maritime transportation, port operations and correspondingly the connections to the hinterland (Notteboom and Rodrigue, 2005).

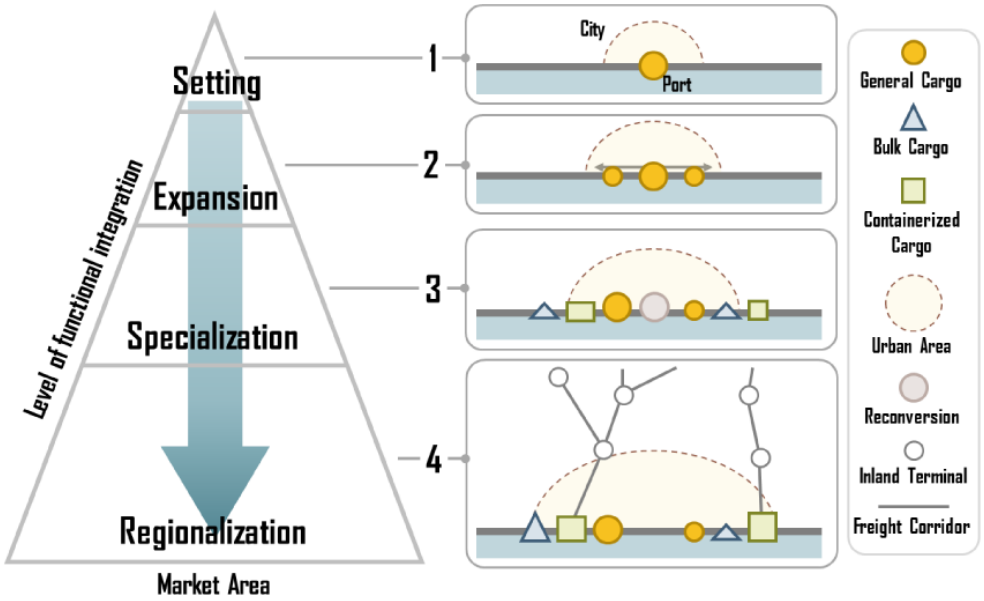


Figure 5: Port Regionalization (Notteboom and Rodrigue, 2005)

Box 2. Development of Port City Rotterdam

By doing a case study on the port development of port city Rotterdam, the largest port in Europe, we can get an idea how ports have developed over time in practice. The development of the port of Rotterdam fits the models of Bird (1963), Hoyle (1989) and Notteboom and Rodrigue (2005) nearly perfect. The origins of the city of Rotterdam lay in the 14th century, when Rotterdam developed as a small fishing settlement with some trade. The port and city developed prosperous, profiting from the Dutch Golden Age (1600-1700), and more and more ports were formed (De Bruijn, 2004). The city is characterized by close spatial and functional proximity, with the port related activities located right between the port and the urban area (Figure 6). By the mid-19th century the port of Rotterdam had become one of the largest port cities in the world, to a large extent driven by the trade with England and Germany. With the development of "De Nieuwe Waterweg" in 1872 and the industrial revolution, the port got a boost and started to expand on the south bank (Kippenberger, 2013). Until the Second World War, the port keeps continually growing downstream, though remaining in proximity of the city. After the war the port is characterized by enormous scale increases, where extensive (petro) chemical industry sites and container terminals were developed (De Bruijn, 2004). The large extensions led the port of Rotterdam to become the biggest port in the world between 1962 and 2004 (Kippenberger, 2013).

Figure 6: Historic Rotterdam (Engelfriet, 2009)

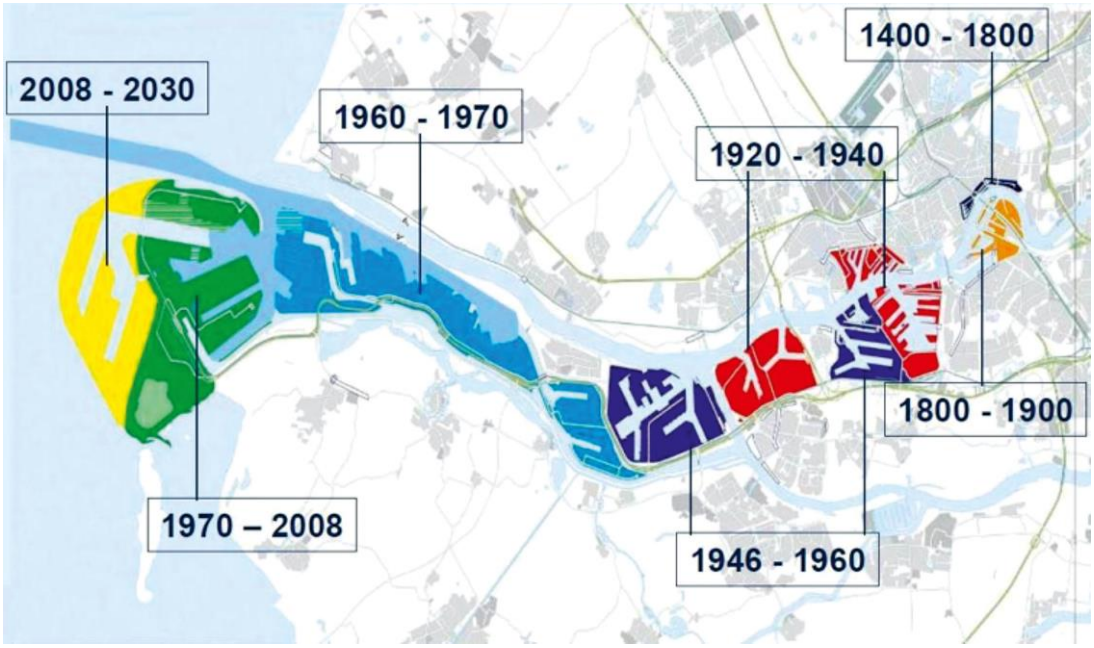


Figure 7: Development of the Port of Rotterdam (Kippenberger, 2013)

Today, the inner city port areas constructed between 1400 – 1800 and 1800 – 1900 have found new urban destinies, whereas the other port areas are still in use. The most renowned port redevelopment project in Rotterdam is the transformation of the former port area on the south bank, the "Kop van Zuid" (Figure 8). The redevelopment involved the creation of a mixed-use area offering luxury housing, leisure and infrastructural change. The redevelopment has helped to change the image of port city Rotterdam and to attract the needed new residents to modernize the economy of the port city (Merk and Notteboom, 2013). Despite major downstream port expansions, even reclaiming land from the sea with the development of the first and second "Maasvlakte" (1970 – 2030), the ports located within the urban environment (CityPorts) are still important fragments of the port. Though the CityPorts are still active, the first redevelopment plans are being executed and the area will be gradually interwoven into the urban fabric (Daamen, 2007). The plans are initiated to reinforce the symbioses between port and city, following the logic that port and city can still profit from being in proximity (Atzema et al., 2010). An example of the ongoing redevelopment of the CityPorts is the development of the RDM campus. The campus is a cluster of innovative businesses and educational institutions, in order to create an integration between education, services and the private industry (Daamen and De Vries, 2012; Merk and Notteboom, 2013). Following the model of Notteboom and Rodrigue (2005) of port regionalization, the port of Rotterdam is characterized by satellite ports and well developed hinterland corridors via barge and rail strengthening the competitive position of the port in Europe. The regionalization included for example the construction of a direct rail connection to the German hinterland (the Betuwe lijn) or the extended gate concept by terminal operator ECT. With the extended gate concept, containers are pushed into the hinterland via inland barge terminals in order to reduce congestion (Veenstra et al., 2012). According to the OECD report on the port cities of Rotterdam and Amsterdam (Merk and Notteboom, 2013), the main challenge for Rotterdam lays in finding a way to use the port cluster to strengthen the position of Rotterdam for the development of a high value added service sector and further development of the urban environment. This case study was on the port city of Rotterdam, but studies on almost any other port would produce similar port – city developments.

Figure 8: The Redeveloped "Kop van Zuid" (Buijse, 2014)

Since the 1990s the world experienced enormous growth in containerized throughput, creating the need for better hinterland transportation. In the regionalization stage multimodal hinterland transportation corridors and inland terminals are incorporated into the port system, which has led to the development of regional load center networks (Rodrigue and Notteboom, 2011; 2009). Depending on the nature of the port region, this will either include inland ports or inland rail terminals (Rodrigue and Notteboom, 2011). The inland terminals allow for the divergence of local truck flows, releasing pressure in the local environment. The port regionalization stage will bring the impact of port development to a whole new level and beyond the port perimeter (Notteboom and Rodrigue, 2008).

The regionalization phase in port development is prompted by two main forces, rising from the global and the local environment. The first factor in port regionalization concerns the globalization process affecting the maritime shipping industry (Rodrigue and Notteboom, 2010). As we have seen in section 2.2., ports have become links in large globally integrated transportation chains, where cargo moves through the ports that allow for the lowest costs and highest efficiency to the complete chain (Robinson, 2002). Port competition has thereby moved from ports competing for cargo, to competition among complete transportation chains. Hinterland accessibility is perceived as one of the most important aspects in port performance today (Van der Horst and De Langen, 2008). This development in port competition has raised the importance of the quality of hinterland accessibility of ports. The second force in port regionalization concerns the constraints and negative externalities that impact the local urban environment. Congestion, scarcity of land for port expansion and environmental issues, these impacts drive off port activities away from the local urban environment (Rodrigue and Notteboom, 2010). The creation of inland terminals, connected via inland waterways or rail, allow the ports to partially limit the negative impacts on the local environment (Notteboom and Rodrigue, 2009). On the other hand does port regionalization raise other concerns in the local urban environment. Where the relocation of port activities will reduce the local embeddedness of port operations, with the loss of employment and value added activities in the local environment. By creating an even greater imbalance between the highly localized negative impacts and the positive economic impacts that spill over to the hinterland (Merk, 2013).

PART II: THE URBAN CONNECTION

As we have seen in the previous sections, the leitmotiv in the literature is the disconnection of the port – city relationship. The relationship was at first disrupted by post-war port industrialization and containerization. Which mainly led to a decrease in the workers needed who to be found in the surrounding local urban environment. The port – city relationship was impaired institutionally in the 1990s with the devolution of port governance, putting ports on a managerial distance from the government (both local as central). The 1990s also gave rise to the globalization process, where foreign firms started to take control over port operations and local port firms. Thereby, displacing historical locally embedded port actors, which were strongly connected with local businesses. Being located in an urban environment further concern many negative externalities, being pollution, congestion and scarcity and mixed interests of urban land (Hall & Jacobs, 2012). These forces led to the move downstream, and it is even claimed that new ports can be established at Greenfield locations away from the constraining urban environment. The move downstream, in search of large available plots of land, cannot be denied. The same applies to the abandoning of inner city port locations. However, what can be observed by studying ports and there location, is that most ports are still located in densely populated urban environments. There also exist examples of urban ports dominating better located neighboring ports, e.g. Antwerp > Zeebrugge or Durban > Richards Bay (Hall and Jacobs, 2012). In this section we will take a closer look at the interaction between ports and cities, in order to investigate whether we can find an explanation for the remaining dominance of urban ports.

4. PORT – CITY IMPACT AND INTERACTION

In order to determine why most ports worldwide remain an urban character, it is useful to define how ports have their impact on cities and vice versa. When looking at the impacts of ports and cities, it is good to keep in mind that the impacts will have various effects on the port – city relationship. Ports and cities affect each other in multiple ways, positive and negative – direct and indirect. The impacts can thereby be classified into four (direct, indirect, induced and catalytic) levels of impact (Ferrari, Percoco and Tedeschi, 2010). The diverse factors can have a direct impact on the performance of either the port or city. For example, the introduction of the container had a direct effect on the level of employment in the port. The developments in the port – city relationship are further influenced by indirect effects. For example: the impact on employment by the integration of international supply chains and internationalization strategies in the shipping industry. The

developments could further have an induced and catalytic impact on the performance of both port and city. Though we will be looking primarily on the direct and indirect effects, it is important for understanding the port – city relationship to understand that the effects have a deeper impact on the relationship. The induced impact reflects the effect of the level of employment (by the direct and indirect effects) and the related spending of income. For example, the level of employment is affected by automation practices or supply chain integration and has an effect on the level of income spent in cities. The catalytic impact reflects the effect of the performance of port actors to spill over to other actors in the port or urban area. They could thereby raise the attractiveness of the area and may lead to the attraction of new firms or an overall increase in employment in the sector, impact economic growth (Cech, 2004). It is likely for port developments to transfer intersectoral spillovers to urban activities (Ferrari et al., 2010).

Ports do both have a positive, as well as, negative impact on its host city. The positive and negative impacts of ports on cities differ in the nature of the effects. The positive impacts on cities are mostly related to economic benefits. Whereas the negative impacts include environmental, land use and traffic impacts. Though the negative impacts eventually will affect the cities economically as well (Merk, 2013). There exists a tradeoff between port performance and social goals. On the one hand port actors, port authorities and governments stimulate in improving port performance and growth and thereby improving income and employment. On the other hand there are conflicting social goals related to a clean environment and the quality of life of the city's inhabitants (Benacchio and Musso, 2001; Musso et al., 2000). There exists a mismatch between the costs and benefits of port activity, where the negative impacts are mainly experienced locally and the benefits spillover to other regions (Merk, 2013). It is the local environment that facilitates the port with the needed inputs of labor, land and capital. The local environment is also paying the cost of the port activities regarding pollution, congestion and opportunity costs for land use (Ferrari et al., 2010). The return on the provision of infrastructure and port services also experience lower payback in the form of labor and added value. As the port industry today is more capital intensive, and due to the internationalization of operations. These factors allow for positive port impacts to be spread out between the port actors, of which more and more are international operating organizations (Musso et al., 2000).

As said before, the urban environment can profit predominantly economically from having a port in proximity. A prime advantage of having a port is that ports form important gateways to international trade. Where ports always have been important engines of economic development for the cities where they are located, but also for the regional and national economy (Jung, 2011). I is mostly a country that can benefit the most from having an efficient port, by the reduction in trade costs and the accompanied trade opportunities (Ferrari et al., 2010). Ports are important for many national

economies, especially if these economies depend to a large extent on international trade (Song and Panayides, 2008). Where the benefits generated by ports reach further than the local or national economy, as most throughput is destined for extensive hinterlands. Port hinterlands have extended significantly in scale the last decades, as transportation costs have seriously been reduced. Likewise, competition has become much fiercer between ports in the same port regions (Ferrari et al., 2010). However, the hosting city can still profit from considerable employment and value added creation by having a port in its environment. The presence of a port not only creates activity as throughput is being processed; it has also led to the concentration of all kinds of related economic activities (Musso et al., 2000; Jacobs et al., 2010). The OECD (Merk, Ducruet, Dubarle, Haezendonck, and Dooms, 2011) did a survey on European port cities, finding substantial value added creation by port and port related activities. For example, in Rotterdam in 2007 the added value of the port and port related activities was estimated at 12.8 billion euros, representing approximately 10 percent of the local GDP. They found even higher rates at the port cluster of Le Havre and Rouen, representing over 21 percent of the regional GDP. Where in the case of Antwerp with 9.8 billion euros, representing 15.5 percent of regional GDP and almost 3 percent of Belgium's national GDP. Though, with the intensified port competition and extended hinterlands, ports face the risk of throughput just passing through the port. As commodities are being shipped straight to the customers without stopping at the port, nor inducing economic activity, employment and added value (Musso et al., 2000). Further, port operations have changed severely the last couple of decades, due to the mentioned factors of containerization, automation and scale economies. This making port operations more capital and land intensive, reducing labor input into the operations (Merk, 2013). The developments resulted in ports being less dependent on the local urban labor market and making the urban environment less dependent on the port for economic growth. However, the port operations remain, although to some extent reduced, important for local employment (Jacobs et al., 2010). An important effect of the changes is that port operations have become much more complex to manage. The increased complexity has resulted in an increase in the requirement of high skilled workers and knowledge intensive business services (Hall and Jacobs, 2012). In order to operate in the complex environment, the port actors are in need of insurance, accounting, legal, ICT and all other kinds of services. The needed skilled labor and intermediate services tent to be found in the urban environment. The increased need for knowledge and services fuels high-income professionals and large value adding firms in the urban environment (Sassen, 2013).

We are interested in why ports would remain their urban character, despite the changes in the industry and the challenges of being located within an urban environment. There are two main explanatory factors to be found: the influence of place-based actors and related variety in the urban

environment. Besides the high sunk costs of many port related industries, remaining their location proximate to the urban environment.

4.1 PLACE-BASED ACTORS INVOLVEMENT

Ports historically serve as gateways to international trade, providing opportunities for economic development of cities, regions and nations. However, as we have seen in previous sections, the maritime transportation industry underwent some profound changes in the management of international trade flows (Hesse, 2010). The emergence of global supply chain systems changed the role of ports, where ports nowadays are considered to be strategic operational nodes in global trade routes and shipping networks (Hall and Jacobs, 2012). Port competition has intensified significantly the last couple of decades. Ports traditionally competed only with neighboring ports, over a common hinterland. Globalization and the steep decline in transportation costs expanded the geographical range of port competition, forcing former non-competing ports to engage in the intensified port competition for throughput (Notteboom, 2007). Where the fate of a port depends to a large extent on its ability to adapt to new requirements, where ports are facing many physical and organizational challenges in order to remain competitive (Notteboom, 2002). Ports can no longer rely on the simple fact that they are the natural gateway to rich hinterlands, and for that reason will attract cargo to the port (Notteboom and Winkelmans, 2001; Notteboom, 2007). Intensified port competition and scale economies, due to growing vessel size and utilization of capacity of the vessels together with the formation of alliances, will favor the largest and most efficient ports. Due to mergers and alliances, shipping lines have become more and more monopolist players in the maritime transportation industry. Where ports are bound to its location, ships have the ability to move freely (Lee et al., 2008). The footloose monopolistic ocean carriers have developed the ability to almost instantly alternate between ports, having considerable impact on the throughput and activity in a port (Merk, 2013). The ocean carries and shippers make use of the ports that offer them the best reliability and offer the lowest costs to their shipping networks. It is therefore no matter of ‘choice’ for ports and cities to handle cargo, but rather a decision that is heavily influenced by other agents. The port selection can be considered to involve the shipping lines and cargo owners on the one hand, on the other hand there are the place based agents (e.g. port authorities, local trade associations and governments) who are trying to influence the decision made by the first mentioned (Hall and Jacobs, 2012). Port selection by shippers and cargo owners is based on many factors, including labor costs and productivity, quality of port operations, port location, hinterland connections, port access and the availability of land (Lee et al., 2008; Merk, 2013). The place based actors try to positively

influence these factors, for example by investing in infrastructure or creating an attractive business climate. Urban ports are therefore successful if the place based facilitators are able to create more attractive conditions than competitive non-urban ports (Hall and Jacobs, 2012).

To get a better understanding of the dominance of ports located in an urban environment, it is also good to look at the different types of non-urban ports and actors that exist. The non-urban competitor ports are to be found in threefold. First, there are the ports initiated by national governments, created to reduce tensions in the former urban port cities or intended to boost the economic viability of a certain region. The ports were for example created to attract investors and lower unemployment rates, to regions to be seen by the government as having high potential for the creation of internationally competitive industries (Hall, 2000). The non-urban ports could also be developed for the spreading economic and industrial activity spatially and away from crowded urban environment (Ariga and Ejima, 2000). These ports are created, not necessarily because of the favored conditions present at the new locations, but rather forced by the national governments policies. Though these policies have created a few high throughput ports, most of the hosting cities and regions fail to develop into diversified economic environments (Hall and Jacobs, 2012). Second, there are non-urban ports set up by carriers and global terminal operating firms acting out of their home locations by creating transshipment ports. These ports are created to raise efficiency and scale economies in their international shipping networks. Though most of these actors started, and are still predominantly active in urban environments. These transshipment ports however, don't really develop into further developed value adding ports, but remain transshipment to multiple destinations. Final, there are the bulk shippers, of which their locations are primarily based on the export of natural resources that are generally connected with urban ports (Hall and Jacobs, 2012). These non-urban ports thereby do not compete for throughput, as they are export driven and most often on remote locations.

The non-urban actors are able to create large ports, though it is often the urban ports that have an advantage. This is especially true if the urban ports are able to overcome local-global interaction problems (Hall and Jacobs, 2012). Where there exists a trade-off between port and urban prospects. Though, the ports' development, strongly pushed by globalization pressures, leads to many conflicts with the local environment. The urban ports still find a lot of support by the place-based actors, but also from a wider range of stakeholders, e.g. national governments. The stakeholders keep reminding the on the importance of ports for urban, regional and national economies, as ports still function as important drivers of economic growth and employment (Song and Panayides, 2008).

4.2 RELATED VARIETY

The success of ports and port-cities depend to a large extent on the influence of place-based actors, in creating the most competitive environment in order to maximize both port and urban performance. Another important mutual beneficial factor in the port – city relationship, is the related activities that are stimulated and attracted by the port operations. As we have seen, the port can profit from (skilled) labor from the local urban environment and knowledge intensive business services, whereas the urban environment can profit from added value and employment creation in the port. Still, the urban character of a port is more and more seen to confine both urban and port development. Hall and Jacobs (2012) also mention the discontinued traditional port – city relationship. However, they claim that the breakdown of the traditional relationship is accompanied by the creation of a whole set of new relationships between ports and cities. They even claim that the constraints of being located in an urban environment (e.g. congestion, pollution or scarcity of land), is rather an important factor why urban ports precisely thrive in today's competitive environment. The ports that are located within the urban environment are in fact forced to be innovative, creating a competitive advantage. Some port-cities may fall in decline because the firms and the institutional environment they operate in become locked into the established industrial practices, losing the ability to absorb new knowledge and to be innovative (Hall and Jacobs, 2012). As the local structure becomes too narrowly focused, it might lose the ability to adapt to changing market demands (Malmberg and Maskell, 1997). In this situation, the initial strength of these port cities may become their weakness. As the focus is too strongly oriented on the established specialized industry, with strong commitments in the institutional framework, capital and labor, R&D, infrastructure etc. (Boschma and Lambooy, 1999). In order to prevent such lock-in situations, it is important for firms and institutions to cooperate. Thereby, it is important that the relations are maintained not only between actors in the same industry, but also beyond their own sector (Atzema et al., 2010). Port actors, port authorities, policymakers and urban actors have to work together in order for the port to remain competitive without the urban environment being excessively affected negatively. As we have seen in the literature review, the port industry has changed significantly the last century. For ports, and thereby port-cities, it is important to be able to adapt to these changes and to be innovative in order to survive in the competitive environment. Knowledge centers and skilled labor tent to concentrate in space; they will be located in urban environments (Hall and Jacobs, 2012; Sassen, 2013). Having a diversified urban economy is seen as an important factor in urban development, allowing intersectoral collaborations and knowledge spillovers to occur more frequent (Hall and Jacobs, 2012; Atzema et al., 2010). Being in close proximity is an advantage for spillovers to occur. It helps to create opportunities for intersectoral collaborations between port and

urban actors at relative low costs, allowing for intuitive knowledge to be transferred, in particular via face-to-face contact. Though, herein lays the danger of directing too much attention to established interests, instead of the innovative aspirations, which could ultimately result in the mentioned lock-in effect (Atzema et al., 2010).

An important factor in creating and maintaining a well-balanced port – city relationship and the beneficial related variety, is the quality of the living and business climate of the urban environment. The city needs to be attractive in order to attract and retain the needed skilled workers (Kuipers, Nijdam and Jacobs, 2011). The same reasoning applies to the settlement of international maritime business service providers, where the headquarters and main offices tent to follow urban hierarchies rather than port size and throughput volumes (Merk, 2013). There are two main forces that affect the location of the maritime service providers. The first factor is proximity, where being located near the port activity fosters the exchange of knowledge and ideas and building trust. The service providers have a better insight in the developments in the port environment and are able to respond to changing market demands. Second, the location of the service providers is based on urban hierarchy, looking to benefit from skilled labor and other related service providers (Jacobs et al., 2010). Where port actors buy most services from local businesses for their daily operations, these will be supplemented by services bought from international centers that handle the more complex needs (Kuipers et al., 2011; Sassen, 2013). The cluster of advanced maritime service businesses in London gives a good illustration of how history (lock-in) and urban hierarchy have allowed the city to have become the world's leading cluster in maritime services. Though, throughput volumes have drastically been reduced and most port functions have disappeared the last decades in the port of London (Merk, 2013; Jacobs et al., 2010). On the other hand, Ducruet (2009) has provided evidence to believe that port throughput is positively related to the presence of a strong service sector. Where ports regions that have a dominant industrial focus tend to perform less and show considerably lower throughput volume growth. Thus, being located near the urban environment is challenging in many ways, but it is also a crucial factor in the success of many port cities.

PART III: RESEARCH DESIGN

The previous sections have shown that the port – city relationship underwent some severe changes the last century. The technological and globalization forces have heavily affected the relationship. Thereby, the interaction between ports and the local urban environment is said to have been reduced severely. However, we have concluded that many ports still thrive in urbanized environments and can still develop mutual beneficial relationships despite the many negative impacts and conflicts arising in the areas where port and city meet. This section will include an empirical study on the relationship between ports and cities. In this analysis we will explore the factors where port and city affect one another. We will test whether ports and cities can still benefit from being in close spatial proximity.

5. DATA

In the empirical analysis we will be using panel data, consisting of 21 European port-cities using a time period of 2000 till 2012 (see Figure 9). Panel data considers multiple actors over multiple time periods. In our case the cross-sectional data will be port-cities and the temporal data is the time span 2000 – 2012. The port-cities are chosen on the basis that they are among the largest European ports and handle both container as well as bulk and general cargo throughput. The reasoning behind this is criterion is that container throughput forms an interesting subject because of its dynamic aspect. The containers can contain virtually anything and be destined for anywhere. Whereas many bulk throughput is destined for distinct manufacturing clients. The container throughput could thereby more likely be destined for the local urban environment. We are looking at the years 2000 – 2012 for two reasons. First, the port sector has changed severely over the last 60 years. By looking at the timespan 2000 – 2012 the developments have had their time to settle and to be implemented in the ports. Second, these are the most recent data available to be used in the analysis.

In the statistical analysis we will investigate the port – city relationship from either side. We are interested in how the developments in the relationship have affected the interactions between the ports and cities. Therefore, we will be looking at both the effect of port performance on the development of the adjacent urban environment, as well as the effect of urban performance on the performance of the port. In the analysis we will investigate the effect of port performance on the surrounding urban environment. We would like to know how a city can profit from having a port in its environment. I will further investigate how the port can benefit from being adjacent to an

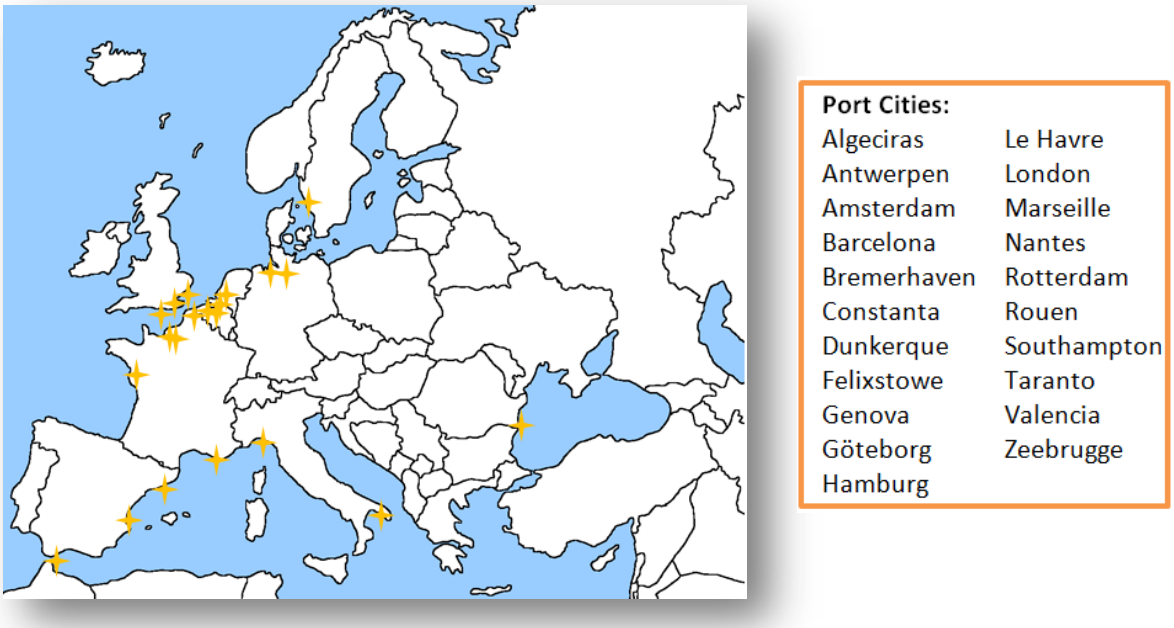


Figure 9 – The Port-Cities Used in the Analysis (adapted from Keil, 2014)

urban environment. In order to perform the analyses, we will make use of the two different panel data models, as described in the methodology. To test the effect of urban performance on port performance, we will make use of two estimators of port performance as our dependent variables. The estimators of port performance consist of port container throughput (TEU) and total tons of throughput (TONS). To test the effect of port performance on urban performance, we will make use of the gross domestic product (GDP) as our dependent variable. The urban estimators are nuts 3 regions, as established by the European Union and as used by Eurostat. The nuts 3 regions represent a more complete observation of the urban environment, rather than stopping at municipal borders.

We will further include several measures, dedicated to the port characteristics. These will be used to partially explain port performance, supplementary they help explain port – city interaction. The variables include port related employment (PEMP), port related gross value added (PGVA), the number of motorways, railway tracks and navigable inland rivers and canals in the region connecting the port to the hinterland (respectively ROAD, RAIL and BARGE) and the maximum port depth (MAXDEP). The maximum port depth of a port can also be seen as an indicator for the adaptation to new technology. As we have seen, the sizes of new container vessels have increased significantly and therefore require more depth to be able to moor. Similar to the port variables, the data further includes multiple urban variables. These will be used to partially explain urban performance, supplementary they help explain port – city interaction. They include the explanatory variables employment in urban related sectors (UEMP), the gross value added by the urban related service

sector (UGVA), the level of education being low, medium and high (respectively LEDU, MEDU and HEDU) and research and development in the form of patents (PATENT). The included patents are related to the shipping industry, to measure responsiveness of the urban environment to the port. The level of education includes all citizens of the urban population in the age group 25 – 64, as a representative of the working population. We will further include a variable measuring the level of spatial separation between port and city (SPSEP), in order to see whether larger distance reduces the interaction between port and city. Appendix 1 includes a more extensive description of the used variables.

6. DESCRIPTIVE STATISTICS

The summary statistics of the variables for the empirical analysis are shown in Table 3. The table displays the mean, standard deviation, and the minimum and maximum observation for all variables, based on the 21 port cities and the time span 2000 – 2012. What can be seen in Table 3 is that there are some striking differences between the different port cities. The minimum and maximum of the observations are considerable different among the various port-cities, also to be seen by the high standard deviations. This is not surprising, as there are all types of port cities included. Ranging from port-cities primarily based round the port activity, e.g. Felixstowe or Bremerhaven. On the other hand the dataset contains large metropolitan agglomerations, e.g. London or Barcelona. This reflects in large differences in for example urban population differences, as well as huge differences in throughput. There are also large differences in infrastructure between the various port cities. There are port-cities included with no navigable inland waterways, to exceptionally well connected port-cities with many inland waterway connections. The difference in motorway networks is also considerably large, but therein also reflects the difference in urban size. It does not come as a surprise that for example London has a much higher accessibility than a small port-city such as Felixstowe. The observations on the spatial separation between the various ports and cities also show some interesting information, where there exist a significant difference in average spatial separation between ports and cities. There are three different observations to be seen in the port-cities included in the dataset. First, ports in the small port cities tend to be located extremely close to the urban environment (e.g. Felixtowe or Zeebrugge). Second, the port is of such a tremendous size, that it stretches from almost inner city and kilometers out (e.g. Rotterdam). Last, there are port-cities that have extended the port away from the urban environment, constructing new port sites at the some distance of the urban environment (e.g. Marseille, Gothenburg or Rouen).

Table 3: The Summary Statistics

Variable	Mean	Standard deviation	Minimum	Maximum
TEU	2 307.9	2 588.2	7	11 340
Tons	65 817.1	70 684.3	19 132	396 520
GDP	52 710.1	77 213.9	1 755	438 536
Population	1 640 106	1 675 240	112 982	8 136 285
Port related GVA	25 749.8	33 306.9	1 037.2	156 172.3
Urban related GVA	49 571.8	100 459.5	366.4	504 934.7
Port related employment	207.4	213.2	10.8	1450.5
Urban related employment	530.4	866.7	29.1	4607.7
Low education	429.6	415.3	40.2	1 797.8
Medium education	481	231.4	135	1 290.3
High education	401.6	366.2	52.1	2 076.8
Patents	2.4	2.6	0.1	16.2
Motorway network	318.7	243.8	1	984
Rail network	614.6	268.5	164	984
Navigable waterways	396	318.2	0	929
Maximum port depth	16.9	4.8	6.8	28.8
Average spatial separation	10	8.3	2.3	31.5

In the empirical analysis we will investigate the relationship between port performance and city performance. Thereby the focus is predominantly at the dependent variables of port performance (TEU and Tons throughput) and the dependent variable of urban performance (GDP). Figure 10 and 11 graphically display the development of throughput and GDP over time for all 21 port cities. What is to be seen is that the developments of throughput and GDP differ among the port-cities. Some port-cities show more resemblance between throughput and GDP, where others tent to move independently. It is therefore hard to tell how throughput and GDP relate to each other. In order to get a more precise look at the relationship between throughput and GDP, we will look at the correlations between the variables. Thereby, we will also be looking at the correlations with the other variables to be included in the empirical research.

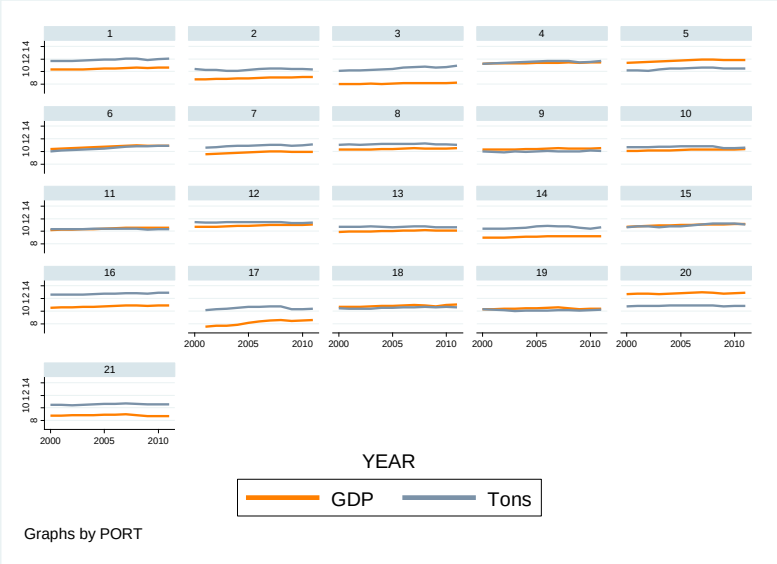


Figure 10: GDP and Total Throughput Development

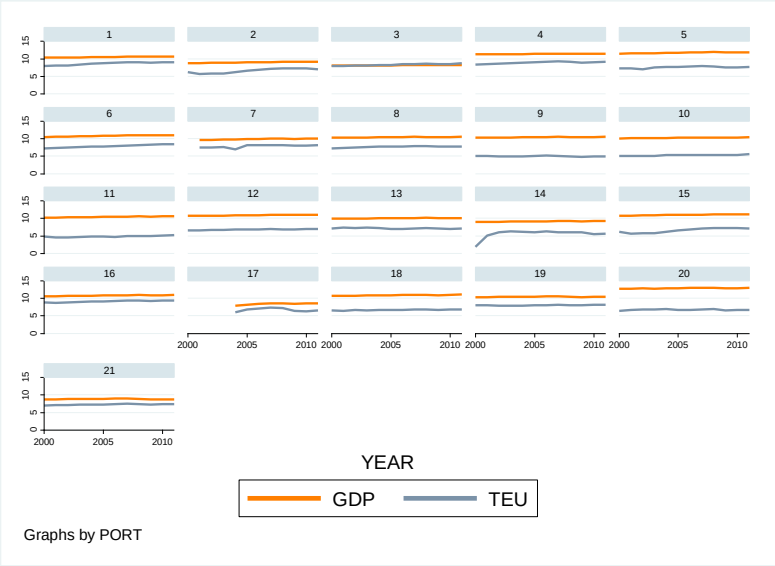


Figure 11: GDP and TEU Throughput Development

Table 4 contains the correlations between the dependent variables and the explanatory variables. What can be seen from Table 4 is that both dependent throughput variables are positively correlated to the dependent city performance variable, respectively r = 0.0349 for TEU and r = 0.3856 for tons. The correlation between TEU throughput and GDP is indicating that there is very little if any relationship between the two variables. The correlation between total tons of throughput and GDP is indicating that there exists a low positive relationship. However, when we are looking at the indirect effects, the correlations are indicating that there exists a relationship between port performance and urban performance. As for example port related employment and port related added value show signs of a very strong positive relationship, respectively being r = 0.9291 for port related employment and r = 0.9211 for port related gross added value. Whereas port related employment and gross added value can be seen as complementary port performance indicators. When looking at the reversed pattern, we find that the complementary urban performance indicators have a much weaker correlation with throughput in a port. Where the correlations indicate that urban related employment has very little if any relationship with TEU throughput and a weak relationship with tons of throughput, respectively being r = 0.0353 and r = 0.4650. The same holds for urban related gross value added indicating weak if any relationship with both TEU and tons of throughput, respectively r = -0.1249 and r = 0.3029. It is also interesting to look at the relationship between urban and port performance and the spatial separation between port and city. The correlation between GDP and spatial separation is 0.1979, indicating little if any relationship between the two. When looking at port performance and spatial separation, the correlations show to distinct correlations between TEU and tons of throughput. Where the correlation between TEU throughput and spatial separation is little if any, r = 0.2004. However, the correlation between tons of throughput and spatial separation shows signs of a strong positive relationship, being r = 0.7374. Possibly higher throughput of other

forms of cargo either need more space or is 'forced' to move away from the urban environment. The complete correlation matrix is to be found in Appendix 2.

Table 4: Correlation Matrix

	GDP	TEU	TONS	PEMP	PGVA	UEMP	UGVA	SPSEP
GDP	1.0000							
TEU	0.0349	1.0000						
TONS	0.3856	0.7324	1.0000					
PEMP	0.9291	0.1558	0.5146	1.0000				
PGVA	0.9211	0.2240	0.5205	0.9187	1.0000			
UEMP	0.9508	0.0353	0.4650	0.9654	0.8409	1.0000		
UGVA	0.9540	-0.1249	0.3029	0.8664	0.9045	0.9221	1.0000	
SPSEP	0.1979	0.2004	0.7374	0.2704	0.2393	0.3907	0.2099	1.0000

7. METHODOLOGY

In order to get an understanding of the port – city relationship and how both ports and cities have an effect on each other, we will need to construct a model representing the port – city relationship. The performance of both the port and city can be compared to a standard production function. The output is the performance of the port or city, based on the inputs capital, labor and land as the factors of production. The capital can be quantified as the economic variables, labor as the demographic variables and land as infrastructure variables (Cheung and Yip, 2011). Thereby we can construct the equation, representing the relationships between ports and cities (equation 1 and 2).

$$\mathbf{P = f(E, D, I, X) + \mu} \quad (1)$$

$$\mathbf{U = f(E, D, I, X) + \mu} \quad (2)$$

In the first equation *P* represents port performance, which is a function of economic factors (E), demographic factors (D) infrastructure factors (I), a vector X representing exogenous factors and the error term (u). The second equation only differs in that it's explaining urban performance (U), rather than port performance. In order for the equations to be used in our statistical analysis, we need to translate the equations into a representative model.

There exist three different types of models when analyzing panel data; pooled OLS model, fixed effects model and random effects model. The constant coefficient model does not take into account that the variables are constructed out of multiple actors over a returning time span. All data will be pooled and an ordinary least squares regression will be used (Yaffee, 2003). We will not be using this model, because it neglects country and temporal effects. Both the fixed and the random effect model

take into account that we have multiple actors over a certain time span. The fixed effects model will acknowledge that we are having multiple actors that significantly differ from each other, though the actors do not necessarily differ significantly over time (Yaffee, 2003). The random effects model differs from the fixed effects model in that the variation across the different actors is assumed to be random and uncorrelated to the predictor and explanatory variables. In the fixed effects model the variation is possibly correlated to the explanatory variables. The fixed effects model will not properly function when there are variables in the model that barely or don't change at all over time (Cameron, 2008). When variables don't vary over time, this will lead to an omitted variable bias in the fixed effects model. A time constant variable is no problem in the random effects model (Torres-Reyna, 2007). As the panel data set to be used includes several variables that are constant over time (spatial separation, maximum port depth, navigable waterways and motorway network), we will have to use the random effects model. Since the explanatory variables are key to the model, it's not possible to estimate their effect on the dependent variables using the fixed effects model. Though, the fixed effects model would otherwise have been the preferred model over the random effects model, as it is thought to be a better tool to estimate ceteris paribus effects (Wooldridge, 2012). As we are using the random effects model, we can translate equations 1 and 2 into random effects models (equation 3 and 4).

$$\mathbf{P_{it}} = \alpha_i + \mathbf{E_{it}}\beta + \mathbf{D_{it}}\beta + \mathbf{I_{it}}\beta + \mathbf{X_{it}}\beta + \varepsilon_{it} \qquad (3)$$

$$\mathbf{U_{it}} = \alpha_i + \mathbf{E_{it}}\beta + \mathbf{D_{it}}\beta + \mathbf{I_{it}}\beta + \mathbf{X_{it}}\beta + \varepsilon_{it} \qquad (4)$$

In the models, represented by equation 3 and 4, P denotes port performance and U denotes urban performance, the dependent variables in the models. The i denotes the different port-cities and t is an indicator for the years. Again, the model makes use of vectors of the explanatory variables E (economic), D (demographic), I (infrastructure) and X (exogenous factors), with the corresponding coefficient β. The intercept, α, represents a random effect on the port-cities. In the case of a fixed effects model α might be related to the explanatory variables, when using a random effects model α is completely random and uncorrelated to the regressors (Wooldridge, 2012). The ε in the model is the error term. The error term has two dimensions, consisting of one for the port-cities and the other one for the years (Yaffee, 2003).

8. HYPOTHESES

Based on the literature review and the model specifications, we can construct the hypotheses to be tested in the empirical research. Thereby, the hypotheses will be constructed from an urban perspective as well as from a port perspective. The hypotheses will help us to determine if and how port and cities can profit from being in proximity.

We will start with the formulation of our hypotheses from an urban perspective. The aim is to get an understanding how a city can profit from having a port in its proximity. In the previous section we constructed our model and Urban GDP is set as the dependent variable reflecting urban performance. The first hypothesis will test if an increase in port performance (TEU or Tons of throughput) has a positive effect on urban performance. As we have seen in the literature review, cities can predominantly benefit economically from the close presence of a port. An increase in the throughput will most likely lead to increased port activity, but also in an increase in the related industries. Here we expect that the increase in throughput will create spillovers to the urban environment. We will test whether there exist a positive relation between developments in port GVA and port employment related to urban performance. We will further test if the supply of infrastructure has a positive effect on urban performance. The last hypothesis will test if there exists a positive relationship between spatial proximity and urban performance. The five hypotheses that will be used to test the relationship between ports and cities from an urban perspective are listed below:

H_0: An increase in port performance does not have a positive effect on urban performance (1)
H_1: An increase in port performance does have a positive effect on urban performance

H_0: An increase in port related employment does not have a positive effect on urban performance (2)
H_1: An increase in port related employment does have a positive effect on urban performance

H_0: An increase in port related GVA does not have a positive effect on urban performance (3)
H_1: An increase in port related GVA does have a positive effect on urban performance

H_0: An increase in infrastructure does not have a positive effect on urban performance (4)
H_1: An increase in infrastructure does have a positive effect on urban performance

H_0: An increase in spatial separation does not have a positive effect on urban performance (5)
H_1: An increase in spatial separation does have a positive effect on urban performance

Next to testing the port – city relationship from an urban perspective, we will test the reversed pattern from a port perspective. The aim is to get an understanding how a port can profit from being in close proximity to the urban environment. In the previous section we constructed our model and throughput, both TEU as well as total tons of throughput, is set as the dependent variable reflecting port performance. The first hypothesis will test if an increase in urban performance (urban GDP) has

a positive effect on port performance. As we have seen in the literature review, ports can predominantly benefit from employment, capital and knowledge provided by the urban environment. Likewise to the urban hypotheses we will therefore test if urban GDP, employment and GVA have a positive effect on port performance. We will then test whether the supplied infrastructure has a positive effect on port performance. As we have seen in the literature review, well established hinterland connections improve the competitive position of ports and further help to reduce the negative associated factor of congestion. To test the whether the port can profit from knowledge creation and urban responsiveness, we will test if there exists a positive relationship between the number of patents for the maritime shipping industry and port performance. The last hypothesis will test if spatial proximity to the urban environment has a positive effect on port performance, where spillovers are more likely to occur in close proximity. The six hypotheses that will be used to test the relationship between ports and cities from a port perspective are listed below:

H_0: An increase in urban performance does not have a positive effect on port performance (1)
H_1: An increase in urban performance does have a positive effect on port performance

H_0: An increase in urban related employment does not have a positive effect on port performance (2)
H_1: An increase in urban related employment does have a positive effect on port performance

H_0: An increase in urban related GVA does not have a positive effect on port performance (3)
H_1: An increase in urban related GVA does have a positive effect on port performance

H_0: An increase in infrastructure does not have a positive effect on port performance (4)
H_1: An increase in infrastructure does have a positive effect on port performance

H_0: An increase in patent applications does not have a positive effect on port performance (5)
H_1: An increase in patent applications *does have a positive effect on port performance*

H_0: An increase in spatial separation does not have a negative effect on port performance (6)
H_1: An increase in spatial separation does have a negative effect on port performance

PART IV: EMPIRICAL RESULTS

In this section we will look at the empirical estimates on the port – city relationship. We will use the models that we have established in the previous section, looking at both port and urban performance. We will first explore the port – city relationship from an urban point of view, with GDP as the dependent variable. This will be followed by looking at port performance, where we will be looking at both TEU throughput as well as total tons of throughput as the dependent variables.

9. URBAN PERFORMANCE

We will start by looking at the effects of port performance on urban performance. We have made eight specifications to the model in equation 4. This is done in order to exploit the possible relationships between urban and port performance and to be able to control for more influential factors. The empirical results of port performance on urban performance are presented in Table 5. The table includes four model specifications using TEU throughput as port performance indicator (model 1 – 4) and another four for tons of throughput as port performance indicator (model 4 – 8). The various models include different independent and control variables. As said in the data description, we will look at both TEU throughput as well as tons of throughput. Since we believe that TEU throughput is a more dynamic indicator of throughput, and more likely to be destined for the urban environment as it can virtually can contain anything. The variables are not included in a single model for multicollinearity reasons, as TEU throughput is a part of total tons of throughput. What we can see straightaway from Table 5 is that in each model throughput has a highly significant positive effect on GDP. We can thereby reject our first two null hypotheses claiming that port throughput (being TEU or tons of throughput) will not have a positive effect on GDP. Though, we will look more thoroughly at the hypotheses in the next section. The estimators are all statistically significant at a 1% significance level. Because all variables included in the models are logarithms, the estimators can be interpreted as elasticities. The estimators for TEU throughput range from 0.043 to 0.051 and for tons of throughput the estimators range from 0.074 to 0.139. All estimators need to be interpreted in the same way, I will give an example by looking at the first model. A 1% increase in TEU throughput is associated with a 0.046% increase in GDP. This is partially to be explained by the effect of an increase in throughput rates would most likely lead to an increase in employment and activity of the port actors. However, when looking at port related employment and GVA, we get an interesting result. Where all throughput variables were highly significant, this is not the case for port related employment and GVA. None of the estimators of port related GVA show any sign of significance. Where port related employment in only three models resulted in significant results. This does not

come as a complete surprise, as we had seen with the very low correlation between the port related variables and GDP. When we look at the urban related employment and GVA, we do get highly positive significant results. This implies that there is a high probability that there exists a strong positive relationship between the urban related variables and GDP. It could be concluded that urban performance is predominantly explained by urban related activities. According to the theory cities became less dependent or even independent from their initial growth engine, and this is to be seen in the table as well. Port related GVA does not significantly affect GDP, where the same holds for port related employment. Though not really showing in the results, one could further say that port activity has a positive effect on urban performance, being only a small fraction compared to urban activity. Population has in each model a strong positive effect on GDP. This can be explained by the fact that having a larger population, there are more employees as well as employers creating value for the city. For example London has a much higher GDP than Felixstowe, but is also a far bigger city with a much higher population. City size has also effects the variable roads, measuring the motorway network. Having an extensive motorway network leads to good transportation possibilities. However, at a certain level additional motorway is primarily used for urban transportation and accessibility. In both models road has a strong effect on GDP, to a very large extent on the basis of the mentioned argument.

We can further see in Table 5, that an increase in spatial separation is associated with a higher GDP. Spatial separation is highly positive significant in the models with TEU throughput included and to a much lower extent in the tons of throughput models. Still this observation can be interpreted in multiple ways. First, this gives us an indication that as the spatial separation becomes larger between port and city, the city has more opportunity to grow and flourish. The competition for land will be less fierce, as will be the negative associations that stick to the port operations (e.g. congestion or environmental issues). It could be possible that urban ports restrict the urban environment in its developments as a separate identity, based on the lock-in effect. Second, as spatial separation is larger this could also indicate of a larger more developed port. As we have seen in the literature review, port operations are in need of more land seeking for it downstream. In the dataset, the ports with the highest spatial separation were in most cases among the largest urban environments included. Combined with this, increased spatial separation associated with higher GDP is because the more developed urban environment. Though, the correlation between population and GDP and spatial separation is for both very low if any. The third possible explanation could be that as spatial separation is increased the port has developed into a larger better performing port and is thereby contributing more to the GDP of the urban environment. Most likely, the explanation is to be found in a combination of the three mentioned relationships between spatial separation and GDP.

9.1 HYPOTHESES URBAN PERFORMANCE

In section 7.1 we have constructed five hypotheses concerning the port – city relationship from an urban perspective. We will first look at whether port performance has a positive effect on urban performance (1). We are further interested in the effect of port related employment and GVA on urban performance, where we expect a positive relationship (2 and 3). We will further test whether the supply of infrastructure has a positive effect on urban performance (4). Last, we will test if spatial separation positively affects urban performance (5).

H_0: An increase in port performance does not have a positive effect on urban performance (1)
H_1: An increase in port performance does have a positive effect on urban performance

H_0: An increase in port related employment does not have a positive effect on urban performance (2)
H_1: An increase in port related employment does have a positive effect on urban performance

H_0: An increase in port related GVA does not have a positive effect on urban performance (3)
H_1: An increase in port related GVA does have a positive effect on urban performance

H_0: An increase in infrastructure does not have a positive effect on urban performance (4)
H_1: An increase in infrastructure does have a positive effect on urban performance

H_0: An increase in spatial separation does not have a positive effect on urban performance (5)
H_1: An increase in spatial separation does have a positive effect on urban performance

The first hypothesis claims that port performance has a positive effect on urban performance. We are able to reject the null hypothesis at a 1% significance level. Thereby, we have found evidence to believe that port performance does positively affect urban performance. The second and third hypotheses are looking at port related performance indicators, where we believe these will positively affect urban performance. We are not able to reject the null hypothesis for either port related employment or GVA. Thereby, we have no evidence that the port related performance indicators positively affect urban performance. However, as we already mentioned in the previous section, both indicators will have a positive effect on urban performance. Only urban performance rather relies considerably more on urban related functions. The fourth hypothesis claims that infrastructure has a positive effect on urban performance. We get mixed signs in the results from the empirical analysis. We can reject the null hypothesis at a 1% significance level for the effect of motorway networks on urban performance. In the previous section we have already given a side note on the effect of motorway network density on urban environment. We are not able to reject the null hypothesis for the effect of rail network on urban performance. We are also not able to reject the null hypothesis for navigable inland waterway's effect on urban performance. Though, the results of navigable inland waterway connections are significant at a 5% significance level, we are not able to

reject the null hypothesis. The results are negative where we expected a positive effect on urban performance, as barge shipping could release congestion and environmental pressures in the urban environment. The last hypothesis is testing whether spatial separation has a positive effect. Though, we are trying to explain the positive relationship between port and city, we expect the relationship to be positive. We expect that a greater distance, but not too far, allows the urban environment to develop and be not as affected by the negative spillovers from the port. Thereby the urban environment can still profit from the port in its surroundings, benefiting from employment opportunities and value adding activities of port actors. We are able to reject the null hypothesis at a 1% significance level, claiming a positive effect of spatial separation on urban performance.

Overall one could say that the urban environment can certainly profit from the presence of a port in its surroundings. As we have seen, port performance is positively related to urban performance. Having more throughput passing through the port, positively affects urban performance. Though not showing from the results, this can be explained by the fact that more throughput will lead to more job opportunities and value adding activities of port actors. A greater spatial separation between port and city benefits the urban environment, though this result can be interpreted in multiple ways. But one thing is for sure, the urban environment can definitely profit from having a port, although the urban functions are more important factors for urban performance.

10. PORT PERFORMANCE

In this section we will explore the results of the empirical research on port performance. We have created two tables, one with TEU throughput (Table 6) and another with total tons of throughput as the dependent variable (Table 7). We have made eight specifications to the model in equation X. for both TEU throughput as well as total tons of throughput, comparable to the urban performance models. When looking at the effect of urban performance on port performance, we can see that urban performance has a highly significant positive effect on port performance. This applies for both TEU as total tons of throughput. This is giving the indication that the larger the urban environment, the more throughput is attracted. This resembles the historical arguments, where increased urban activity leads to increased demand for goods to be imported through the port. We have good reasons to believe that to some extent the relationship between port throughput and GDP can be positive. However, the results of the empirical results do raise some questions and causality concerns. *Does throughput increase due to better urban performance and thus larger demand? Or is it the reversed pattern and is GDP higher because of a higher throughput, accompanied by higher employment rates and value adding port activity?* We have already investigated the relationship

between GDP and throughput in the urban performance model yielding a positive relationship. The estimations could be explained by the historical thought that urban activity attracts cargo. It is however more likely that positive effect is based on port activity, since more cargo leads to more port activity creating value for the city. When we look at population, we find estimations giving an indication that larger urban environments are associated with less throughput. These results are giving direction to the previous questions. Where one could say that the relationship can't be explained by the historical arguments of larger cities attracting more throughput, but rather that an increase in throughput leads to higher urban performance.

When we look at the other urban performance indicators of urban employment and GVA, we get similar results. Both urban related employment and GVA show signs of a negative relationship with port performance, though most estimations are not statistically significant. When looking at the estimations of infrastructure on port performance, we find a statistically significant negative relationship between a more dense motorway network and throughput. This can, again, be explained via the same reasoning as in the model with urban performance. That is, at a certain level an increase in the density of the motorway network is predominantly for urban use and not to release pressures or to improve opportunities for port transport. The estimations of inland navigable waterways show us an indication of a positive relationship with attracting more throughput. The possibility of hinterland transport via barge shipping could be an attractive feature in attracting cargo to a port. According to the estimations, increased maximum port depth leads to higher throughput. This is mainly explained by the fact that the largest ports in throughput are the ports with the maximum port depth and that can handle the new largest vessels.

When looking at spatial separation, we get an interesting result. The estimations in Tables 6 and 7 indicate that if the spatial separation increases this will have a negative effect on port performance. This gives us an indication that ports do profit from being in near presence of the urban environment. Whereas the urban environment profits from a greater separation, the port still benefits from being adjacent to the urban environment. When looking at the effect of patents on port performance we get an indication of what could be an explanation for the result on spatial separation. The estimation of the effect of patents on port performance indicates that an increase in the number of patents in a port-city raises port performance. Showing signs of the port profiting from expertise and knowledge clustered in the urban environment. When we look at the correlation between port performance and patents we get an indication that there is a strong positive relationship, where the same holds for the correlation between urban performance and patents. This is quite intuitive, as larger cities generally have better and more R&D facilities and knowledge workers. Thereby, having a larger port in that city tends to get more attention from knowledge

facilities, resulting for example in patents for the shipping industry. Where a port can obviously profit from the knowledge gained in the adjacent urban environment. The knowledge is likely to transfer to the local port, to be implemented in other ports at a later stage. Though the empirical analysis is quite basic, a more thorough and complete analysis would probably produce more estimations indicating a positive relation of urban performance on port performance.

10.1 HYPOTHESES PORT PERFORMANCE

In section 7.1 we have constructed six hypotheses concerning the port – city relationship from a port perspective. We will first look at whether urban performance has a positive effect on port performance (1). We are further interested in the effect of urban related employment and GVA on port performance, where we expect a positive relationship (2 and 3). We will then test whether infrastructure supply has a positive effect on port performance (4). This will be followed by a test if the number of patent applications positively affects port performance (5). Last, we will test if spatial separation negatively affects port performance (6).

H_0: An increase in urban performance does not have a positive effect on port performance (1)
H_1: An increase in urban performance does have a positive effect on port performance

H_0: An increase in urban related employment does not have a positive effect on port performance (2)
H_1: An increase in urban related employment does have a positive effect on port performance

H_0: An increase in urban related GVA does not have a positive effect on port performance (3)
H_1: An increase in urban related GVA does have a positive effect on port performance

H_0: An increase in infrastructure does not have a positive effect on port performance (4)
H_1: An increase in infrastructure does have a positive effect on port performance

H_0: An increase in patent applications does not have a positive effect on port performance (5)
H_1: An increase in patent applications *does have a positive effect on port performance*

H_0: An increase in spatial separation does not have a negative effect on port performance (6)
H_1: An increase in spatial separation does have a negative effect on port performance

The first hypothesis claims that urban performance has a positive effect on port performance. We are able to reject the null hypothesis at a 1% significance level. Though, as we mentioned in the previous section that we are having causality problems here. By means of this hypothesis we have again proved that GDP is positively affected by port throughput. We don't find evidence that urban performance leads to positive port performance. The second hypothesis states that urban related employment will have a positive effect on port performance. We can't reject the null hypothesis, so

we don't find any evidence this hypothesis will be true. The third hypothesis claims that an increase in urban related GVA will have a positive effect on port performance. The null hypothesis can't be rejected, so urban related GVA does not positively affect port performance. We find do find evidence on a 1% significance level that urban related GVA negatively affect port performance. Indicating the larger the city, the less important the port is to the urban environment. The fourth hypothesis claims that infrastructure has a positive effect on port performance. We, again, get mixed results from the empirical analysis. We can't reject the null hypothesis that motorway accessibility positively affects port performance. We even get a significant negative result on a 1% significance level, following the explanation that at a certain level additional motorway connections is primarily used for urban transport rather than port transport. We can also not reject the null hypothesis for rail accessibility. We do can reject the null hypothesis for navigable inland waterway connections at a 1% significance level. Indicating that ports with good inland shipping possibilities are able to attract more throughput to their port. The fifth hypothesis states that an increase in the number of patent applications for the shipping industry in the urban environment has a positive effect on the level of throughput in a port. We can reject the null hypothesis at a 1% significance level, providing evidence that ports can profit from patents developed in the adjacent urban environment. As we have seen in the literature review, ports have to be innovative in order to survive in the competitive globalized market. Thereby, they can significantly profit from knowledge gained in the urban environment. The last hypothesis claims that an increase in spatial separation between port and city negatively affects port performance. We can reject the null hypothesis at a 1% significance level, providing evidence that a port can benefit from being in close proximity with the urban environment. Thereby, the port can profit from being close to capital, human capital, service providers and knowledge facilities. Being adjacent to the urban environment can lower the threshold for positive spillovers to occur.

Overall one could say that the port does profit from being in close proximity of the urban environment. Though, it's not directly urban performance or the population that is beneficial. It is not the city that attracts throughput to a port, but the urban environment provides ports with important inputs for ports to survive in a highly competitive market. From the empirical results can be concluded that being in spatial proximity gives ports an advantage in attracting throughput to the port. Further, R&D facilities and human capital help port to become more competitive. Together with the outcomes of port performance on urban performance, we can conclude that ports and cities can definitely complement each other positively.

Table 5: Urban Performance

		Urban performance							
		GDP (1)	**GDP (2)**	**GDP (3)**	**GDP (4)**	**GDP (5)**	**GDP (6)**	**GDP (7)**	**GDP (8)**
	TEU	0.046***	0.045***	0.043***	0.051***				
	Tons					0.139***	0.133***	0.139***	0.074***
Economic	**Port GVA**	-0.037	-0.026	-0.027	0.003	-0.0267	-0.019	-0.344	0.009
	Urban GVA	0.307***	0.291***	0.277***	-0.008	0.310***	0.302***	0.312***	-0.009
	Population	0.585***	0.548***	0.526***	0.431*	0.510***	0.491***	0.503***	0.472*
	Service employment	0.181***	0.178***	0.177***	1.088***	0.247***	0.249***	0.254***	0.988***
	Port employment	0.042	0.050	0.065*	-0.056**	0.019	0.023	0.028	-0.046*
Demographic	**Low education**			0.017	-0.115			0.024	-0.110
	Medium education			-0.106	-0.716***			-0.114*	-0.649***
	High education			0.074	-0.127			0.019	-0.107
	Road				0.761***				0.585**
	Rail				-0.087				-0.056
Infrastructure	**Barge**				-0.453**				-0.372*
	Max. port depth								
	Spatial separation		0.113***	0.141***	0.175***		0.044	0.061	0.099**
	Constant	-2.046***	-1.763**	-1.281*	2.445	-2.623***	-2.406***	-2.212***	1.840

Table contains random effects. All variables are in natural logarithms. ***, **, * statistically significant at 1%, 5% and 10%, respectively. Standard errors are robust to heteroskedasticity and serial correlation within port-cities.

Table 6: Port Performance TEU

		Port performance						
		TEU (1)	**TEU (2)**	**TEU (3)**	**TEU (4)**	**TEU (5)**	**TEU (6)**	**TEU (7)**
	GDP	1.270***	1.379***	0.298	2.561***	0.971***	4.150	2.668
Economic	**Port GVA**	0.941***	0.859***	1.722***	0.402***	0.742***	0.357	0.439**
	Urban GVA	-0.726***	-0.668***	-1.321	-0.296**	-0.700***	0.055	-0.483
	Population	-1.833***	-1.691***	8.094**	-3.103***	-1.486***	-2.079	-5.562**
	Service employment	0.381*	0.359	-8.731*	-0.097	0.751*	-8.869*	2.383
	Port employment	-0.132	-0.155	1.537***	0.026	-0.263	1.081***	0.336
Demographic	**Low education**					-0.053	3.820***	1.464
	Medium education					-0.100	7.727***	-0.963
	High education					0.307	3.567*	-1.425
	Patents					0.094***	-0.034	0.037
	Road			-13.155***	-0.825		-8.770	-0.131
	Rail			-0.207	0.058		0.827	0.677
Infrastructure	**Barge**			8.824***	-0.349		3.388	-1.230
	Max. port depth				3.924***			4.275***
	Spatial separation		-0.668***	-2.873***	1.109***	-0.629**	-3.463***	1.518*
	Constant	16.281***	14.827***	-38.366*	15.947***	15.153***	-17.748	36.307

Table contains random effects. All variables are in natural logarithms. ***, **, * statistically significant at 1%, 5% and 10%, respectively. Standard errors are robust to heteroskedasticity and serial correlation within port-cities.

Table 7: Port Performance Total Tons

		Port performance						
		Tons (1)	**Tons (2)**	**Tons (3)**	**Tons (4)**	**Tons (5)**	**Tons (6)**	**Tons (7)**
	GDP	0.512***	0.500***	0.361	1.717***	0.535**	2.691	1.664
Economic	**Port GVA**	0.263***	0.270***	0.970***	0.180**	0.269***	0.157	0.214
	Urban GVA	-0.244***	-0.248***	-0.749	-0.135	-0.245**	0.078	-0.295
	Population	-0.415**	-0.478**	4.344*	-2.364***	-0.499	-1.290	-3.703**
	Service employment	0.038	0.042	-4.704	0.468	0.172	-5.270	2.524
	Port employment	0.067	0.063	0.841**	-0.064	-0.081	0.671**	0.155
Demographic	**Low education**					0.197	2.345**	0.714
	Medium education					-0.022	4.257***	-1.449
	High education					0.192	1.971	-1.487*
	Patents					0.036**	-0.001	0.047
	Road			-6.361**	1.025		-4.988	0.997
	Rail			-0.386	-0.227		0.689	0.585
Infrastructure	**Barge**			4.600**	-0.896**		2.072	-1.127
	Max. port depth				2.351***			2.961***
	Spatial separation		0.184	-0.985***	1.401***	0.075	-1.449***	2.002***
	Constant	10.698***	11.294***	-18.131	14.407***	9.333*	-8.723	28.722

Table contains random effects. All variables are in natural logarithms. ***, **, * statistically significant at 1%, 5% and 10%, respectively. Standard errors are robust to heteroskedasticity and serial correlation within port-cities.

CONCLUSION

In this research we were determined to get an answer on a long debated question, do ports and cities still benefit from being in close spatial proximity. The leitmotiv in the literature stresses that the separation, both spatially as well as economically, has eroded the former close integrated mutual beneficial development of ports and cities. We have seen that port and cities historically developed in close relationship with each other, what has been the cornerstone in the development of many of the leading metropolitan areas in the world. The relationship between ports and cities formerly was self-reinforcing, where positive developments in urban growth led to increased port activity and vice versa. However, technological developments and globalizing forces have said to disrupt the immemorial relationship, and ports being located within the urban environment today are rather concerned as an impediment in the success of both ports as well as cities. The hypothetical arguments against a possible positive relationship between ports and cities are considerable and constructed from many different perspectives. On the other hand, counter arguments of a possible positive relationship of being in close proximity are to be found less frequently and many times these arguments are primarily based on historical views. Ports make less use of the urban labor pool, and pecuniary benefits are spread across extensive hinterlands and among the numerous international actors, leaving the local environment primarily with the negative externalities. However, when looking at the world's leading ports, we can observe that despite all the negative concerns many ports still function within an urban environment and are closely connected to these urban settlements. The urban ports even remain their dominance over better located competitive non-urban ports. The urban character of these ports thus must surely have some kind of advantage over the non-urban ports.

As we have seen, there exist two main arguments in the explanation of the remaining urban dominance in port competition. First, concerns the involvement of local place-based actors in creating the most competitive ports and port environments. In this present day both local and national governments, port authorities and port business communities still stress that the development of ports could be a key factor in the economic development of local economies. Though the impacts have been reduced, the local environment can still profit from employment creation and the value adding activities concentrating in and about the port cluster. Second, we have seen how acting in an urban environment forces the ports to be innovative and creative in order to remain the support of the local environment and to perform in the highly competitive market. In order to deal with the complexity of operating in this environment, the port actors make use of the

knowledge institutes and knowledge intensive business services to be found in the urban environment.

The empirical research has brought forward some interesting and compelling results. The research on 21 European port cities have shed some light on the developments in the port – city relationship, by studying port and urban performance over the time frame 2000 – 2012. The results may give an explanation why the port – city relationship is so much debated in the literature. When looking at port and urban performance together with spatial proximity, we get some interesting mixed results.

When looking at urban performance, the results show that the urban environment can certainly profit from having a port. Urban performance and port performance are positively related, where an increase in port performance will be beneficial to the urban environment. Having more throughput passing through the port will provide employment opportunities and will lead to more value creation in the port cluster. This will also apply to the related activities, of which also to be found in the urban environment. However, when looking at spatial proximity, the urban environment does benefit if the distance between the city and the port is greater. Suggesting that too close proximity will hold the urban environment back and the negative externalities will be at work affecting city performance. When looking at the relationship between port performance and urban performance, we again find a positive result. Though, this result raises some causality concerns, regarding the direction of the effects. We are to believe that we can almost certainly assume that the causality can be seen as that port performance causes the positive effect on urban performance, rather than the reversed pattern. We can make this assumption, for as we know that most of the throughput passing through the European ports is destined for extensive hinterlands. Just a small fraction of the throughput is destined for the local environment of the port. The most striking result from the empirical results is that the relationship of spatial proximity and port performance is positive. Where we found a negative relationship with urban performance, we find that ports thus do profit from being in close proximity with the urban environment. This result implies that the port actors thus do profit from the local urban environment. The urban environment provides ports with important inputs for ports to survive in the highly competitive market.

Overall, when looking at the results of the empirical research, we can conclude that both ports as well as cities can profit from each other's presence. Cities can benefit from employment opportunities and the value adding activities. The ports benefit from the presence of labor, especially skilled labor and knowledge that concentrates in urban spaces. We started out with our main research question: *do both ports and cities still profit, after decades of major technological and globalization changes and the numerous bilateral negative externalities, from being in close*

proximity? The answer to this question would then be yes, both ports and cities do profit from being in close proximity. Especially the port cluster can profit from being located near or within the urban environment. We cannot deny that port activity has moved downstream, predominantly in search of excessive land for new large capital intensive terminals. Though, the increased distance is relatively small and does not impede the beneficial interaction between the port cluster and the urban environment.

DISCUSSION, POLICY RECOMMENDATIONS AND FUTURE RESEARCH

This research has shown that port and cities are still closely related in this present day. Thereby, proximity is an important factor in the success of port cities. This research has contributed to the existing literature in several ways. The discussion on the relationship between ports and cities dates back to the beginning of the 20th century and is still very present in today's literature. The leitmotiv is the separation in the port – city relationship in many dimensions, e.g. economical, geographical, and institutional. This research has shown, both theoretical and empirical, that the interaction between ports and cities is still an important factor in the performance of ports as well as cities. The majority of the literature focuses solely on the impact of ports on regional development. This research broadened the scope by also including the reversed pattern, looking at the impacts of the urban environment on port performance. This generated some interesting results that are helping to explain why so many ports still operate in or near the urban environment. New is the spatial dimension included in the empirical analysis. The spatial separation is to be found in other studies (e.g. Bird, 1963; Hoyle, 1989; Norcliffe, 1996), however these studies are theoretical in nature and date back to the past century. Where the container did make its entrance and the globalization process did already affected the maritime port and shipping industry, however speculating on the outcomes of these developments. The empirical analysis in this research focused on the performance of the port and urban environment of 21 European port cities form 2000 till 2012. Where the factors of change have had their time to settle, and allowed for a study on the most recent impacts in the port city relationship.

We have seen that both ports and cities can profit from having related variety in the economy, ranging from manufacturing plants to business services. Related variety concentrated round the urban environment allows for knowledge to be transferred at greater ease and allow for an increased probability of intersectoral knowledge spillovers to occur. Skilled labor and knowledge intensive business services are becoming ever more important for port actors to operate in the increasingly complex industry. Where the urban environment also benefits from attracting knowledge workers and high value business services, as they generate high incomes and value added. The knowledge workers and business services are attracted to well-developed urban locations, with a high quality living environment. As policy recommendation, local governments should do its utter best in creating an attractive living environment, where also port authorities could take responsibility. Next to encouragement of the existing port and urban actors, the advent of new businesses and human capital should be stimulated. Allowing for greater job opportunities, value added and knowledge creation, it can further help to prevent the port city from a lock-in.

This research can be extended and better specified for further future analysis. The data used in the empirical analysis allows for improvement in several directions. Due to limitary data availability, this research included 21 European port cities, where an extension would be desirable. Especially, including North-American and East-Asian port in the analysis could give a more comprehensive view on the port – city relationship. These regions have very different characteristics (e.g. import vs. export based), however both regions are characterized by ports and cities to be closely related. Further, a better specification of the port sector and service sector is preferred. Especially, the port sector and port related sector could be better defined. This will provide more reliable statistics on the effects in the port – city relationship. As for the empirical research, the fixed effects model would have been the preferred model. However, due to multiple variables that remained constant over time, at least for the studied time period, we were 'forced' to use the random effects model. There also arise some causality concerns. Traditionally, increased city performance would have resulted in port activity growth. Today, most throughput is predominantly destined for extended hinterlands, rather than the local urban environment. Thereby, we can assume it is port performance that will have a positive effect on urban performance, instead of the reversed pattern.

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APPENDIX 1: DATA

Maximum port depth (meters) **Port-directory.com; worldportsource.com**

Spatial separation **Google maps – World Port Source**

Port related employment and GVA (sectors based on Havenmonitor 2012) **Eurostat**

Agriculture, forestry and fishing, Industry (except construction), Manufacturing, Construction, Wholesale and retail trade; transport; accommodation and food service activities; information and communication, Wholesale and retail trade, transport, accommodation and food service activities.

Urban related employment and GVA **Eurostat**

Information and communication, Financial and insurance activities; real estate activities; professional, scientific and technical activities; administrative and support service activities, Financial and insurance activities, Real estate activities, Professional, scientific and technical activities; administrative and support service activities, Public administration and defense; compulsory social security; education; human health and social work activities; arts, entertainment and recreation, repair of household goods and other services, Public administration, defense, education, human health and social work activities, Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies.

Gross domestic product (GDP) at current market prices by NUTS 3 regions **Eurostat**

Volume (in TEUs) of containers handled in each port, by loading status **Eurostat**

Gross weight of goods handled in each port, by direction **Eurostat**

Population on 1 January by broad age group, sex and NUTS 3 regions **Eurostat**

Road, rail and navigable inland waterways networks (KM) NUTS 2 **Eurostat**

Patent applications to the EPO by priority year, NUTS 3, IPC sections and classes **Eurostat**

Ships or other waterborne vessels; related equipment

Education age 25-64 (as representative of working population) Nuts 2 **Eurostat**

Low - Less than primary, primary and lower secondary (levels 0-2)

Medium - Upper secondary and post-secondary non-tertiary (levels 3 and 4)

High - Short-cycle tertiary, bachelor or equivalent, master or equivalent and doctoral or equivalent (levels 5-8)

APPENDIX 2: CORRELATION MATRIX

	ln_avg	ln_teu	ln_tons	ln_gdp	ln_pemp	ln_pgva	ln_pop	ln_semp	ln_ugva	ln_ledu	ln_medu
ln_avg	1.0000										
ln_teu	0.2004	1.0000									
ln_tons	0.7374	0.7324	1.0000								
ln_gdp	0.1979	0.0349	0.3856	1.0000							
ln_pemp	0.2704	0.1558	0.5146	0.9291	1.0000						
ln_pgva	0.2393	0.2240	0.5205	0.9211	0.9187	1.0000					
ln_pop	0.2615	0.0405	0.4461	0.9816	0.9654	0.9289	1.0000				
ln_semp	0.3907	0.0353	0.4650	0.9508	0.8361	0.8409	0.9125	1.0000			
ln_ugva	0.2099	-0.1249	0.3029	0.9540	0.8664	0.9045	0.9401	0.9221	1.0000		
ln_ledu	0.7785	-0.0812	0.6094	0.5685	0.6003	0.5418	0.6518	0.6667	0.6366	1.0000	
ln_medu	0.6315	0.1794	0.7002	0.8733	0.8560	0.8265	0.8924	0.9328	0.8344	0.8296	1.0000
ln_hedu	0.7095	0.0486	0.6253	0.7608	0.6903	0.6774	0.7551	0.9046	0.7759	0.8596	0.9447
ln_barge	0.7896	-0.2504	0.4080	0.2590	0.2196	0.1766	0.3005	0.4707	0.3810	0.8739	0.5945
ln_road	0.6664	-0.3638	0.3276	0.2844	0.3293	0.2400	0.3833	0.3910	0.4273	0.9085	0.5509
ln_rail	0.1976	-0.4446	0.0858	0.4544	0.5528	0.4479	0.5774	0.3534	0.5763	0.6915	0.4438
ln_patent	0.2736	0.5004	0.5852	0.6608	0.6763	0.6712	0.6364	0.6534	0.5088	0.2761	0.6667
ln_maxdep	0.5621	0.5442	0.8373	0.2213	0.4099	0.3427	0.3401	0.2489	0.2000	0.6394	0.5221

	ln_hedu	ln_barge	ln_road	ln_rail	ln_pat~t	ln_max~p
ln_hedu	1.0000					
ln_barge	0.7725	1.0000				
ln_road	0.6507	0.9145	1.0000			
ln_rail	0.3790	0.4676	0.7670	1.0000		
ln_patent	0.5262	0.0143	-0.0755	-0.0754	1.0000	
ln_maxdep	0.4475	0.4494	0.5185	0.3802	0.2769	1.0000