

# **The Seaport Network Hamburg**

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# Introduction

## *1 - The General Framework of the Study*

The activity of transportation is one of the major factors of influence on the development and integration of the local economies. The prosperity of a certain region depends often on the level of accessibility to its resources with respect to the other locations. Within the transportation network, seaports seem to be the most interesting example of a territorial economic system, which is forged on the basis of a node of transport, and which exploits the locational advantages at a site where different modalities of transport meet and interlace [Marchese, 1996] [Weigend, 1956].

The seaport economy gives origin to a set of economic activities, which are direct and indirect related to the maritime cycle of production. The seaport region is much more than just a transport node: it is a potential pole of economic growth [Perroux, 1950]. The maritime activities of production at the seaport require typically a high degree of specialization of the labour force. The specialization of the production at the maritime region gives origin to the external economies of scale, called economies of scope, whose nature is cumulative.

According to the law of Verdoorn, there is a positive relationship between the rate of growth of the product, and the rate of growth of the productivity. This law is on the basis of the model of technical development of Kaldor [Valli, 1993]. This model seems to fit well the path of economic growth of a seaport region, in the sense that the economic prosperity of a maritime region is more and more depending on the capital deepening, and on the rate of technological development [Musso, 1996].

The economy of the seaport is becoming more and more capital intensive and land intensive. This is due to two fundamental changes in the transport sector, as follows: first, the diffusion of the containerisation and the inter-modality, which are two technical innovations complementary to each others [Hayuth, 1982] [Slack, 1985]; second, the improvements of the transport network on the land side, towards the hinterland of the seaport. Furthermore, the diffusion of the information technology in the maritime sector has induced the growth in productivity of the port labour, while simultaneously the demand for port workers with a high level of specialization has become more pressing [Borruso, 1971].

At the same time, the technical innovations in the maritime sector allowed a higher level of freedom, or indifference, in the locational choices of some port related activities of production. Due to the lower costs to transport the raw materials to the inland locations, some industries relocated outside the area of the seaport, sometimes far away from the port region. At the locations in the inland, the advantages to locate were higher because of the lower costs of the land and of the labour force. In a further stage, the industries relocated at the countries where the raw materials were extracted.

During the last decades, the transportation chain has been faced with a restructuring process, that was mainly due to the diffusion of the containers and the inter-modality. The application of the information technologies to the transport chain stimulated the creation of new economic activities, in the sectors of the distribution and logistics. The seaport regions were the best candidates to become the central nodes of the distribution and logistics networks. However, the handling of containers is a land extensive and capital intensive activity. It has to be supported by a set of efficient technological equipments at the seaport, as well as by an efficient network of transport infrastructures on the land side, towards the hinterland, in order to avoid any delay in the transfer of the goods [Charlier, 1992b].

The maritime site is a crucial node of the transport network, where it takes place the change in the transport modality within the logistic chain. Because of the temporal discrepancies between the maritime and land transport, the cargo have to be kept for a while at the maritime site. Therefore, warehouses are necessary at the seaport region. The two classical port activities of transshipment and storage add value to the goods, the former because of the spatial transfer of the freights, the latter because of the transfer through the time. Another way to add value to the goods is the performance of the activities of distribution and logistics. The seaport region has to be able to attract such activities, which add value to the freights because they change the utility function of the goods [Van Klink, 1995].

On the oceanic site, the shipping companies trend to use vessels of bigger and bigger dimensions, and to make their stopping calls just at few main ports per continent, in order to exploit the economies of scale at the best [Nuhn, 1994]. In fact, the locational choices of the shipping companies are an important exogenous factor of influence on the structure of the seaport region. Therefore, the economies of density in the maritime sector induced the flourishing of the

hub & spoke system, as well as a strong competition between the main ports on the same continent.

If a main port wants to stay in competition with the other main ports of the continent, then it is fundamental to guarantee the availability of free land for the operations related to the handling of the containers, and for the activities of distribution and logistics. This point remarks the importance of the accessibility to the economic resources of the seaport.

Seaports are strictly related to their hinterland and foreland, so that these three elements form together a continuum space [Nuhn, 1994]. The technical progress and the improvement of the transport infrastructures on the land side, enable the seaport to penetrate the continent deeper and deeper. In the recent years, the activities of distribution and logistics aimed to the integration of the different phases of the transportation activity.

The role of the multi-modal transport operator MTO [Marchese, 1996] has been enlarged, in the more recent years, by the new figure of the total logistics provider. It is supposed to hold the reins of the whole logistics chain, but there is still a lot of uncertainty. This new economic actor should be able to choose the best route for the transport from-point-to-point, and not just the best transport modality only for one or few segments of the transport chain. It follows that there will be a new form of competition between integrated transport routes, rather than between transport modalities [Oppenheim, 1995]. Furthermore, the spatial constraint of the geographic distance between the seaport and the final inland destination of the cargo should become weaker and weaker.

The scarcity of the free territory at the seaport area has been always one of the fundamental problems that the local administration had to solve. As the Anyport model of Bird depicted for the 70s, the seaport paid attention to the use of the port territory, and to the construction of new docks and quays out of the location of the port core [Bird, 1971]. This is the last stage of port development in the Bird's model. It reflects the engagement of the seaport to attract the vessels with a growing loading capacity, that were at the time mainly oil tankers and bulk ships. The Anyport model of Hoyle for the 80s embraced a further stage of development of seaports [Hoyle, 1988]. It referred to the redevelopment of the waterfront, that is at the present time a ongoing process in many seaports. The waterfront is usually redeveloped for business and tourist purposes, which are indirectly related to the port activity.

An innovative solution to the lack in free territory has been given at the end of the 90s, and gave origin to the next stage of port development, the seaport network. Van Klink described this new phase with reference to the port of Rotterdam. The port was expanded at a new functional site, at a location outside of the administrative port area. This port node is geographically distant from the port core, but is functionally related to the main port [Van Klink, 1995].

According to the new stage of port development, the long term investments in new port infrastructures have to take into account the building of new functional sites, outside the administrative area of the main port, in order to solve the more and more urgent problem of the lack of space.

The seaport network embraces various aspects of the spatial structure of the port economy: 1) the *physical network* of the transport infrastructures, because the seaport is a complex node where the different transport modalities meet and interlace; 2) the *economic network* of economic activities of production (directly and indirectly port related) that are exploited at the seaport node, because potentially it is a pole of economic growth for the whole maritime region, 3) the *commercial network* of the trade relationships between the seaport and its hinterland and foreland, because the three elements build up an indissoluble continuum space; 4) the *functional network* of the seaport, when the seaport expands and invests in new functional nodes outside the administrative borders of its territorial body. The functional process of networking implies also the integration of the new port locations into the seaport network.

## **2 - The International Debate on the Seaports in the Economic and Transport Geography**

The study of the seaports and their maritime city-regions includes the fields of research of the economic and transport geography at the international scale. Since the beginning of the 20<sup>th</sup> Century, the seaports has been conceptualised as a spatial part of the maritime city, hence the focus of the debate was on the functional relationships between the port and its city [Reinhardt, 1901], [Schöller, 1953].

The relevance was given in particular to the impact of the port economy on the surrounding maritime region [Rühl, 1920]. Some studies were aimed to integrate the seaport into the geographical structure of the city, with reference to

the German port cities [Oppel, 1912], to the port cities in Texas [Hannemann, 1928], and with reference to the English maritime cities [Schultze, 1930].

In particular Mecking, at the German Congress of Geography in the year 1927, gave prominence to the fact that the research on the seaports included more the technical aspects and the relations to the national economy, rather than the geographical point of view [Mecking, 1928]. A next study gave one of the first definitions of port-city-interface, as the crossing area between the maritime space and the land space [Mecking, 1930].

The close relationship among the seaport, its hinterland and its foreland was studied by Sargent, Boermann and Morgan, with reference to the commercial structure of the port economy [Sargent, 1938], [Boermann, 1952], [Morgan, 1952]. One model to study the hinterland of a port was the gravity model of Ullmann [Ullmann, 1941]. At the beginning of the 70s, Bird and Kenyon resumed the spatial model of Ullmann to explain the flourishing of a seaport site in terms of *great inertia*, *great momentum* [Bird, 1971], [Kenyon, 1970]. Weigend gave a wide range of studies in particular on the hinterland of the seaports [Weigend, 1956, 1958]. The classical assumption under the space constraint was the following: the larger the geographical distance between the seaport site and its hinterland, the weaker their embedment [Weigend, 1958]. In the 80s, Hayuth pointed out the causes of the spatial variations of the hinterland during the time [Hayuth, 1982].

During the 60s, the revitalization of the waterfront began in the U.S.A. [Kenyon, 1968]. The study focussed on the use of the land at the wharfs, and on the structure of the port area with reference to the maritime functions exploited at the seaport site. In particular, Kenyon forecasted the future necessity of availability of free territory at the port location, because he supposed that the terminal operations of loading/unloading of the cargo at the wharfs were growing of importance, especially with reference to the handling of the containers.

In the same period, Forward suggested the participation of the regional agent in order to plan properly the use of the land at the maritime interface, in particular with reference to the revitalization of the waterfront in the case of Vancouver [Forward, 1968], of the Canadian ports [Forward, 1969], and of the Australian ports [Forward, 1970]. Therefore, the public planner was supposed to take a relevant role in the administration and organization of the port territory as a integrated part of the port city.

Afterwards, Norcliffe presented a study on the port cities of Northern America, and criticized the destination of use of the port area for economic activities not properly related to the port economy [Norcliff, 1981]. McCalla pointed out the spatial split between the functions and the destination of use of the inner port territory at St. John and Halifax, which was used for urban purposes rather than for port related activities [McCalla, 1983].

During the 80s, several studies embraced the close relationships between seaports and their city-regions. In particular with reference to the British literature, Hoyle and Pinder presented a wide range of researches on the field. They point out that the maritime activities exploited at the seaport location may promote the regional economic growth of the surrounding area [Hoyle, 1973, 1981, 1996], [Hoyle, Pinder, 1981, 1992], [Hoyle et al. 1992], [Hoyle, Pinder, et al., 1988]. By following the theory of Christaller [Christaller, 1933], a seaport location may support the geographical function of a central place, where the regional growth is stimulated due to the process of circular and cumulative causation [Myrdal, 1957].

In fact, a seaport region should reach a critical mass in order to start the process of economic growth. During the 90s, the interest of the economic geographers was focussed on the definition of models of economic growth which include the spatial elements. The geographical factors were referred in particular to the activity of transportation. The transportation activity was always been considered as a derived demand generated by the other economic activities. The New Economic Geography NEG stressed the importance of the accessibility to the economic factors of a region. In particular, the model of Krugman considered the geographical distance between two regions as an endogenous factor of the model. The economic activities of production and the labour force tend to locate at the region that is more accessible [Krugman, 1991].

Brownill stressed again the fundamental role of the public planner in the organization and structuring of the port territory [Brownill, 1988, 1990], with reference to the London Docklands, as well as Hershman for the U.S.A. [Hershman, 1988], and Bruttomesso for Italy [Bruttomesso, 1993]. Martin and Rogers referred to the model of Krugman to remark the patterns of accessibility to a region. They pointed out the role of the public infrastructures, defined in a broad sense, at the domestic and international scale [Martin, Rogers, 1995].

The German literature on the field of seaports and city-regions includes several studies of Nuhn on the economic and transport economy and geography

[Nuhn, 1994, 1996], as well as on the port of Hamburg with reference to the planning of future expansions of the port area [Nuhn, 1989], [Nuhn, Oßenbrügge et al., 1983]. Priebes points out the possibility of a port-city without a city-port [Priebes, 1998]. The Italian literature refers to several publications of Marchese and Musso, in particular on the spatial impact of the structure of the port economy on the city-region, in terms of the external benefits and costs that the presence of the maritime structure of the seaport implies on the surrounding territory [Marchese, 1996], [Musso, 1996].

The very last developments in the research on the seaports are given by the recent study of Van Klink on the port of Rotterdam [Van Klink, 1996]. A new stage of development is added to the two models of Bird [Bird, 1971] and Hoyle [Hoyle, 1981]. The last stage in the model of Hoyle refers to the redevelopment of the waterfront. Van Klink suggests the stage of the port network, when the seaport locates a new maritime settlement outside its administrative area, in order to resolve the problem of the lack of free territory at the port location.

### ***3 - The Structure of the Dissertation***

This dissertation starts from all the previous premises, and it resolves upon to deal with the manifold geographic and economic aspects of the structure of the seaport regions. In particular, the seaport network of the Free and Hanseatic City of Hamburg has been investigated thoroughly.

I approached for the first time the field of the transport geography and economy during the period August 1997 - March 1999, when I wrote the thesis of Laurea at the University of Trieste-Italy on the port of Hamburg. Since May 1999, I had the opportunity to work for the BALTICOM Project – BALTIC Transport Communication and Regional Development in the framework of the INTERREG II C, and to develop this dissertation at the University of Hamburg.

The methodology of the research follows the source of the statistical data, that was the Statistisches Landesamt der Freien und Hansestadt Hamburg. The temporal range of the data mostly embraces the years 1970-2001. Sources different from it are mentioned in such a case.

The dissertation is organized into three theoretical sections (Sections 1 to 3) and four empirical sections (Sections 4 to 7), and is divided into 17 Chapters.

The Introduction gives the general basis on which this study lays, as well as the international debate on the field of research on the seaports, their city-regions and their hinterland and foreland. The structure of the dissertation is also explained in the Introduction. At the end of the empirical part, the Conclusions provide a summary of the results, some final remarks and recommendations.

**SECTION 1** is referred to the transport function of the seaports. **Chapter 1** deals with the different interpretations of the concept of accessibility to the seaport. Furthermore, there are described the economies of networking, and the main indicators of the dimension of a port. **Chapter 2** explains the role of the institutions and of the economic agents at the seaport, at the local, national and international level.

**SECTION 2** refers to the seaports as distribution nodes of the transport chain. In the **Chapter 3**, the spatial and economic agglomeration of the maritime sector has been analysed, as well as the economic and environmental impact of the transportation activity. **Chapter 4** treats of the inter-modal, multi-modal and combined systems of transportation, while **Chapter 5** explains the spatial scale of the competition between seaports, in particular with reference to the economic accessibility to the hinterland and foreland, and to the competition between integrated routes of transport.

**SECTION 3** refers to the seaports as logistics nodes. **Chapter 6** explains the impact of the activity of logistics on the seaport region, in terms of the relationship between the freight transport and the economic growth, as well as in terms of the new concept of city logistics for the freight transport within urban areas. Furthermore, there are summarized the main patterns of the restructuring process of the logistics supply chain.

**SECTION 4** begins the empirical study on the seaport of Hamburg, as node of transport of the network. **Chapter 7** refers to the spatial and economic location of the seaport of Hamburg. There are given the patterns of accessibility to the seaport, according to the wide interpretation that was given in the Section 1. Besides the geographical elements of accessibility and the dynamic of the port labour, the role of the local agents of Hamburg is particularly stressed, as follows; first, it is explained the relevance of the strategies of port and transport policy of the Senat; second, the regional role of the local entrepreneurs of Hamburg is supported by the statistical data. In particular, the analysis of the data refers to the value added of the firms posted in Hamburg, and to the foreign trade of the local importers/exporters. **Chapter 8** refers to the maritime function of the seaport of Hamburg. The analysis of the statistical data refers to

the impact of the containerisation on the structure of the cargo handled at the main port of Hamburg, as well as to the function of gateway for the foreign trade of the German Länder. Furthermore, the transit function for the cargo through the seaport of Hamburg refers to the statistical data on the maritime transit, on the transit by road, as well as on the transit by inland waterways.

**SECTION 5** deals with the main seaport of the European Northern Range. **Chapter 9** introduces the peculiarities of the maritime agglomeration at the main ports of the Northern Range. Furthermore, this chapter analyses their market position and their spatial scale of competition. **Chapter 10** refers to the restructuring process of the German seaports after the fall of the Berlin Wall. It gives also an overview on the impact of the process of political and economic restructuring on the states of the Central and Eastern Europe. It refers in particular to the Baltic Sea Region BSR, and to the European instrument of networking between the seaport regions on the Baltic Sea that was given by VASAB 2010.

**SECTION 6** refers to Hamburg as a distribution and logistics node of the transport network. The inter-modal agglomeration at the seaport of Hamburg is given in the **Chapter 11**. The next chapters give a deeper analysis of the modal split of the seaport region, as follows. **Chapter 12** refers to the maritime transport modality. It reports the statistical data that are related to the maritime accessibility of the vessels to the seaport, and to the deepening of the river Elbe. Furthermore, it is given the analysis of the statistical data on the cargo traffic and the geographical split of the maritime traffic of the port of Hamburg, in particular with reference to the dynamic of the BSR. **Chapter 13** gives the analysis of the railways network, with reference to the inter-modal services that are offered at the national and international level, especially after the deregulation of the rail sector. It is relevant the role of the Railways of the Port of Hamburg at the local level, in particular with reference to the plans of improvement of the links of the railways network inside the port area. **Chapter 14** refers to the inter-regional role of the network of inland waterways of Hamburg. It is analysed the integration into the inter-modal transport system of this transport modality at the seaport of Hamburg, as well as the recent works of improvement of the network of channels and of the river Elbe. Furthermore, the statistical data refer to the structure of the cargo handled, and to the geographical split of the commercial traffic of the Hanseatic seaport. **Chapter 15** refers to the road transport modality, that is supposed to be the less environmental friendly with respect to the other mode of transport. The links of

the road network have been spatially evaluated at the regional, national and international levels.

**SECTION 7** is aimed to open a new vision of the role of the seaport of Hamburg in terms of a functional seaport network. **Chapter 16** refers to the plan for the building of a deep sea container terminal outside of the administrative territory of the Land of Hamburg, in order to strength the competitiveness of the German seaports against the other main ports of the European Northern Range. The statistical data on the seaport of Hamburg give some evidence in favour of the establishment of a functional seaport network. It is shown the dynamic of the structure of the cargo, with reference to the maritime traffic, as well as the analysis of the traffic according to the typology of the freight vessels. A first step towards the development of the seaport of Hamburg into a seaport network is given by the mini-land bridge by rail, promoted by the HHLA towards the Baltic Sea. The constant search for the availability of new port areas is stressed in the **Chapter 17**. It refers to the deepening of the river Elbe, and to the restructuring process of the port area, in particular with reference to the building of the new site of Altenwerder. Finally, the **Conclusions** give the synthesis of the dissertation on the seaport of Hamburg, some remarks and recommendations.

# **Section 1**

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## **Seaports as Trans-port Nodes**



# 1 The Accessibility to the Seaport

## 1.1 *The Concept of Accessibility*

The concept of accessibility is traditionally interpreted as the accessibility to a region rather than in terms of accessibility to the potential economic actors. This approach leads to an aggregation problem in terms of spatial aggregation and sectorial aggregation [Vickerman, 1999].

The **spatial aggregation** refers to the synthesis of a region as a nodal point, which is supposed to represent the whole region as a homogeneous entity. This aggregation is usually made according to a single transport mode, which is assumed to reach the central point, representative of the whole geographical area.

Therefore, two key assumptions are made. The first assumption is the *spatial nodal* concentration, through the process of geographical aggregation of a region into its central place [Christaller, 1933]. It is supposed to be representative of the main concentration of population, and of economic and social activities, as well as to be the centre of the political and administrative power of the area. The second assumption is the *modal* concentration, which refers to the depiction of the whole region by the use of a single transport modality, usually the most common used. This assumption often leads to a mystification of the real accessibility patterns of a region, due to the different parameters that can be applied. In fact, if a peripheral region is under study, and if the road transport modality is considered, then a lack of accessibility may appear, for example, because of the poorness of the road infrastructures, even though the region itself may perceive to have a high level of accessibility with respect to a different transport mode, for example the air transport or the short sea shipping. Furthermore, the recent development into the transport sector leads to the integration between different transport modes with the goal to achieve a higher efficiency of the transportation activity through the application of the inter-modality and logistic concepts.

The **sectorial aggregation** is referred to the assumption of the homogeneity of the aggregate flows of people and goods moving along the links of the networks, that is not the reality. Under this assumption, the value of the spatial and temporal distances is supposed to be homogeneous for each user of the same infrastructure.

In a broader sense, the concept of accessibility refers to the rapid movement of people and goods between different sites. The accessibility between places increases when the economies of scale and time in the transportation sector are performed. This means that the transport activity is becoming less costly between the two locations, while the propensity for interaction is growing. It follows that the rate of accessibility of a certain seaport region reflects the level of the transport network, both in terms of quality of the infrastructures and of its carrying capacity.

The process of economic integration of the peripheral regions has been explained in a traditional way through the application of the conventional concepts of accessibility and economic potential [Vickerman, 1999]. Within this context, the concept of accessibility assumes different interpretations, as follows. On one hand, a dis-aggregated approach considers the accessibility within regions and the accessibility to networks. On the other hand, the New Economic Geography NEG aims to explain the diversity between regions, that is the convergence and divergence of forces within the process of economic integration, by shaping spatial economic models, which embrace the characteristics of the production, of the imperfect competition markets, as well as the transportation costs. These models have a traditional approach to the demand for transport activities, that is considered as a derived demand, rather than as a self-generated demand. Therefore, the structure of the transport market seems to be missed. In fact, the economic development and integration of the peripheral regions seem to depend by two factors, as follows: a) by the geographical periphery, that is conventionally understood in terms of spatial geographic location at a certain distance away from the core region<sup>1</sup>; and b) by the imperfection of the structure of the transport market itself.

The concept of accessibility embraces also the attraction patterns of a seaport region. The attractiveness of a seaport region may be defined as the whole range of opportunities and economic activities located at the maritime site.

The following two non-symmetrical indicators can be used to measure the accessibility. The first indicator may be the attractiveness of the seaport region as a place of *origin* of the transport movements, while the second may be the attraction patterns of the seaport region as a place of *destination*. In the former

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<sup>1</sup> This traditional interpretation implies a time and costs delay due to the physical distance and the presence of possible obstacles to the transportation activity itself.

case, the seaport region may have a high level of accessibility as origin due to the easy connections to the other destinations. It is emphasized the accessibility to other places. In the latter case, the seaport region may be good reached from the other geographical sites. The accessibility to the local factors at the seaport are remarked.

From a geographical perspective, there are two ways in order to overcome the space [Westlund, 1999]. The first way follows the principle of contiguity: the integration of adjacent territories is performed through the spatially juxtaposition of geographical areas. The territory may be defined as a collection of areas or lands under some kind of political or military control. The second is the interaction of networks through the co-operation between points spatially separated: in this case, the spatial dimension becomes a weak factor, while the network interchange between the nodes of the network defines a new non-territorial space.

The territorial integration requires the network interaction between the nodes of a territory. The spatial interaction of the networks does not need a defined territory. In both cases, the removal of the territorial barriers, as well as the reduction of the friction induced by the network interaction are the two relevant impediments to remove.

The accessibility to a seaport region may be variously explained. Certainly, the spatial agglomeration of the maritime economic activities allocated at the maritime site is the first pattern of a seaport region, as well as the exploitation of the economies of scale within the maritime sector thanks to the technological innovation.

According to Weigend, the concept of seaport can be described as the site<sup>2</sup> of contact between the maritime space and the land space. At this location both services directed to the hinterland and to the organized maritime space are available. Therefore, the seaport can be conceptualised as a node, where the

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<sup>2</sup> Within the vegetal ecology, the concept of site is referred to a homogeneous area where some associated physical characters become relevant for the human settlement. A set of spatial interconnections and interrelations among localities rise. They are recognizable through the concepts of distance and dimension. Therefore the physical distances between the human settlements are crucial, as well as the administrative divisions and the boundaries between States [Pagnini, 1974].

oceanic and land transportation are spatially linked, and where they spatially meet and interlace each other [Weigend, 1958].

The geographical characteristics of the seaport site define the natural accessibility, while the human intervention brings the infrastructure and superstructure equipments to develop the seaport location.

The appeal of the seaport region is due also to the availability of a skilled labour force, that may be considered as a form of capitalization of the professional training.

This is particularly true because of the growing specialization in the port related activities, both in terms of mechanization and application of the information technology to the maritime operations.

The institutional framework within the public administration as well as the maritime operators at the seaport regional level are absolutely relevant.

But the influence of the decisional choices performed by the economic and institutional actors exogenous to the seaport region is undoubtedly important because of the continuous networking interchange between the seaport open system and its environment.

In fact, the maritime seaport site may be interpreted as an open system. It is possible to point out two different set of elements that are in relationship to the open system under observation: the physical factors and the human factors.

According to the neo-classical economic theory, the aggregate function of production  $Y$  is composed by the economic resources of capital  $K$  and labour  $L$ , as following:

$$Y=f(K,L)$$

The capital  $K$  can be split into:

- a) Natural Capital  $K_N$ : environmental and natural resources. Because of the non-economic nature of these elements, the problem of the most appropriate evaluation of the natural capital rises. In fact, there is a strong divergence between the discount rate to apply in order to value the natural capital damage suffered by the future generation.
- b) Physical Capital  $K_P$ : land, infrastructures, superstructures. The economic nature of the physical capital is plane.

The labour force  $L$  may be explained in terms of human capital as one of the endogenous elements of the economic growth. It derives from the learning-by-schooling, learning-by-doing and learning-by-knowledge processes. The all three processes influence the productivity both of the labour  $L$  and the physical capital  $K_p$ . The location of the point of convergence of the human capital  $L$  depends on the initial level of the seaport economic system under study. As Pareto demonstrated, the distribution of the welfare between regions tends to favourite the regions already reach, while the peripheral regions seem to have to remain comparatively poor [Bouchaud et al., 2000].

A further relevant pattern within a seaport network is the establishment of the non-material capital. It is given by all the relationships between the economic agents, the flows of goods between the seaports or the inland locations, etc. This is a spatial characteristic of the networking activity between seaport regions.

The economic growth of a seaport region is related to the higher intensity of the capital. This can be explained by following the model of Kaldor, which states that the function of the technical progress assumes that every innovation takes place together with a certain amount of capital investment. Therefore, the rate of growth of the production  $Y$  is a function of the rate of growth of the capital  $K$  [Valli, 1993]. Furthermore, there is a positive relationship between the rate of growth of the product and the rate of growth of the productivity, as is stated by the law of Verdoorn.

According to Solow, the technical progress may be supposed to be endogenous to the economic system. Hence, the production function  $Y$  can be rewritten as the following aggregate function of production [Valli, 1993]:

$$Y=A(t) f(K,L)$$

where  $A(t)$  is a multiplier used to show the technical progress through the time  $t$ . The technical progress is supposed to be neutral in the sense that it does not change the marginal substitution rates between capital  $K$  and labour  $L$ . Hence, it only shifts the aggregate production function  $Y$  upwards/downwards because of the variation of the product  $Y$  for fixed levels of the inputs.

The value of use of the economic resources changes according to the economic activities exploited at the seaport location. In general, the main characteristics of the economic resources are the following:

1. The ownership of the economic resources. It implies the control over them by a public or private agent, or by a public-private partnership. Furthermore, this control may be performed directly or indirectly.
2. The transformation of the economic resources into activities.
3. The versatility of the economic resources.

Each economic agent is supposed to compose his own utility function with respect to every seaport region according to the economic activities that may be performed at that certain maritime site. The economic agents should not change their current location if their utility function is maximized, but they could change route, mean of transport, and time scheduling of their movements. The utility function can be assumed to be modelled as follows [Nijkamp et al., 1998]:

$$\text{Equation 1.1} \quad u_{ij} = v_{ij} - \beta c_{ij}$$

where  $u_{ij}$  is the utility function for the economic agent in terms of net gain derived by performing the transport between the two sites  $i$  and  $j$  of the transportation network. The parameter  $v_{ij}$  gives the value of making the trip  $ij$ , while the parameter  $c_{ij}$  indicates the communication costs sustained for the trip  $ij$ , that is weighted for a cost-sensitive parameter  $\beta$ .

The location advantage  $LA_i$  of a certain maritime site  $i$  can be expressed as an expectation function  $E$  of the maximum net gain  $\max_j(u_{ij})$  for each economic agent  $j$ , as follows:

$$\text{Equation 1.2} \quad LA_i = E[\max_j(u_{ij})]$$

The following chapters give an interpretation of the concept of accessibility to the seaport regions and networks, according to the economic and transport geography.

## **1.2 The Economies of Networking between Seaports**

The seaport location is a potential regional growth pole because of the multiplier effects the maritime activities spread out to the surrounding region.

According to Perroux, the economic space is defined by the economic relationships among economic factors [Perroux, 1950]. In a broader sense, the spatial proximity of the economic elements loses of importance. Within the

seaport region, the economic relationships between the economic agents nest a network space in which the economies of scope are exploited at the local regional level. The functional relationships among the seaport location and the other maritime or inland functional sites (for example, the public logistics terminals) become of primary relevance when the seaport network is considered. Because of the reduction of the inland general transportation costs due to the betterment of the transportation networks, to the application of the two mutual concepts of inter-modality and containerisation, as well as to the promotion of the integrated logistics network, the space constraint of the physical distance between the seaport and the hinterland destination seems to become weaker and weaker.

By moving from this point of view, it might be defined a functional network of seaport related activities between the maritime port sites and their own hinterland. The economies of networking within the seaport network might derive from the economies of scope that each seaport region performs. In order to set the function of every seaport site, it should be defined the seaport typology with respect to the cargo handled at each seaport node.

The classification of the seaports depending on the cargo typology defines the maritime locations as universal seaports (i.e. Rotterdam, Hamburg), or as specialized seaports for particular cargo typologies (i.e. oil, container, etc.). The seaports of the potential network may be classified depending on the scale of competition (i.e. regional seaports, main seaports, etc.), or depending on the function performed (i.e. communication seaports, etc.) in the transport network. In order to compare seaports, the rate of containerisation is usually calculated, although sometimes it should be more appropriate to apply of other kind of indicators depending on the typology of cargo each seaport site usually handles.

The distribution centres located outside the seaport area play an important role in the seaport network, when the functional space has to be defined. The function of these load centres gained of importance after the application of the inter-modality concept and the use of the containers. In this way, the seaport site has externalised certain “unpleasant” functions, and has become a gateway for the cargo handled outside the seaport region.

At the same time, the local port administration achieves the implementation of certain activities in order to generate added value and to induce both direct and indirect effects on the labour market inside the seaport region. If a free port area exists, as in Hamburg, the goods in transit through the port can be elaborated in

order to produce added value. This is an economic instrument of endogenous economic growth. The transit of goods inside the free port area is exempted from any tax or imposition as long as the goods are stored inside the area. This is because the free port area is jurisdictionally a territory outside the boundaries of the customs of the European Union. The EU puts more and more restrictions to the free ports, hence it might be useful to consider the existing free port areas outside the EU, and to investigate the opportunities that might be exploited at these other nodal points. This should be an opportunity of economic growth for the transition economies that makes use of the local economic potential and resources in order to promote the economies of scope at the most peripheral seaport regions of the network.

### **The Theory of the General Systems**

According to the General Systems Theory of L. von Bertalanffy, a system can be defined as a set of mutual interdependent relationships between more elements [von Bertalanffy, 1972]. A system is something more complex. A system may be defined as the sum of both its elements *and* the relationships between them. This holistic approach is expressed by  $1+1>2$ .

### **The Laws of Thermodynamics and the Concept of Entropy**

The system theory is founded on the first two physical laws of the thermodynamics. The first law of the thermodynamics states the principle of energy conservation in a closed system. The energy in a closed system may be defined by the sum of the kinetic and potential energy of the elements in the closed system<sup>3</sup>. The second law of the thermodynamics states the increase in the entropy of a closed system. Supposing a closed system, the higher the level of entropy the higher the degree of disorder in the system. The entropy may be also defined in terms of the non-availability of energy in a system in order to make a job. In a close system, an increase in the entropy implies a decrease in the level of energy available because of the assumption of irreversibility in the transformation process. The zero law of the thermodynamics states that if two bodies are both in thermodynamic equilibrium with respect to a third body, then all the three bodies are in thermodynamic equilibrium with respect to each others.

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<sup>3</sup> Both the chemical and nuclear energy of the elements are excluded.

The fundamental principles for the existence of a system may be summarized as following [Parsons, 1970] [Celant, 1982] [Da Pozzo, 1982]: a) principle of self-preservation; b) principle of equilibrium state in relationship both with the external environment<sup>4</sup> and with its internal operating forces. The terminology "environment" means the set of physical, climatic and biological elements that influence the life of a system; c) principle of delimitation of its boundaries; d) principle of coherence; e) principle of definition of its own needs. The system and its own needs have to be explained moving from a holistic perspective. A system is not just the simple sum of the individual elements.

An open system is characterized by a continuous interaction process between its elements and the surrounding environment. Therefore a dynamic relationship between the open system and the environment takes place. This relationship implies a lively and endless adjustment of the internal equilibrium of the system itself.

#### **Minimization of Costs and Risks, Maximization of Synergy by Networking**

A network system NT can be seen as a general method of minimising costs and risks by concentrating exchange flows to given links. Therefore the networking process should be aimed to minimise the interaction costs by the use of the concept of corridors as fixed links between nodes [Westlund, 1999].

$$NT = \text{Min Interaction Costs} = \text{Min Risk}$$

The costs in an economic network can be defined as the sum of the transaction costs and the transport costs, which together form the transfer costs, plus the production costs and the development costs. This whole sum gives the supply cost function.

The transaction costs may be defined as the costs not directly associated with the production process. They may be the negotiation and the contract costs, as well as the costs of buying and selling the product. The transport costs are all those costs sustained to move physically the economic product from the site of origin to the site of destination. The transaction costs plus the transport costs are called transfer costs, which are the total opportunity cost of moving goods and materials from one place to another. Hence, the transfer costs are inclusive

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<sup>4</sup> Both the natural environment and the other systems.

of the loading and discharge costs, as well as of the administrative and transport costs.

The production costs are defined as the costs sustained to produce an economic good, while the development costs are referred to the investment in Research and Development R&D in order to achieve a higher level of efficiency in the production system. The sum of all these costs gives the cost function of the supply side of a market economy.

If the networking activity is thought in terms of an evolutionary process, then the exploitation of synergy effects during the network evolution may be described as an increased level of cohesiveness within an inter-networking process [Capineri et al., 1998]. During this process, a higher cohesion between the element of the network is achieved through a dynamic internal interchange that leads to a higher performance of the network as a whole. The affinity function  $A_f$  between the homogenous and heterogeneous elements of the network is fundamental for achieving a higher level of cohesiveness. Within this frame, it is useful to specify that the concept of **connectivity** refers to the structural attributes of the network components.

The network synergy may be explained with respect to its tri-dimensional attributes, as follows: interconnectivity, inter-modality, and interoperability.

The attribute of **interconnectivity** refers to the network oriented synergy dimension. A higher degree of interconnectivity means the achievement of a high level in the horizontal cohesion between different networks, as well as a high level of accessibility to the networks system from the wider possible dimensional scale.

The attribute of **inter-modality** is referred to the share oriented synergy dimension of the network. This attribute is particularly used in the transportation network to express the sequential chain of the different transport modalities involved in the transportation cycle. In this case, the share of the transportation network is the vehicle used for the transport activity. It can be a vessel, a truck, a rail wagon, as well as a container.

The attribute of **interoperability** refers to the institutional oriented synergy dimension a network may be endowed. The interoperability attribute is aimed to the operational and technical integration and co-ordination of the network activities in order to promote the network interconnectivity and inter-modality at the different functional levels by all the network users and actors.

Within a network context the concept of **synergy** has to be introduced in order to explain the positive effects the users of a network achieve. It is difficult to provide an exhaustive definition of network synergy without missing some aspects of this concept. In fact, a holistic intuitive approach is more suitable rather than a rational one in order to wholly grasp its sense. Notwithstanding, a rational approach is required to carry on a scientific research.

From that, the synergy effects may be defined as the growing capacity in performance of a network system due to the higher level in efficiency and effectiveness with respect to the interrelationships among the various functional levels of the network. The explanation of this growth may be found into the dynamic and endless redistribution of activity and resources within the functional levels of the network. This continuous dynamic adjustment is the fundamental attribute of the networking process. Without it, no network structure can exist. The dynamic redistribution has to be spontaneously, voluntarily, and continuously performed by the nodes of the network in order to exploit some synergy effects, although if a hierarchical structure of nodes and links may persist. If these fundamental conditions decay, then no synergy effect is present anymore, even when an organization of nodes and links in the form of a network seems to persist [Capineri et al., 1998].

The redistribution of resources and activities can be achieved if the aggregate networks are able to adjust their internal structure performing a dialectical exchange with the other networks and the environment. Hence the increasing specialization of the nodes involved in the networking process should lead to a higher efficiency and effectiveness of the performance of the network system. As result of this betterment, a higher level of energy should be available to the network system as a whole, as well as a decreased number of activities should be performed.

The synergy effects in a network may be present at different scales according to the network typology and to the degree of complexity of the aggregate networks. In this sense, a city-system may be thought as a durable complex network, where the substitution effect is relatively low because of the counteractive inertia trend mainly due to the sunk costs sustained during its formation and growth phases.

When an economic network is analysed, then the distribution of power in the non-physical network emerges as an intangible synergy effect within the economic space. The higher the entropy of power of the economic actors, the more equal the synergy distribution in the network.

Generally, the concept of network may be spatially defined as a multi-dimensional system consisting of objects, connections, relations, and units respectively called nodes, links, exchange functions, and shares. All these four dimensions are strictly related to time dimension because of the dynamic attribute of the network system. The network system is conceived as an open system performing a continuous internal and external interchange and adjustment with respect to its internal elements and the environment. Hence, the mutations due to the passing of the time are an essential living aspect of the networking process.

The first dimension of a network is the concept of **node**. A node may be identified as the economic, social, and/or political agent of the network, as well as in terms of a spatial entity. In both cases and according to the level of analysis, the distinction between simple and complex node of a network is possible.

Therefore, at a micro (economic) level of analysis, a *simple node* is defined as an entrepreneur, or an individual firm; at a meso (spatial) level in terms of a city, or a region; and at a macro level as a state, a continent (spatially), or as an industry (economically). The simple nodes shape a simple network. In the transportation geography and economics the concept of node may be defined as the terminal points of access to the transportation network. Hence in the maritime network, the nodal points are the seaports and harbours, while in the railway network the terminals are the railway stations.

In general, if some variables are (spatially) concentrated according to specific attributes, then this grouping is called **cluster**. Hence, a cluster can be defined as a set of simple nodes (spatially) agglomerated according to a single functional level. The relationships between the simple nodes form a link (often hierarchical) between the different simple networks.

In the transportation geography and economy, an example of a cluster of one-function nodes may be a container terminal at a port site or a distribution centre at an inland terminal. At both locations, an agglomeration of simple nodes takes place. For example, the simple transport functions exploited at a container terminal located on a quay are at least the maritime and the road one. If the quay is equipped with rail tracks, then it is also an access nodal point to the railway network. Therefore, a cluster of a simple function of transport may be defined. The same definition may be applied to an inland distribution centre, if exclusively the transportation function is considered. In fact, a distribution centre

is conceived of exploiting a wider range of functions, hence it is more useful to refer to as a complex node.

In this sense, a **complex node** can be defined as a (spatial) agglomeration of clusters. where it takes place a variable number of one-level functions. The complex nodes produce a complex network. The hierarchical position of the complex node within the complex network depends on the number of one-level functions it performs. This indicator shows also the rate of complexity of the complex node itself. Hence a complex node may be an inland distribution centre if the whole function of transport, distribution, value added generation, and strategic meeting point for the logistics managers are taken in account. A city may be also defined as a complex node, because of the complexity of economic, social, and political activities that are spatial agglomerated at that particular area.

The second dimension of a network is the concept of **link**. A link is a connection between nodes. A useful distinction can be made between physical and non-physical links. A physical link is given by a material connection between nodes. An example can be a transport infrastructure, such as a road, a railway, or a pipeline between two terminals. A non-physical link can be described in terms of relationships, ties, paths, waves, flows of goods, services, information, capital, and so on.

Every link performs a certain **exchange function** between the nodes of a network. The link may be defined as the third dimension of a network. For example physical links such as the transport infrastructures exploit the transport function between a seaport and an inland terminal. In the case of a non-physical link, the flow of goods realises the trade function between two commercial sites.

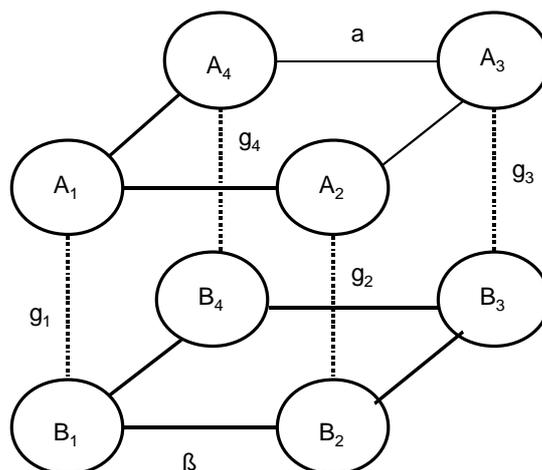
The fourth dimension of a network is the concept of **share**. A share can be defined as the element of the exchange function between two nodes. It is useful to distinguish between physical shares such as goods, car units, passengers, and non-physical shares such as services, information, power, and so on. These are all the mobility units of the network and there are all shared at least between two nodes of the network itself.

In the transport network, a share may be a shipment, or the transport unit itself such as a vessel, or a truck. If the economic links given by the direct investments are considered, then the share may be identified as the exercise of the decisional power the investor exploits with respect to the location where his capital investment has been made. The exercise of power the investor is able to

perform is expressed through the strategic managerial choices spatially related to that site and his ability to influence the behaviour of the local agents.

The Figure 1.1 outlines the concepts just set out. Two simple networks are taken into account, A and B. It is supposed that each network is composed by a set of three simple nodes, respectively  $A_1, A_2, A_3$  and  $B_1, B_2, B_3$ . The three simple nodes of the network A are connected by the function  $a$ , while the three simple nodes of the network B are linked by the function  $\beta$ .

Figure 1.1 – The draw of a network and a cluster.



The two simple nodes  $A_1$  and  $B_1$  are related by the one-level function  $g_1$  and form the cluster  $C_1$ . The two simple nodes  $A_2$  and  $B_2$  are related by the one-level function  $g_2$  and form the cluster  $C_2$ . The two simple nodes  $A_3$  and  $B_3$  are related by the one-level function  $g_3$  and form the cluster  $C_3$ .

In this simple example, the complex node  $X$  has a (hierarchical) range of 3 because it embraces three levels of clusters. It has to be emphasized that the complex node is not just made up by the sum of the two simple networks and the one-level functional relationships between the nodes.

Table 1.1 – The concepts of network and cluster.

Level of the Cluster	Nodes of the Simple Network A	Nodes of the Simple Network B	One-Level Function of the Cluster
$C_1$	$A_1$	$B_1$	$g_1$
$C_2$	$A_2$	$B_2$	$g_2$
$C_3$	$A_3$	$B_3$	$g_3$
Function of the Simple Network	$\alpha$	$\beta$	Complex Node X

The essence of the complex node has to be interpreted moving from a holistic perspective. The whole is not just the sum of the single components, but something more:  $1+1>2$ . Following the economic interpretation, these agglomeration effects can be referred to in terms of (positive or negative) externalities and to be related to the so-called economies of scope and to the non-market effects spreading inside.

The concept of networked goods may be defined in terms of the economic goods which are exchanged within a network. They are the shares of the exchange function between the nodes. In a transportation network, a networked goods can be a vessel, a car, as well as a rail wagon. Within a trade network, the exchanged shares that correspond to the various networked goods may be shaped according to the cargo classification usually adopted by the official statistics<sup>5</sup>. A networked good influence the supply side because of the induced demand of economic goods when a higher number of units enter the network. For example, in the road network the higher the number of car users, the higher the demand for car vehicles, and the higher the derived supply related to this growing traffic.

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<sup>5</sup> For example the cargo classification and the corresponding trade volume and value according to the methodology in use by the Statistical Regional Office in Hamburg – Statistisches Landesamt Hamburg, or by the Italian Statistical Institut in Triest – ISTAT Istituto Italiano di Statistica.

The networks can be variously classified according to the considered attribute. In the following paragraphs, it is given a classification of the seaport networks according to the physical attributes, the economic attributes, the degree of complexity, the degree of hierarchy, and the time attribute [Westlund, 1999].

### **The Physical Attributes**

According to the previous definitions, it is possible to distinguish between physical and non-physical networks. An example of a **physical network** is the railway network: the nodes are the railway stations, the links are the railway tracks, and the shares are the trains in transit. An example of a **non-physical network** is the direct capital investment an entrepreneur invests at a certain location<sup>6</sup> because of a strategic location choice in order to build up a new port facility such as a new container terminal. In this case, the first node is the economic actor itself necessarily spatially settled at a certain site, who makes the direct investment that is the economic non-physical link, at the new selected location that is the second economic node involved. The economic non-physical share is a control power performed by the investor on the new site where the direct investment is realized.

Concrete examples of non-physical networks are the Eurogate's container terminal at Gioia Tauro and at Wilhelmshaven, and the ECT's container terminal at Trieste<sup>7</sup>, as well as the investments in the inland terminals the main ports of the North Range exploit in order to deeply penetrate the Central and Eastern European market.

### **The Economic Attributes**

When the economic attribute is analysed, then economic and non-economic networks can be highlighted. The links in a **economic network** are defined in terms of long term investments in interaction capability, within a permanent implicit or explicit contract, that is, in terms of an intangible capital structures. The time factor is fundamental when the economic links are considered. The economic links should be analysed in terms of capital objects, hence as sunk costs, which have to be amortized in the long run as capital investments.

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<sup>6</sup> That location can be in a foreign country, as well as in the home country.

<sup>7</sup> Till the year 2000.

Following this interpretation, the economic network can be outlined as a type of infrastructure, often a non-material infrastructure.

According to the attribute of time, the links of a **non-economic network** can have a durable or a temporary character. The durable non-economic links of a network could be useful seen as a sort of investment, hence as a different kind of infrastructures. The temporary links of a non-economic network could be seen in terms of interaction costs.

### The Degree of Complexity

If the different characteristics of the links and nodes of a network are under analysis, it is possible to distinguish between simple and complex networks. A **simple network** A is compounded by a certain number of nodes  $A_i$  with one and the same function  $g_i$  connected by links with one and the same function a.

A **complex network** consists of various types of simple networks, which form a system if taken all together. The primary task of the nodes of such a system is to act as a connection or intersection points between the simple networks. An example is given by the transportation system. A transport system is made up by different transport modalities, each of them form a different transport network. In this case, the main function of the nodes is to exploit the transshipment activity between the single-mode transport networks.

The nodal points may have a dual function in terms of hierarchical decision-making if they work as centres for linking the simple networks, and in terms of administrative networks if they co-ordinate the interaction between the different networks. Therefore, a nodal point can be both an order receiver and an order giver.

Networks like city systems or production systems are classified at a more complex level. They include attributes such as separate transportation systems, decision-making bodies, and information networks, as well as capital, political, social, knowledge networks, and so on.

When an individual single-function system develops towards a multi-functional system on various operational levels, then it emerges the problems of the increasing complexity and of the co-ordination tasks.

### The Degree of Hierarchy

The hierarchy structure of a network is assumed when the nodes at the same level are connected only with up and downward nodes but lack in contacts with nodes at the same level of hierarchy. This is a typical network structured **vertically**. The more the lack in connections between the same level nodes, the more pronounced the hierarchy structure of the network.

If the network develops as a **horizontal** configuration, then the levels of the networks exploit a single function at a single level, hence this type of network lacks of hierarchy.

On the contrary by definition, a more or less marked hierarchy structure characterises a multi-function network. In this case, the vertical links between nodes, hence at different functional levels, are combined to the horizontal connections between the one-function level nodes. The network is shaped as a **combined** structure between the vertical and the horizontal network structures.

### The Time Attribute

If the time attribute is considered, then the durability of the networks is under proof. Hence it is possible to make a useful distinction between temporary and durable networks. A **temporary network** can be defined in terms of short-term links between the nodes. Anyway, the intensity of the share between the nodes could be extremely high, although the temporary character of the network could be understood as a weakness of the network itself. An example of temporary network is the emergency telephone network in case of a natural disaster.

A temporary network is typified as an unstable structure performing an increasing level of uncertainty. On the opposite, a high degree of flexibility, a high level of independence, and a sharply ability to change are the worthy qualities of this network structure.

A **durable network** is a long-term network between nodes. The durable character of the network implies a stable and strong relationship between the nodes. These durable connections are quite hard to be dissolved. A good example of durable network is given by the transport infrastructures. The building of the transport infrastructures claims for long-term capital investments. This means that a high sunk-cost level has to be faced in the short run (i.e. few years), while the benefits return back in the long run (i.e. few decades).

According to the time attribute, a durable network is characterized by stability and by minimising the level of uncertainty. On the contrary, this network presents few negative qualities such as forms of rigidity, dependency and difficulty to adapt itself to the changing conditions of the environment, without facing really hard costs.

### **1.2.1 The Interaction Costs of Networking**

Due to the dynamic character of the network structure, the network system performs certain activities necessary to its self-maintenance. This set of actions may be defined as interaction activities. The interaction between and within networks is a fundamental condition for the existence of the network. From an economic point of view, the exploitation of these interaction activities gives origin to the interaction costs. Such costs are sustained by the network system in order to exploit the exchange both inside the network and between the different networks and the environment. The amplitude of the interaction costs in turn influence the genesis and shaping of the networks [Westlund, 1999].

The interaction process between networks may be described as an **external** exchange activity among different interconnected networks. In this case, the network can be compared to an open system. The interaction process within networks is a form of **internal** interaction between the nodes of the network. In this case a close system is the most suitable comparable structure. It is important to highlight the fundamental condition of existence of a network, that is the dynamic exchange both between the nodes and the networks.

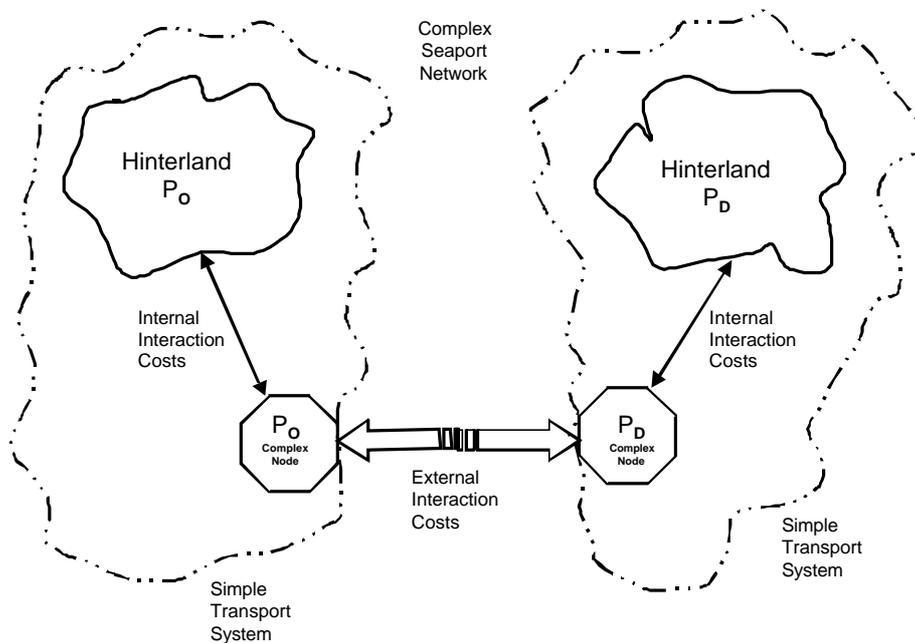
There are various implications depending on the different degree of durability of the networks and the adaptability to change with respect to the mutated conditions of the environment. A dynamic adaptation and responsiveness with respect to the changing environment and the other network systems seems to be the key for the self-conservation of the network structure itself, hence, a dynamic equilibrium, rather than a static steady state, should be achieved.

It is useful to distinguish between internal and external interaction costs. The internal costs are the exchange costs between the simple nodes of a simple network. The external costs are the interchange costs between simple networks as well as the simple network and the environment.

If a complex network system is considered, then there are two types of *internal costs of interaction*. The first type of costs are the exchange costs that each complex node of the complex network sustains internally. The second are the costs that are sustained between the different complex nodes. The *external costs of interaction*, instead, will be defined as the interchange costs between the complex network system and other complex networks, as well as the environment.

Supposing a simple transportation system made up by a seaport site and its hinterland connections as drawn in the Figure 1.2. The interchange between the seaport location and its hinterland gives origin to the internal interaction costs of the simple transportation system. Due to the feasibility of a multi-modal transport network on the inland side, the seaport may be considered as a complex node where the maritime, road, rail and inland waterway terminals should be interconnected. The change of transport mode within the complex seaport node generates the internal interaction costs of the complex node between the transport modalities involved.

Figure 1.2 – The complex seaport network.



If an other simple transport system is supposed to exist, then the maritime costs sustained to send the shipment from the seaport of origin  $P_o$  to the seaport of destination  $P_D$  may be defined as external interaction costs.

If the two simple transport systems are brought together, then a complex transport system can be described in terms of the maritime links between the two seaports, and the hinterland connections that spread out from each maritime complex node.

The interchange costs between the complex seaport node of origin  $P_o$  and the complex seaport node of destination  $P_D$  generate the external interaction costs between the two simple transport systems, although they are internal interaction costs with respect to the complex seaport network. An example can be given by the complex seaport network of the main ports of the European Northern Range. Each main port, such as Hamburg or Rotterdam, may be defined as a complex node. If it is related to its hinterland connections, a simple transport system may be described for every main port.

If another complex seaport network is considered, for example the North American seaports, and if an interchange between the two complex networks takes place, then the interchange costs sustained may be defined in terms of external interaction costs between two complex seaport networks.

It is likely to suppose that the logistics efficiency of a seaport complex node may be improved through the minimization of both the internal and external interaction costs, both with respect to the complex node and network.

The development of a global logistics system has been stimulated, beyond other reasons, by the goal to achieve the reduction of the interaction costs through the integration and co-ordination of the different transport modes and the building up of an efficient inter-modal transportation system.

The concept of **cohesion** can be explained as a property between, and within nodes and networks. It can be related to the degree of durability of a network. The higher the level of cohesion the longer the durability of a network. The same can be applied to a complex node in terms of an internal network.

In particular, with respect to the regional dynamics, the concept of cohesion may be assumed to be the glue between the spared elements that give impulse to the regional growth. In a regional context, the spatial meaning of the cohesion attribute is expressed by the integration of the multi-functional and complementary activities and roles settled there. The assumption of synergy effects leads to the generation of value added, not only in monetary terms, as much as in terms of regional growth at both economic, social and cultural levels.

In this sense, the cohesion within a region may promote the endogenous development of the peripheral areas [Capineri et al., 1998].

In order to explain the dynamic relationship between nodes and networks, the concept of affinity has to be stressed. The concept of **affinity Af** may be expressed in this context as the degree of optimal combination of homogeneity and heterogeneity of the nodes in the network [Westlund, 1999]. Homogeneity and heterogeneity of the nodes are two worthy attributes to be evaluated. In this sense, the degree of affinity of the nodes of a network may be defined as an aggregate function Af of the homogeneity Ho and heterogeneity He attributes of the nodes.

$$\text{Equation 1.3} \quad \text{Affinity} = \text{Af}(\text{Ho}, \text{He})$$

The relationship between homogeneity and heterogeneity is one component of the total interaction costs. The total interaction costs can be referred both to the internal exchange inside a network, and to the external exchange between different networks.

The affinity function may be extended to the interrelations between networks. The evaluation of the homogeneity and heterogeneity degree in the relationships between different network structures is a relevant aspect in order to ponder over the level of competitiveness, as well as the elasticity of substitution between networks.

It is particularly important with respect to the classical form of competition between transport modes, and even more with respect to the new form of competition between transport systems, within the multi-modal system of transportation of the global logistics.

The **efficiency  $E_x$**  of a complex node may be defined by the aggregate function  $S_i$  of the interaction costs of the internal links between the networks in the complex node [Westlund, 1999], hence the total interaction costs sustained inside a complex node where different networks meet to each other.

$$E_x = S_i \text{ (Internal Interaction Costs between Networks)}$$

with:  $i$  = type of the networks in the complex node. The lower the value the aggregate function  $S_i$ , the higher the efficiency of the networking process in the complex node.

### Network Durability and Substitution between Networks

One of the most relevant concerns of the transport policy regards the modal shift from the road transport to the alternative environmental friendly transport modalities, first of all the railways. This problem refers in general to the degree of durability of a network. Ceteris paribus, the degree of Durability of a network is a function Dur of the Discounted Investments in the network itself. The investments are discounted at the composed rate  $r$  for a time period  $t$ .

Equation 1.4 - Durability = Dur(Discounted Investments)

where: Discounted Investments = Investments  $\cdot (1-r)^t$

and: Investments = Capital Investments + Maintenance Costs

The investments in the network embrace both the original capital investments to build up the network, and the maintenance expenditures to upkeep it. The level of the investments is supposed to be a composed **expectation function Ep** of the achievable gains of the network. The expected gains are the likely minimization of the interaction costs between the actors as well as the expected maximization of the synergy effects induced by the reduced interaction costs just mentioned.

$$\begin{aligned} \text{Investments} &= \text{Ep}(\text{Network's Gains}) \\ &= \text{Ep}(\text{Min Interaction Costs}) \cup \text{Ep}(\text{Max Synergy}) \end{aligned}$$

Therefore, the degree of durability of the network may be expressed as a function Dur of the discounted value of the expected gains achievable during the networking process for a given time  $t$ . The Equation 1.4 can be rewritten as follows:

$$\text{Durability} = \text{Dur}[\text{Ep}(\text{Network's Gains}) \cdot (1-r)^t]$$

It follows that the higher the network gains expected, the more durable a network is expected to be, and the larger the amount of investments in the network itself, hence the higher the potential of the network to face and win the competition against the others rival networks. The two relevant variables in the function of durability of a network are the discount rate  $r$  and the time period  $t$ . The discount rate  $r$  can be related to the rate of interest that the investor has to pay in order to borrow from a bank the money to invest, hence it is related to the fluctuations of the official discount rate.

According to this hypothesis, the substitution effect between networks can be described as a delayed process characterised by inertia [Westlund, 1999]. The sharper the degree of competition between networks the higher the probability of substitution between networks. A high level of competition means a high value of the elasticity of substitution  $e_{sub}$  between networks, that is a high complementary degree between the networks, hence a high level of the inverse crossing elasticity between the networks.

The elasticity of substitution  $e_{sub}$  between two transport networks, for example between the railways network RW and the inland waterways network IW, may be expressed as the ratio of the percentage variation of the quantity demanded for the RW transport by the percentage variation of the price of the IW service, as the Equation 1.5 shows.

$$\text{Equation 1.5} \quad e_{sub}(RW/IW) = \text{var}\%Q_D(RW) / \text{var}\%P(IW)$$

By moving from the perspective of an economic entrepreneur, the rigidity of a network structure becomes a valuable attribute to attract the capital investments because it reduces the uncertainty degree of the expectation of the investors with respect to the discounted value of their own investments. Hence, the economic entrepreneur is usually much more comfortable to invest in a durable and not flexible network if he expects to realise the maximal level of profit in comparison to the alternative available networks.

Furthermore, the more complex the network structure, the greater the interaction cost for the change, that is required in order to induce a substitution between networks, or a shift from one system to another. A dynamic factor to induce a substitution between networks is the emergence of new actors, for example the formation of new nodes within the dynamic of the multi-function nodes of a city-system.

The substitution between networks may be absolute or relative. This is related to the growth and transformation of the multi-function nodes, as well as the change and enlargements of their internal networks.

The increasing complexity of spatial nodes may be explained as the increasing numbers of one-function nodes which become integral parts of the complex node itself [Westlund, 1999]. This process can be seen as a function of the general diversification of the society and the economy.

In fact, this dynamic restructuring of the complex node is due to the impact of the internalisation and/or externalisation of certain functions of the internal networks. This adjustment implies a change in the complexity of the network as a whole, rather than a change of the spatial node as an isolated element.

The concept of cluster assumes a new meaning, as the expression of a potential or realized horizontal network interaction between nodes which have similar characteristics but are not necessarily spatially concentrated. Therefore, the spatial proximity between nodes as well as the spatial concentration of networks structures at the same geographical location loose of importance.

The distinction between the builder of a network and the users of a network structure sometimes may be difficult because of the network typology itself. If a transport network is considered, then the discrimination is quite easy to do. Usually, the transport infrastructures require long term investments that can be supplied only by the public sector. A change occurred in the recent years, when the search for private investors with regard to particular transport links has been relatively common. The users of the transport network itself are obviously all the agents who enter the network. If an economic network is considered, then the direct investor is at the same time the builder and the user of the non-physical network itself.

### **1.3 The Geographic Accessibility**

The maritime port site may be modified and transformed by the human activity to attract the external maritime operators and to adapt the harbour location to the changing requirements of the economic market.

It may be useful to define more precisely the two terms of port and harbour. A port is a nodal location where the interchange between transport modalities and/or transport carriers take place, both with respect to the cargo and passenger traffic. A harbour is a geographical site which offers protection against the adversity of the ocean or sea, such as winds, currents and waves. Hence, a harbour is a natural area which potentially could become a port if the human activity intervenes [Mayer, 1988].

The natural patterns of a harbour or a seaport site are certainly of primary importance when the geographical accessibility is considered. The favourable characteristics of the natural environment which play a positive role for the prosperity of a seaport location are the following: 1) the smooth accessibility

to the seaport site; 2) the sufficient depth of the water; 3) a smooth tide range; 4) a favourable climate condition, so that the seaport activities may be exploited during the whole year without seasonal weather hindrances; 5) a geographical landscape suitable for the development of the appropriate maritime infrastructures and superstructures in order to allow the exploitation of the seaport functions.

The location of a seaport site is mutually related to a set of dynamic factors of influence. Hence, the geographical physical landscape is the essential element that enables the transformation of a harbour into a port. The scarcity of the natural resources is the fundamental pattern of the geographical location of the maritime site. The human activity may have a remarkable environmental impact on the spatial organization of the seaport location as well as on the potential development of the seaport region. The most appropriate discount rate for the natural capital should be applied in order to evaluate the depletion of the environmental resources and to achieve a sustainable economic development and growth of the seaport region.

Depending on the geographical location, the seaport or harbour can be a inner seaport if it is situated far away from the ocean, or an external seaport if it is overlooking the littoral.

### **1.3.1 Classification of Seaports and Harbours**

#### **The World Port Index**

According to the World Port Index, the seaports and harbours can be classified as following [U.S. Hydrogr. Office, 1953] [Ente Autonomo del Porto di Trieste, no year]:

1. *Coastal or littoral ports and harbours.* They are the maritime ports in the strict sense of the word, due to the fact that they are overlooking the sea.
2. *River ports and harbours.* They are located along the river-banks, but upriver from its estuary. The estuary port in the properly sense of the world is located exactly on the river estuary.

Both of them can be split into:

3. *Natural ports and harbours.* No human activity modified the natural port site.

4. *Tide gate ports and harbours.* This port location is equipped with locks and other hydrological devices in order to isolate the harbour area by the effects of the tide excursions of the open sea or ocean. This kind of port can be also defined as artificial if it has been entirely arranged and equipped by the human activity.

The coastal ports and harbours can be classified as follows:

5. *Breakwater ports and harbours.*

while the river ports and harbours as:

6. *Dock ports and harbours.*

Both the breakwater and the dock ports and harbours are equipped with structures and diggings which do not break the port area. Other two kind of ports can be mentioned, as following:

7. *Canal or lake ports and harbours.* They are located at the inner part of a canal or lake, and they are linked to the sea through a navigable water link.

8. *Open anchorage ports and harbours.*

A final kind of port can be mentioned:

9. *Speedy port.* The main characteristic of this port is the relevance of the time factor with respect to the terminal operations. Both the ocean carriers and the ferry operators that perform both cargo and passengers services wish to minimise the time they spend at the terminals because of the incidence of the sunk costs of their vessels.

### **Infrastructures**

The seaports and harbours can be classified with respect to the existing infrastructures and the seaport equipment at the maritime site [Marchese, 1996]. The infra-structural complex can be wholly specialized or partly specialized. It is possible to distinguish:

1. *Commercial ports and harbours, in the sense of non-specialized complex.* The activity of this kind of ports and harbours regards the collecting and redistribution functions of finished products. The typology of goods handled at these port sites is quite various [Ente Autonomo del Porto di Trieste, no year].

2. *Industrial ports and harbours.* Their activity is oriented towards the raw materials and semi-finished product supplied to the industry. Therefore, the bulk-cargo is the major cargo typology handled at these sites [Ente Autonomo del Porto di Trieste, no year].
3. Ports that handle exclusively *one typology of cargo.*
4. *Tourist ports.*
5. *Fishing ports.*
6. *Poly-functional ports.* In general, these ports are the most important.

The seaport sites developed during the time till they reach enormous dimensions. New relevant problems came out, such as the neutralization of the diseconomies due to the territorial impact of the maritime activities, the cost to face to the deepening and cleaning of the river-bed in order to ensure the accessibility to the seaport, the costs of the bureaucracy.

#### **The human activity**

The seaports may be classified depending on the level of the human activity, as follows: 1) international seaports and harbours; 2) colonial seaports and harbours; 3) national seaports and harbours; 4) regional seaports and harbours; 5) local seaports and harbours.

With respect to the range of activity of a seaport or harbour, the seaport sites may be defined with respect to the extension of their hinterland and foreland.

The economic activity of a seaport site is the discriminator factor that enables the wider scope of possible classification, as following.

1. According to the main economic goods handled at the seaport site (petroleum, coke, fish).
2. According to the main economic activity exploited at the seaport site with respect to the cargo handled. This criteria determines if the seaport is:
  - i) Industrial seaport (raw materials and semi-finished products);
  - ii) Commercial seaport (various cargoes as finished products);
  - iii) Transit seaport;
  - iv) Transshipment seaport.

The **transshipment** is a transport activity exploited by a mother ship and at least one feeder ship. The mother ship selects a hub seaport with the goal to minimise the stopping time necessary for the terminal operations on the cargo. Then the goods are loaded/discharged to/from smaller vessels called feeders [Costa, 1995]. The feeder ships play the role to complete the distribution chain from the hub seaports to the near ports and harbours. This transport system is called "hub & spoke".

3. According to the sort of transport exploited, as follows:

i) Passenger seaport.

ii) Scheduled-shipment seaport.

From a geographical perspective, the shipping companies make their stopping calls on a regular basis and following a precise schedule as well as a fixed route, invariable during the time [U.S. Bureau of the Census, 1988b].

iii) Tramp-shipment seaport.

These seaports are only occasionally touched by the vessels.

iv) Tanker seaport.

### ***1.3.2 The Problems of Accessibility to the Seaport***

From a historical perspective, the inner ports and harbours flourished and became influence regional centres both from an economic and a political and social point of view [Degrassi, 1997/98]. The reason of this success can be explained by the vessel typology used in the past. The small vessels were able to navigate along the stretch of the river from the estuary towards the inner territory and reach the inner ports and harbours which offered a better protection against the adversities of the open sea and ocean. Furthermore, before the revolutionary innovation in the transport sector due to the invention of the steel locomotive and the diffusion of the rail network towards the hinterland, the land transportation network was not efficient enough, hence the maritime transport system was the most economically favourable.

The decline of the inner ports and harbours began with the diffusion of the steel navigation. Serious accessibility problems came out, as it is explained as follows:

- *The accessibility inadequacy of the canals to reach the inner ports and harbours.* The river stretches usually travelled by the smaller vessels appeared to be insufficiently deep to allow the transit to the steel ships, endowed with a deeper draft and growing cargo capacity.
- *The accessibility dependence to the tide fluctuation.* This is a direct consequence of the previous problem.
- *The sedimentation of sand and other materials on the access river-bed stretch.* The accessibility to the inner ports and harbours hung on the deepening of the river-bed stretch between the open sea and the port location itself. The cleaning operations had to be done ahead regularly and systematically.
- *The need to minimise the mounting operative costs of the vessels.* The incidence rate of the sunk costs of the vessels implied that the stopping calls of the ocean operators were directed towards those ports or harbours that were able to offer the most rapid and direct access, and where quicker and quicker terminal operations for the loading/discharge of the cargo could be exploited. This is a location choice that can decide the flourishing or not of a maritime site.

Due to these considerations, it follows that after the diffusion of the steel navigation and the railway network, the external maritime coastal ports and harbours flourished, while the inner ports and harbours suffered a period of decline.

After the introduction of the containers and the inter-modal transport, the accessibility to the seaport site changed of meaning. The adequacy of the infrastructures and superstructures at the port location in order to support the loading/unloading operations at the quay in an efficient way become the imperative of the last 30 years. In the case of the port of Hamburg, accessibility to the seaport meant an adequate depth of the stretch of the river Elbe towards the North Sea, as well as the restructuring of the port area in order to provide new land for the container handling operations.

The scarcity of free land within the port area is becoming a real problem especially during the last decade. In fact, containers require a large amount of space for handling and for the stock operations. The rate of containerisation shows the growing trend to make use of this standard mode of transport. The

main advantage in the handling of containers is their flexibility without hanging by its content.

The establishment of the distribution centres nearby or within the seaport area was the next step in order to improve the accessibility of the maritime node. Complementary to the efficiency patterns at the port location are the improvement of the land transport links towards the hinterland destinations, in order to avoid any bottleneck in the transport chain. The more fast the handling operations at the port quay, the more attractive is the seaport site.

Accessibility means not only the exploitation of the two important function of transport and distribution. During the last decade, the main ports tried to acquire the new logistics functions, in order to attract the economic activities that are related to the maritime sector and can generate added value at the seaport site. The new concept of accessibility embraces also the access to the logistics organization and the quality of the services offered at the port location.

The problem of the lack in space at the port area may be avoid by the establishment of a durable link with a specialized maritime location, where the traditional operations of transshipment may be exploited. The plan of a new deep-sea container terminal on the German littoral is an example of such a node.

The economic accessibility to the logistics organization seems to become the next problem to be solved, if a main seaport has to stay in competition with the others. Because of the land scarcity at the seaport area and the improvement of the transport infrastructures towards the hinterland, the main ports lose first the industrial activities. The cost of the land was lower at the inland locations, as well as the transport cost for the transfer of raw materials was brought down.

Similarly, the main port have to shift some traditional transport operations outside its boundaries, while have to keep and cultivate at its site the transport activities related to the logistics sector. A commercial and logistics seaport have to work jointly with the derived traffic from the indirect transshipment at the new specialized node. The specialized node of the seaport network may be a maritime site such as Wilhelmshaven or Cuxhaven, as well as a dry inland terminal.

### **1.3.3 The Transport Infrastructures and the Land Use**

The transport investments are usually perceived to have a relevant spatial impact on the local structure at the seaport site, and on the urban structure of the seaport region in general. It is possible to point out two relationships between the transportation activity and the use of the land [Giuliano, 1995]: the matter of analysis, as well as their dynamic.

The first relationship embraces several aspects each of them related to a specific context. The geographical scale of analysis may regard the impacts of the transportation activity and the land use at a micro-level (inside the seaport area) or macro-level (inside the seaport region). The geographical location of the long-term investment for transport infrastructures analyses the impact of such durable investments with respect to the potential rate of the use of the land depending on the change of destination of use. In fact, this indicator is sensibly lower in the more developed regions rather than in the underdeveloped area.

An other context of research may be the extent of the transport change. This can be due to a variation of the quantity of transport<sup>8</sup> as well as the diffusion of the technological innovations in the transportation sector. A further important impact of the change in the transport sector is the scale of the investments into the operative transport systems. Another field of analysis may keep distinguished the patterns of the use of the land from the economic growth of a region.

The second relationship concern the dynamics between the transport investments and the land use at the seaport region. There is in fact a mutual interdependence between them, as represented in the Figure 1.3.

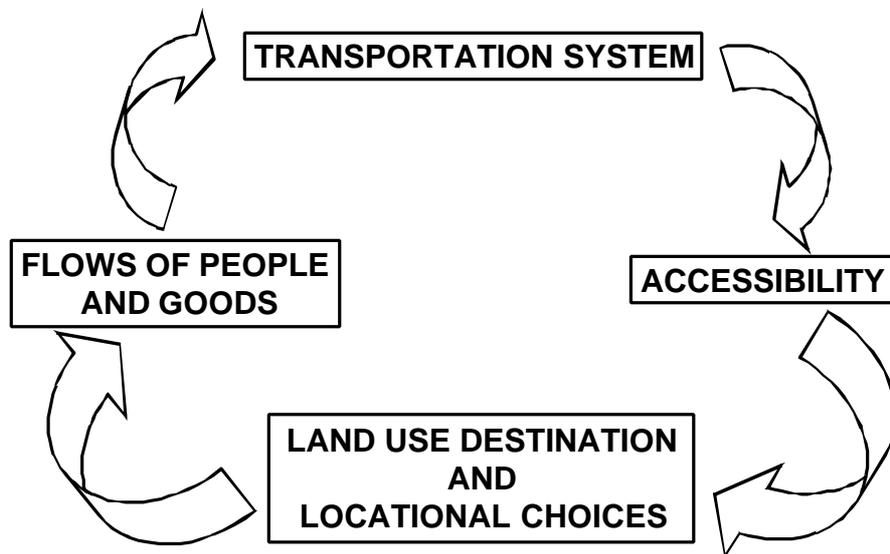
The characteristics of the transportation system already existing and operating at the seaport region determines the accessibility patterns to/from the seaport location itself.

The accessibility peculiarities of the seaport region melts the land use destinations because of the location choices of the producers and investors. This factor of attraction of the seaport region determine therefore the location of the production activities and the land use destination, that in turn have a spatial impact on the movement of the labour force inside the seaport region.

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<sup>8</sup> For example, because of a variation of the fuel price.

Figure 1.3 – The circular mutual relationship between the transportation activity and the destination of use of the land.



The travel patterns of the workers may be indicated by the daily trips inside the seaport region. The flow of passengers and goods along the transport network may be assumed as an indicator of the spatial impact of the geographical location of the production activities at the seaport region. A circular mutual relationship between transportation and land use has been defined.

#### **1.4 The Accessibility to the Economic Resources**

It is possible to define four types of benefits, that are directly related to the port operations [Hoyle et al., 1981], as follows:

1. The employment that is generated not only by the handling of the cargo, that is the fundamental activity of a port, but more and more by the wide range of port-related services and by the construction, maintenance and reparation of the capital goods.
2. The general growth of the regional income, that is generated by the economic activities just mentioned at the point 1. By the multiplier effect, those activities are able to induce a diffuse growth of the economy.

3. The location choice in favour of the port region that is made by the industries which are expanding their activity. Their location choice is influenced by many factors, last but not least by the availability of adequate maritime services at the port of the city-region. The following investments may give origin to an industrial clustering, as well as to a clustering of entrepreneurs, that take advantages by the external economies which follows this polarization of economic activities at the maritime region.
4. The indirect consequences from the economic existence of the port itself. These are the most significant, because they promote in a real and active way the whole regional economy.

The Figure 1.4 shows the mutual relationships between the economic activities of the maritime core, and the port activities that are indirect related to it.

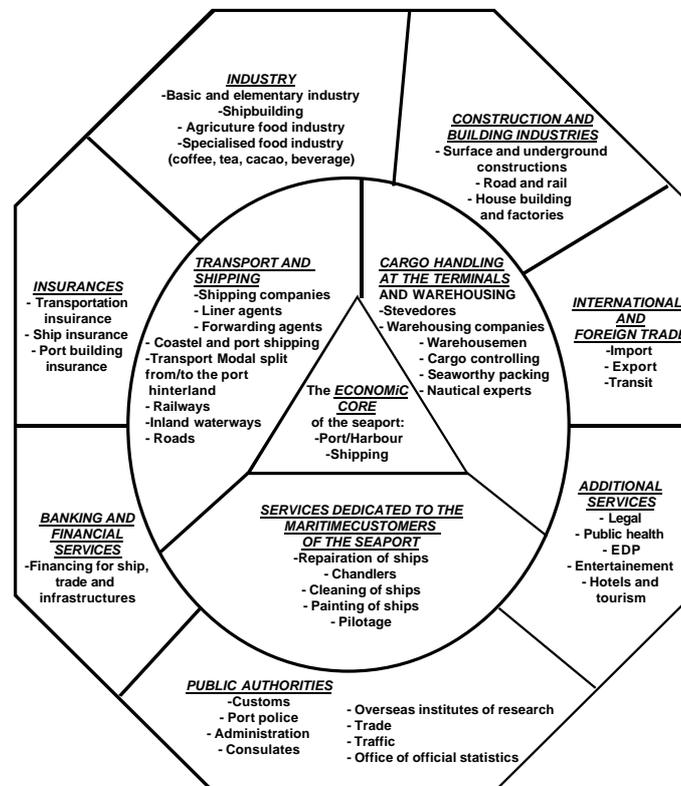
The degree of competition of a maritime port is exploited on two different levels, as follows:

1. *Between the seaport itself and the others seaports in competition.*

With respect to this first case, usually the seaports in competition try to adequate their superstructure and infrastructure to those of the others rival ports. Following this policy, every port must to keep itself in line with the state-of-the-art of the qualitative improvement of the other competitive ports, if it wants to stay in competition. The shipping companies choose the ports where to make their stopping calls. Therefore, a seaport may be excluded because of the lack in the supply of structures and services in line with the technological requirements of the cargo fleets, such as and adequate deep of the water, modern terminal equipment, efficient inter-modal links, etc. Obviously, a similar exclusion implies enormous losses for the port and regional economy.
2. *Between the seaport itself and the others industrial locations in the hinterland.*

In this second case, the location choice of the industry may be addressed towards the maritime locations far away from the seaport region, but that are for different reasons much more attractive from the economic point of view for the establishment of their industrial complexes. In this case, the incidence of the costs of transport in order to transfer the goods from/towards the inland location is really low.

Figure 1.4 – The economic network of mutual relationships of the seaports.



Source: Port of Hamburg Marketing and Public Relations, 2001.

### 1.4.1 The Maritime Functions at the Seaport

From an economic perspective, the seaport node exploits a set of various functions. The primary function is to transfer the economic goods and people from the oceanic vessels to the land, and then to the land carriers, and vice versa. The transit of goods and people bring a positive influence to the seaport or harbour itself, to its city and to the surrounding seaport region. This effect can be explained in terms of benefits on the quality of life and on the economic level in general.

This activity of the seaport or harbour regards both the national and international flow of goods. At the same time the incoming/outgoing trade movement through the seaport site shows the competitiveness of the single

countries, its economical relations, as well as the existing commercial traffics [Kreukels et al., 1996].

In general the seaports develop a set of internal and external economic relationships. The seaport site may be defined with respect to its gateway function, as follows [Nuhn, 1994]:

1. *The gate towards the rest of the world and the national market.*

The weight of its importance may be measured by the imports and exports of goods, including the transit goods and the cargo re-exported towards the neighbour countries.

2. *The function of interface or intersection point.*

At this nodal point the goods are transferred between the different transport modalities [Mayer, 1973] and the information are up-to-dated in real time and dynamically transmitted between the economic operators.

3. *The function of central place.*

At this location the goods and the information are collected, classified and/or re-distributed.

4. *A strategic basis.*

From this location it should be possible to begin and to control all the operations related to the hinterland.

Besides the traditional commercial transit activity defined as the trade function of a seaport site [Marchese, 1996], many seaports and harbours promote a secondary function, that is the industrial activity of manufacturing of economic goods. The aim is to generate added value to the goods, through the transformation and semi-product manufacturing process of goods at the seaport location itself. The industrial function is defined as the terminal activity, exploited with the purpose to supply an industrial cluster settled at the same quay or at another location. The relevant aspect is that a functional relation between the terminal operations and the industrial cluster must exist.

Therefore in addition to the traditional terminal operations of cargo loading/discharge, at these seaport sites the incoming goods from every part of the world may be partially manufactured:

1. *In the traditional sense:* the economic goods are manufactured into semi-finished products or finished products at the refineries, at the blast furnace or at the industrial clusters at the seaport site.

2. *In the modern sense:* the containerised goods are removed from the containers, packaged again, controlled, labelled, etc. All these operations take place at the so called distribution centres. The whole set of the economic activities generate added value, and stimulate the employment at the seaport region.

Furthermore, the logistical restructuring of the transportation chain enables the seaport region to exploit a major role in terms of strategic management of the logistics activities in order to promote the economic growth and welfare at the seaport region. Hence, the influence of the economic agents at the local level seems to be remarkable.

Due to the fact that seaports are spatially tied to their geographic location, it may be defined a first sector of production at the maritime port in terms of non-reallocable seaport activities. This sector is assumed to be spatially tied to the geographic location of the seaport region itself. Hence, the population employed in the non-reallocable sector can not be reallocated from one maritime region to another, hence they are in fact tied workers. The non-reallocable sector is assumed to be capital intensive.

This production sector is defined in this context in a broad sense. The non-reallocable sector embraces the maritime core activities, the transport activities, which are traditionally performed at a seaport site<sup>9</sup>, as well as all the infrastructures and superstructures supported by medium or long term public and/or private capital investments. Therefore, the non-reallocable activities enclose the monetary expenditures, as well as the strategic economic policies performed by the private and public actors, and aimed to improve the accessibility to the seaport region. If the public administration is assumed to play the prevalent role, then the non-reallocable sector may be defined using the concept of public infrastructure.

The exploitation of the activities of professional training for the maritime sector at the seaport region is also embodied into this definition. The professional training may be seen as a form of capitalization of the human resources at the seaport region. A specialized labour force supply enables the seaport region to be more attractive for the reallocable activities typical of the second type of production, hence to attract also the workers from the other seaport region.

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<sup>9</sup> Transit, transshipment and trade.

The second type of production at the seaport region is given by the reallocable activity, which performs increasing returns to scale, and is assumed to be labour intensive. The reallocable activities may be relocated from one seaport region to the other, that means a certain degree of mobility of this production activity (mobile workers). The activities of this production sector are defined in terms of the industrial production, of the distribution and logistics services aimed to generate value added, as well as in terms of the stopping calls of the shipping companies at the seaport region on a regular basis<sup>10</sup>.

#### **1.4.2 The Role of the Public Infrastructures**

The public infrastructures play a major role on the relocation of the economic activities of the mobile sector of the seaport region.

The state is demanded to provide the necessarily public infrastructure in order to promote and facilitate the link between the supply side and the demand side of the market, that is between the production and the consumption. Therefore, the concept of public infrastructure may be defined in terms of any facility, good, service, or institution the state provides to achieve this goal [Martin et al., 1995]. In this sense, the concept of public infrastructure embrace not only the transport infrastructures, but also the telecommunication infrastructures and the information technology infrastructure, as well as the social and juridical organization, and the education and the energy services of the seaport region. By moving from this assumption, it follows that the quantity of goods that arrives to the consumers depends on the public infrastructure provided by the state. The public infrastructure is assumed to play a major role at the seaport region because they should stimulate the transactions between the demand and the supply side of the market.

The quality and quantity of the public infrastructure influence the structure of the trade costs. If the public infrastructure is not enough developed, then the costs of trade within and between the seaport regions will be high.

The public infrastructure can be distinguished in two categories, domestic and international. The principal function of the domestic public infrastructure is supposed to be the promotion of the home trade at the local level, while the

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<sup>10</sup> Hence the tramp shipping is not included.

main role of the international public infrastructure should be the stimulation of the international trade [Martin et al., 1995].

The category of the domestic public infrastructure embraces the transport infrastructures, the telecommunication networks, as well as the public administration<sup>11</sup>. The international public infrastructure category includes the building or improvement of long-term facilities such as harbour and ports, international airports, as well as the betterment of the trade administration and of the international communication system. Hence, the import and the export activities between the two seaport regions are promoted.

If the domestic public infrastructure is well developed, then the home trade within the seaport region will be intensive because of the lower price of the products and the higher level of the demand.

This is true in a situation when the trade between two regions is well integrated<sup>12</sup>. In this case, the tendency of the reallocable activities will be to relocate into the seaport region where they exploit the economies of scale because of the better local public infrastructure [Martin et al., 1995].

The key issues for relocating the reallocable economic activities from one seaport region to another will be the differential patterns of the domestic public infrastructure, when the inter-regional trade is integrated. The domestic public infrastructure may be understood as a factor of accessibility and attraction of the seaport region. But the location choice in order to move the reallocable economic activities from one seaport region to another is supposed to depend on the level of the international public infrastructure [Martin et al., 1995].

This means that the location choice of the reallocable activities between seaport regions which offer the same level of domestic public infrastructure will be determined by the differential in the public international infrastructure. In this sense, the public international infrastructure performs a multiplier effect on the

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<sup>11</sup> The public administration as local administration and tax collection agency may be supposed to generate costs that may give origin to economic distortions [Martin et al., 1995].

<sup>12</sup> The integration of the trade is supposed to happen when the two seaport regions passes from an autarky economic equilibrium state, where the location of the production is given by the capital endowment, to a free market equilibrium with free movement of capital as well as free trade.

public domestic infrastructure. The trend will be towards a concentration process of regional divergence due to the lower transport costs and the stronger economies of scale [Krugman, 1991].

This result may be understood as a serious obstacle to achieve the goal of regional convergence. In particular at the EU level, the financing of new telecommunication, transport, education, and energy infrastructure in the peripheral regions is a fundamental issue.

At the level of the policy of the regional aid, it may be suggest the financing of the public domestic infrastructure, in order to make the seaport region more accessible and attractive for the reallocable activities. In this sense, the home trade will be stimulated, because of the relocation of such activities of production at the peripheral regions.

On the contrary, if the regional aid policy tends to the financing of public international infrastructure, then the international trade and role of the seaport region will be stressed, but it will probably lead towards a path of regional divergence. In fact, the reallocable activities will be not interested to move towards a peripheral region served by well developed public international infrastructure because they are able to reach the local market without relocating.

## **1.5 *The Indicators of the Dimension of a Seaport***

A scientific research has to make some assumptions about the most appropriate indicators to measure and compare homogeneous data. The indicators of the seaport dimension may be classified as quantitative and geographical indicators, as explained in the following chapters.

### **1.5.1 *The Quantitative Indicators***

The first quantitative indicator of the seaport dimension [Richert, 1996] is usually the tonnage of goods transhipped at the maritime site. This indicator is not wholly satisfactory because it does not weigh up the monetary value of the different cargoes.

It is very useful to give a definition of the terminology used in the seaport statistics about the cargo classification [Bird, 1971], as well as to note that

within the seaport geography discipline the basic interests are given by the volume, the nature and the direction of the cargo flows [U.S. Bureau of Census, 1988b]. Therefore, a distinction can be made between the two categories of the bulk cargo and the general cargo.

The **bulk cargo** are characterized by a low weight/value rate of the goods and by the exploitation of the economies of scale due to the large quantities handled [Mayer, 1973].

The bulk cargo can be classified into liquid cargo and dry cargo. The latter may be split into primary dry cargo (coal, iron, corn); secondary dry cargo; granulose bulk cargo; powder dry cargo, etc. These bulk cargo are handled by grabs, pumps, exhaust fans, belt conveyors, cup and chain elevators, etc. Following this criterion of classification, the suction cargo and the grab cargo can be defined [Mayer, 1973] [Marchese, 1996].

A bulk cargo is essentially a homogeneous cargo, without package. It usually consists of fuel or raw materials. The transportation of a bulk cargo allows the exploitation of the economies of scale because of the use of larger and larger cargo vessels. The cargo dimension corresponds to more than 100.000 tons. The goods are directed towards the warehouses located on the ground inside the port area. Then they are manufactured directly at the industrial plants located at the maritime site or in its hinterland.

The **general cargo** or break-bulk cargo may be split into conventional cargo (timber, fruits, iron, fertilisers, etc.) and containerised cargo.

This terminology describes a heterogeneous set of dry goods, packed in small lots, as foodstuffs or raw materials with a high value per weight unit, or manufactured products, and all characterized by a high delivery rate. Their high value per weight unit allows the transit of these goods through the port and their cheap delivery by road or by rail.

This chain of operations could generate diseconomies if any transshipment delay occurs during the cargo handling at the seaport terminal. Therefore, the cost of the vessel increases due to the congestion problems during the loading/discharge of the ship.

The method of the standard cargo units by handling pallets, containers and trailers has been the revolutionary innovation in the transportation sector that brought a solution to the general cargo handling bottleneck.

The break-bulk cargo handling is a labour intensive activity due to the nature of the general cargo, and a waste of time activity during the transshipment [Borruso, 1971]. This slackening in the loading/discharge operations build an economic barrier along the transport chain between the producer and the final consumer of the goods.

In this sense, the standard cargo units enabled the shortening of the terminal operations by the technical automation of the loading/discharge activity. The goods handled in such a way are called unitised cargo.

A double handling technique of the goods at the seaport site may be defined, as following:

- Cargoes moving through the seaport as it be a gateway between the land space and the ocean space.
- Cargoes transhipped towards the specialized deep-sea terminals for their storage and often for a first processing within the seaport area.

The arithmetical sum of the bulk and general cargoes gives the total tonnage in transit through the seaport site. This is a possible measurement of the seaport dimension. It is noticeable that the break-bulk cargo have an intrinsic high value per weight unit, hence they may potentially give rise to the higher benefit to the regional seaport economy with respect to the other cargo typologies.

As an alternative to the total tonnage transhipped at the seaport site, an other indicator could be used in order to measure the prosperity of a maritime location. A most appropriate indicator could be the ratio of the general cargo by the total tonnage with respect to the transit cargo [Weigend, 1958].

A third indicator is given by the containerisation rate. The rate of containerisation may be calculated as gross or net containerisation rate.

The **gross containerisation rate** is defined as the percentage rate of the general cargo, that is the ratio given by the gross weight of the containers<sup>13</sup> transhipped at the seaport site divided by the gross weight volume of the general cargo, commonly expressed in million tons and calculated over the same period of time, that is usually a solar year. The HHVW Hafen Hamburg Verkaufsförderung und Werbung makes use of the gross containerisation rate.

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<sup>13</sup> That is the weight of the cargo and the container.

The **net rate of containerisation** is defined as the net weight of the containers/trailers (1000 tons) divided by the net weight of the general cargo. The net weight of the general cargo is calculated subtracting by the total volume of the break-bulk cargo (1000 tons) the weight of the containers/trailers, calculated over a solar year. The Statistisches Landesamt of the Free and Hanseatic City of Hamburg makes use of this statistical indicator.

### ***1.5.2 The Geographic Indicators***

The Geographers are also interested to analyse the direction of the cargo flows of the seaport region. Usually, the geographical origin and destination of the goods handled is defined, as well as the geographical area of the incoming and outgoing cargo, or of the import and export goods. If the land space is considered, then a further cargo classification may be proposed, as follows:

- Economic goods produced inside the seaport area or the seaport city-region for the local consumption or manufacturing.
- Economic goods in transit through the maritime port site incoming from or outgoing towards an inland destination.
- Imported goods to be sold inside the seaport area or seaport city-region and its hinterland, and exported goods originated inside the seaport area or seaport city-region and its hinterland.

Unfortunately, a similar classification can not be defined for the maritime space. Therefore, the distinction between the imports and exports handled, as well as a detailed analysis of the cargo typologies seems to be relevant for studying the seaport site or seaport region.



## **2 The Role of the Institutions and Economic Agents at the Seaport**

The human activity is have a remarkable role on the development of a seaport. In fact, it is complementary to the geographical patterns, because the human intervention may have a dynamic influence on the maritime location. The human activity was absolutely relevant during every historical period, because it played often the decisive role in order to determine the ascent or the decline of a seaport site.

The Industrial Revolution gave a remarkable historical push to the seaports and harbours overlooking the North Sea and the Canal. It stimulated the ascent of those maritime sites to the rank of intercontinental ports connecting the European continent to the rest of the world [Weigend, 1958].

The relevance of the human factors in this case is extremely high. The seaport site, considered as an open system, interacts in a constant and dynamic way with the external operators but on different scales. At the macro scale, a world level of maritime activity can be defined. In this case, the seaport itself has no decisional or influence power.

At the local level, the port authority or the national and local governments are able to address the port policy, the port administration and the planning of the transport sector activities. At this level, the proposals are discussed and approved by the local authorities or by the competent bodies.

The Mediterranean seaport sites provide a good example of maritime locations unable to influence the course of the history. These seaport sites are in fact open systems that adapted themselves to the historical events such as the discovery of America, the ascent of the Ottomans Empire, the opening of the Suez Canal. Their passive adaptation is mainly due to the impossibility to change the course of the external world-wide events that occurred.

In the same way, the political decisions of the national governments may influence the ocean trade and traffic. For example, the application of protectionism steps with respect to the restriction on the quantity of a certain

goods allowed for the importation; or a port can suffer a stop in the transit cargo due to the decision of a foreign State to re-launch the its own maritime sites<sup>14</sup>.

The human agent should act at the local level for developing the seaport site. The opportunism and the creativity of the local port administration, as well as the promotion of the trade interests, are elements of vital importance for the economy of the seaport. In fact, conservatism and an extremely caution in the port activity management could exploit the opposite effect. The result could be the stagnation of the economic activity at the seaport site as well as at its tributary areas.

A new conception with respect to the seaport role is the notion of port-territory or port-region [Marchese, 1996]. Following this interpretation, the seaport is understood as a set of sheets of water, offshore structures, coastal spaces and inland spaces where the commercial and industrial maritime activities, as well as the induced activities, are settled in a co-ordinated way.

### **2.1 *The Administration of the Seaports***

At a world-wide scope, there is quite a broad range of different types of port administrations. Therefore, it is not possible to have an empirical application of the two theoretical models of public and private entrepreneurship to the seaport management.

Within the European scale, the distinction between the Northern Range seaports and the Mediterranean seaports with respect to the administration system is very clear. The application of a formal methodology enables to describe four models of seaport administration [Degrassi, 1997/98], as follows:

1. *Ports directly administrated by the State.* These are generally the Italian and French ports.
2. *Ports administrated by the local authority or the municipality.* This is the typical management of the ports of the North Range. The German ports are part of the territorial body. Hence, they are directly administrated by the municipality, that is the Land itself in the case of the two main seaports of

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<sup>14</sup> Examples are given by the port of Gøteborg and by the ports of the former Socialist countries.

Hamburg and Bremen-Bremerhaven. It is interesting to underline that no port authority is put in charge for the administration of the seaport activities.

3. *Autonomous ports administrated by dedicated bodies.* They are managed by a port authority with financial and budget autonomy. The Spanish ports and the six major French ports enjoy this category.
4. *Ports administrated by private bodies.* This category embraces few Northern European ports and the British ports.

The restructuring of the supply chain in the last years, had a significant influence on the role of the seaport, as nodal point of the transport system. The meaning of seaport evolves from the simple jurisdictional and territorial body to the wider concept of container of seaport operators, the so called **port community**. The port community embraces both the private and public seaport agents, spatially tied to the maritime location. The seaport operators are supposed to act to fit the requirements of the port clients, that are the vessels and the cargoes. Their instrument is to improve the attractiveness of the seaport location. The port community try to better the quality, as well as the efficiency, of the set of maritime services available at the seaport region, in order to meet the needs of the transport operators of the logistic sector.

The seaport has become a complex cluster of services. At the seaport location the basic seaport infrastructures are available in order to exploit the traditional loading/discharge operations on the cargo transported by the maritime carriers. Furthermore, a complete range of subsidiary services are offered, such as the distribution and logistics activities, warehousing, bunker operations [Hornby, 1987], the supply of spare components, the shipping reparations, the assistance to the crew, and so on [Ridolfi, 1996] [Informare, 1997].

From a global point of view, the privatization of the maritime sector induced a better efficiency of the seaport operations, the growth of the economic gains and the stimulation of the international competition for the supply of the maritime services at the seaport site. The seaport supplies the maritime equipment to the shipping companies and to the manufacturers [Kreukels et al., 1996], that are traditionally known as the port users. The services are the following:

- The equipment available to the clients to exploit the primary function of transshipment. Therefore, the loading/discharge operations on the cargoes are performed.

- The equipment necessary to locate the production plants and the distribution centres within the seaport area. In this case, the industrial activities and the activities of the tertiary sector are considered.

It has to be taken into account the fact that the competition sphere between the Western European ports is mainly focused on the transport function.

The institutional figure of the seaport administration is supposed to have to achieve the social welfare using the instruments of port and transport policy at the local, urban, and regional level. The social welfare may be interpreted in terms of the economic growth of the seaport region as well as of the improvement of the living quality at the seaport region. The economic growth of the seaport region is usually measured by the annual variation of the Gross Domestic Product GDP per person. The indicators to measure the living quality may be defined as following: the recreation and entertainment activities; the impact of (new) seaport functions on the labour market, i.e. the creation of new job opportunities; the environmental impact and the achievement of a sustainable economic growth at the seaport region; the availability of green areas; the land use destination and availability; the infra-structural impact in terms of congestion routes, number of accidents for each transport modality, pollution, etc.

The new figure of the **regional manager** may be introduced in order to fit both the requirements of the private agents that operates within the seaport region, and the social and economic goals the local political bodies pursue in order to achieve the economic growth of the seaport region itself. The private port operators exploit their own strategic decisions with the goal of maximising their utility function, while the public administration is supposed to maximise the social and economic welfare at the seaport region. Hence, the regional manager at the seaport region should have the strategic role to stimulate the consensus among the public and the private interests within a framework of multiple functional use and preservation of the maritime natural and artificial resources [Hershman, 1988].

The seaport functions may be classified into maritime traffic services, general services and services for goods<sup>15</sup>. The field of competence of each seaport

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<sup>15</sup> A more detailed list of elements might be produced for each seaport with the goal to have an homogeneous and detailed description of seaport functions and competence.

function embrace both a governmental sphere if they are executed with own state staff or through firms under public contract; and a private sphere, if the private enterprises operate within a competition or monopolistic market.

Following a historical approach, it is remarkable to analyse the institutional path followed in the past by the public administration with respect to the port and transport policy, as well as the managerial analysis of the strategic choices of the local firms carried out in the past. This study may be particular useful to understand both the development and the state-of-the-art of the transport and port infrastructures, especially in the former Socialist countries.

The role of the regional manager at the seaport regions in the transition countries should be particularly delicate. The regional manager should be able to pick out the future goals of the political seaport administration, as well as to discover their motivations to move on a transformation path of regional development. The transition should be preferentially realized through a dynamic growth process of active participation of every seaport location involved into the building of a seaport network, rather than a poor imitation of the Western standards. An example could be the New European Space and in particular the promotion of a real functional Baltic space.

Port and transport policy are obviously influenced by the peculiarity of the cultural factors and heritage of each country, as well as by the social and economic goals of the seaport agents, such as welfare and economic growth. The promotion of the economic activities that generate added value is a pretty useful instrument of the economic policy the local administration can powerful use in order to improve the economic conditions at the seaport region, which may induce a positive impacts on the social welfare and on the living quality. The local patterns should be strongly preserved because they are the particular characteristics of each seaport region, as well as they constitute the potential local factors for promoting the endogenous development and growth. The differences among the various seaport locations should be stressed, because of the necessary functional characteristics of subsidiary of the nodes, if the seaport network is integrated.

The seaport regional manager should also have the function to conciliate the local needs with the influences of the national, and supranational issues, due to the character of open system of the seaport region. The regional manager should evaluate the impact on the regional port policy of the national transport policy of the national government, as well as of the supranational legislation issued by the supranational institutions, such as the European Union.

In a global economy, the location decisions of the shipping companies as well as the others exogenous economic agents have a remarkable impact on the seaport policy, a strategic matter that the seaport regional manager should pay careful attention.

## **2.2 The Locational Choices of the Economic Agents**

A double sphere of influence can be drawn when the interaction between the seaport open system and the external economic agents is analysed, as follows:

1. The oceanic transport is fully dominated by the line shipping companies and by their strategic location choices.
2. The links towards the hinterland are influenced by a wide set of external economic agents, responsible for the building and running of the roadways, railways and air links.

Within the sphere of the seaport competition, the most important location choice [Marchese, 1996] is taken by the big line shipping companies when they plan the stopping calls of their fleet [Slack, 1990], both at a continental and regional level [Kreukels et al., 1996].

The economic maritime operators perform their location choice on the preferred maritime port site for their stopping calls under these fundamental questions:

- Which seaport/harbour offers the best accessibility from the sea/ocean site?
- Which seaport/harbour supplies the more efficient hinterland transport links, by roadways, by inland waterways, by railways, by pipelines?
- Which seaport/harbour affords the best combination of port tariffs, flexibility and quality to the shipping companies?

When the maritime economic operators have to choose the seaport where to make their stopping calls, two kinds of factors emerge:

- a) *Exogenous factors*. These are, for example, the geographical location of the seaport site, the adequacy of the seaport infrastructures, the local legislation, etc.
- b) *Endogenous or service factors*. The quantity and quality of the services supplied, efficiency and performance of the existing equipment, etc.

A recent study [Informare, 1997] carried out between the commercial and industrial operators of Austria, Switzerland, Bayer-Germany and Pianura Padana-Italy pointed out the following main elements a seaport site should fit in order to be economically attractive to the external economic operators:

1. The favourable costs	69,3%
2. The shortest time stopping at the port	61,4%
3. The quality of the service	30,7%
4. The cargo security	30,7%
5. The adequacy of the infrastructures	20,0%
6. The geographical proximity	18,0%

It is plain that the quality of the service and the cargo security weight together for the 61,4% with respect to the whole decisional choice factors. Few economic operators considered some of these patterns to be absolutely necessary when they have to choose a certain seaport site rather than another. This means that a harbour could be absolutely not taken in account if just one of the previous essential elements is missing.

Considering the world-wide sphere of influence the location choice of the ocean shipping companies exploit on the seaport economy, it is important to note the relevant restructuring changes on the composition of the world fleet after the new entrance of the Southern-East Asia shipping companies [Kreukels et al., 1996]. In the year 1995, the first 20 world-wide line shipping companies exercised their control over the 85% of the world market [Confetra, 1997].

Since the '70s, a sharp competitiveness among the maritime transport service operators has been taking place. The main characteristics of this competition among the shipping companies may be singled out, as follows [Nuhn, 1994]:

1. The great potential of the financial companies to exercise control over the parcel of shares of other companies.
2. The availability of large financial funds because of the holdings.
3. The technological and organizational innovations [Kuby et al., 1992].
4. The competition of the shipping companies of the former Socialist states, not liable to the free market competition principles and therefore to pursue

the goal of the minimum costs and the law of the demand and supply. This aspect kept its validity till the Fall of the Berlin Wall in the year 1989 and thereafter the following crumbling of the Socialist planned economies.

The shipping companies applied the most various strategies in order to cut down the costs and to improve the maritime services, as follows [Mayer, 1974] [Nuhn, 1994]:

1. The increased dimension of the ships (over 4000 TEUs<sup>16</sup>) with the goal to reduce the costs per unit [Kuby et al., 1994].
2. The shortening of the stopping time at the seaport terminals in order to reduce the wharf costs [Kuby et al., 1992].
3. The spatial clustering at the main seaports for the best exploitation of the technical equipment available locally [Mayer, 1973] [Slack, 1990].
4. The introduction of the shuttle services and the feeder ships. Consequently a shift from the ocean carriers to the medium-short distance maritime and land transportation took place. A feeder ship is a medium-short distance vessel. It performs the distribution service of the cargo collected from the ocean ships at the main ports towards the secondary seaports and harbours. On the opposite way, a feeder ship collects the goods from the regional and secondary maritime sites and conveys the cargo to the main port [Ente Autonomo del Porto di Trieste, no year].
5. The optimisation of the transport network from the ship towards the final client.

Furthermore, the shipping companies constantly observe and evaluate:

6. The infrastructures and the services performed both at the seaport site and its hinterland dedicated to the transport of the economic goods.
7. The national and local legislation in force at the seaport location.

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<sup>16</sup> The term TEU is the acronym for Twenty-foot Equivalent Unit and it refers to the standard dimension of a container.

In short, this set of dynamic factors induced the reduction of the number of shipping companies and their economic agglomeration into strategic alliances at the world-wide operational level.

The integration of the transport chain begun with the management of the so called Round The World RTW services. The RTW service is a world-wide service focused on the operational intercontinental maritime direct links [Schäfer, 1988].

The integration of the transportation system involves the location choice performed by the big industrial companies with reference to the geographical location of their distribution centres [Kreukels et al., 1996].

The industrial companies are interested into the secondary function exploited at the seaport site. Therefore, with respect to the location decisions of the shipping companies, a different set of elements are evaluated in order to carry out the location choice focussed on the industrial and distribution functions.

The decisive factors are the cost of the industrial area, the cost of the energy, the taxation, as well as the cost of the labour force and its productivity at the seaport region.

### ***2.3 The Role of the Regional Institutions***

One of the aim of the building of a seaport network should be the integration of the seaport regions by the promotion of the process of networking. The economic growth and the social welfare at each seaport region may be achieved by the promotion of the process of external interchange between seaport regions, and also by the process of internal networking, in terms of a local interaction between the economic agents. The convergence between seaport regions is supposed to be encouraged by the addition of value to the seaport regional network.

The structure of the transportation sector has to be analysed with reference to the peculiarities of each transport modality. The demand for transport service has to be treat independently as a proper productive activity, rather than as a derived demand. The JIT requirements call for minimising the transfer costs in the transport activity, as well as for orienting the production to the customer needs. The transfer costs show the total opportunity cost of moving goods from one place to another. They are estimated by the sum of the transaction costs

plus the transport costs. The customer orientation asks for a flexible response to the demand of the clients for diversified products.

The transportation activity is undoubtedly the economic activity of production which inherently performs the most relevant spatial impact on the geographical asset of the territory. The ecological impact of transport stresses the spatial dimension because of the negative externalities generated at the local level of each single transport node and link in terms of pollution and congestion, as well as at the global level in terms of global warming effects. The logistical restructuring process weakens the constraint of the physical distance between two geographical locations due to the compression in the time-space dimension. Furthermore, the optimal efficiency of the logistics operations seems to be a powerful instrument in order to counteract the external costs of transport on the environment.

Three different kind of instruments are available in order to add value to the seaport regional network, as follows: 1) the project instrument; 2) the programme instrument; and 3) the policy instrument [Banister et al., 1999]. Every instrument may be referred to five different operative levels, that is: 1) the urban, local level; 2) the metropolitan, regional level; 3) the inter-regional level; 4) the national level; and 5) the supranational, EU level.

Every decisional level performs a different sphere of network interchange. The network interchange occurs both within each operative level (i.e. internal networking) and between every single network (i.e. external networking) because of the fundamental character of open system a network is supposed to own, as well as the essential assumption of the entropy law. The total interaction costs are the economic evaluation of both the internal and external interchange by networking.

#### **The Local, Urban Level**

The seaport network remarks the strategic relevance of the urban, local level of decision and intervention in order to promote the endogenous economic growth and the welfare of the seaport region. The project instrument is the operative tool that enables the generation and addition of value to the seaport network. At this level of action, the lack in financial resources available to the local bodies for improving in efficiency the urban, and local links and nodes may be a serious impediment not easy to solve.

In general, two kinds of financial sources are available: public and private. In order to build the major infrastructure works, a large amount of investments is usually required within the short-medium term, while the profits are typically obtained in the very long run. On this basis, the state was entrusted to supply the public infrastructure within a monopolistic economic framework. The assignment of several economic activities, formerly supplied by the governmental institutions to the private sector, often promoted new forms of public/private partnership for searching private co-investors.

The privatisation process in the urban transport services, such as in the entire public transport sector, might be a source of negative externalities in the transport chain. A lack in the co-ordination and optimisation in the transport movements between the independent private transport operators might give origin to a lower efficiency with respect to the previous condition of state monopolistic supply of the urban transport as public service. In fact, the urban transport sector may be shaped as an imperfect competitive market, where the supply side is quite pulverized among several individual transport carriers.

The integration among the different freight transport operators should be a goal to pursue by following various scale of intervention, as following:

- the centralization of the transport activity for each transport modality by founding a local corporation.
- the use of the most appropriate software applications and data bases for a better co-ordination of the movements of the freight vehicles inside the urban seaport area;
- the establishment of distribution centres at the inter-modal points both inside and outside the urban seaport area;
- the use of green vehicles for delivering goods inside the urban seaport area.

The Table 2.1 refers to the actions that might be suggested in order to promote a urban system for freight transportation, that be integrated and environmental sound. All of them might be able to add value to the seaport network acting from the local, urban level.

At Hamburg, the movement of the container from one terminal to another within the seaport area, as well as the distribution of the goods towards the local urban destination within the seaport region are mainly performed by trucks. There are two indicators which support the positive forecast of growth in the

intensity of the freight traffic in the urban area of Hamburg. First, the growing turnover of cargo of the port, which is indicated in particular by the net rate of containerisation. Second, the relevance of the local entrepreneurship in order to generate value added, which is expressed in monetary terms by the statistics on the special trade of Hamburg. In particular with reference to the transport movements by road in Hamburg, the congestion problems along the main traffic routes during the pick-hours have to be solved (Map 1).

Table 2.1 – The local, urban level of decision.

Level of Decision	Key Issues	Critical Success Factors
<p style="text-align: center;"><b>Local, Urban Level: Project</b></p>	<p>For each Transport Modality:</p> <ul style="list-style-type: none"> <li>• Individual Links</li> <li>• Infrastructure Network</li> <li>• Terminals</li> <li>• Interchanges</li> <li>• City logistics</li> <li>• Environmental impact</li> <li>• Economies of scale</li> <li>• Economies of time</li> <li>• Economies of scope</li> <li>• Just-in-time requirements</li> <li>• Containerisation</li> </ul>	<ul style="list-style-type: none"> <li>• Restrictions</li> <li>• Competition between transport modes</li> <li>• Finance and subsidy</li> <li>• Individuals</li> <li>• Schumpeterian entrepreneurship</li> <li>• Levels of integration</li> <li>• Organization between the transport operators</li> </ul> <p style="text-align: center;"><i>Adding value to links and nodes in the urban – local network.</i></p> <p style="text-align: center;"><i>Favourable conditions for promoting a local innovative Schumpeterian entrepreneurship.</i></p>

The shift from the road to the inland waterway mode should be carefully evaluated, in order to exploit the extensive transport network at the local level of the seaport. The intervention of the local government is essential in order to promote the favourable conditions to improve the efficiency of the freight transport by barges within the seaport area. The launch of the Elbe Container Line in the year 1999 shows the effectiveness of the jointly action among different transport operators.

The critical success factors may be regulatory, such as the imposition of restrictions on the freight transport by road within the seaport area, as well as operative, such as for example the betterment in the inter-modality patterns between deep-sea vessel and barges at the maritime terminals. The financing and subsidizing of the rail and inland waterway transport modes might be a solution in order to compensate the under-pricing in the road transport service.

#### **The Metropolitan, Regional Level**

The project instrument may be used in order to add value to the seaport network by moving from the metropolitan, regional level of intervention. The local government may pursue the integration of the very suburban area into a metropolitan multi-nodal network by implementing the most appropriate projects. The problem of the territorial administrative competence of the local government may arise if the geographical area of the metropolitan district differs from the administrative territory of the city. The administrative boundaries may express a conflict of interests between the needs of the core area with its own local government, and the larger metropolitan region, submitted to one or more different administrative territorial bodies.

The boundaries of the metropolitan region Hamburg are in fact quite more extended with respect to the administrative territorial boundaries of the Land of the Free and Hanseatic City of Hamburg. The new figure of the regional manager should be suggested in order to promote the networking process between the various territorial authorities. The regional manager had to coordinate and integrate the economic and institutional activities into the new city-region functional framework (Map 1 and Map 2).

Undoubtedly, the project tool might exploit a catalyst effect among the set of various administrative local authorities, each of them performs its competence over different administrative territories, in order to joint the common goals of economic growth and social welfare in the city-region. The interchange among the economic and institutional agents the regional manager had to be capable

to promote is one powerful instrument for adding value to the metropolitan-, regional network. In order to achieve such a project, transaction costs have to be faced to stimulate the interaction between the territorial political authorities. The improvement in efficiency of links and nodes of the city-region are supposed to compensate definitely the transaction costs that were born. The Table 2.2 shows the key issues, as well as the critical items of success at the metropolitan, regional level of intervention.

Table 2.2 – The metropolitan, regional level of decision.

Level of Decision	Key Issues	Critical Success Factors
<p style="text-align: center;"><b>Metropolitan, Regional Level: Project</b></p>	<p>For each transport modality:</p> <ul style="list-style-type: none"> <li>• Regional links</li> <li>• Infrastructure network</li> <li>• Public Logistics Terminals PLT</li> <li>• Inter-modality</li> <li>• Logistics and networking effects</li> <li>• Environmental impact</li> <li>• Economies of scale</li> <li>• Economies of time</li> <li>• Just-in-time requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Administrative territorial competence</li> <li>• Co-ordination between the local authorities</li> <li>• Integration between the local agents</li> <li>• Competence for improving the transport efficiency</li> <li>• Regional Management</li> </ul> <p style="text-align: center;"><i>Adding value to the metropolitan – regional network.</i></p> <p style="text-align: center;"><i>Sustainable economic growth inside the metropolitan region.</i></p>

### The Inter-regional Level

At the inter-regional level, the programme instrument should enable the integration between seaport regions by following the broader issues of network connectivity and logistics. The three fundamental network characteristics of inter-modality, interoperability and interconnectivity should be achieved in order to add value to the seaport network.

A coherent collaboration programme between the seaport regions should particularly emphasise the benefits of its realization, in order to attract as many potential private/public investors as possible. The regulatory and organizational framework represents a valid tool of transport policy, in particular when the negative externalities<sup>17</sup> generated by the different transport modalities are not completely internalised into the market price of the transport service. The under-pricing in the transport sector occurs when a transport modality hides its full social cost. The structure of the transport sector is typically shaped as an imperfect competitive market system, which is assumed to allocate inefficiently the economic resources. Hence, the under-pricing in the transport service shows the lack in efficiency of the market instrument of allocation. The larger the share of the full social cost a transport mode is able to hide, the sharper the under-pricing it may get.

The programme should be exploited as a powerful instrument for redistributing the hidden full social cost between transport modes. The programme instrument should enable the regional administrative bodies to evaluate the real full cost for each transport modality, as well as to promote a sustainable transport policy. The efficiency in the inter-regional transport network might be improved by minimising<sup>18</sup> the level of uncertainty, as well as by warranting the continuity in financing and investments. A co-ordinated inter-regional transport policy should be able to add value to every transport node and link of the network involved. The territorial competition between bordering regions is certainly a thick barrier that should be dissolved. Often happens that the bigger the geographical distance between regions, the higher their propensity to interact.

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<sup>17</sup> For example, the environmental and social impact, such as pollution and degradation of the natural resources, as well as noise and number of accidents.

<sup>18</sup> Or, at least, by reducing.

The functional collaboration and competition between seaport regions should be promoted in order to improve the efficiency of the seaport functions of the network. The affinity between nodes and links had to be exploited at the best, because the maximization in the degree of homogeneity and heterogeneity of the network implies the best internal and external interaction activity for every level of the seaport network. Affinity means the performance of complementary functions, that are equal-distributed between the seaport regions, rather than a sharp specialization of economic activities nor a strong concentration just at few seaport sites. The co-ordination of the interregional interchange should be stimulate the adjustment of the economic functions between the seaport regions, which are spontaneously involved in the networking process.

The positive impact of networking refers both to the core and peripheral seaport regions. The agglomeration of production activities at the core seaport region is supposed to give origin to negative externalities such as congestion and pollution. The economic growth and the welfare of the core seaport region is consequently reduced, although till now no measurement has been commonly accepted in order to properly depreciate the official value of the Gross Domestic Product GDP into a more realistic “green” GDP. The shift of any economic function to the peripheral seaport regions should relax the stress the core seaport regions seems to suffer, as well as should be an effective instrument in order to promote the economic growth and welfare at the peripheral location.

The globalization of the economy, as well as the complementary restructuring process at the regional level lead both towards the integration between the maritime and land space in the seaport network. In fact, foreland, seaport region and its hinterland may be seen in terms of a continuum space, rather than as three split dimensions, as it was before the diffusion of the two innovative complementary concepts of inter-modality transportation and containerisation. Furthermore, the application and diffusion of new information technologies in the transport sector, as well as the more and more frequent horizontal integration of the companies within the post-fordist organizational framework contribute to add value to the high quality network of the transport infrastructure especially in the Western economies.

The new economic figure of the Multi-modal Transport Operator MTO is assumed to exploit the provision of the logistics services within a wholly integrated transport network. The Table 2.3 summarises the key issues and the critical patterns of success at the inter-regional level of decision.

Table 2.3 – The inter-regional level of decision.

Level of Decision	Key Issues	Critical Success Factors
<p style="text-align: center;"><b>Inter-regional Level: Programme</b></p>	<p>For each transport modality:</p> <ul style="list-style-type: none"> <li>• Inter-regional links</li> <li>• Inter-modality</li> <li>• Interconnectivity</li> <li>• Interoperability</li> <li>• Logistics and networking effects</li> <li>• Competitiveness</li> <li>• Environmental issues</li> <li>• Information network</li> <li>• Economies of scale</li> <li>• Economies of time</li> <li>• Economies of scope</li> <li>• Economies of networking</li> <li>• Just-in-time requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Functional collaboration and competition</li> <li>• Interchange of complementary functions</li> <li>• Co-ordination for developing the infrastructure transport network</li> <li>• Information and knowledge interchange</li> <li>• Inter-regional management</li> <li>• MTO Multi-modal Transport Operator</li> </ul> <p><i>Adding value to the inter-regional network and communications.</i></p> <p><i>Sustainable balanced growth between regions.</i></p> <p><i>Favourable conditions for promoting a New Innovative Space.</i></p>

## **2.4 The Role of the National and Supranational Institutions**

### **The National Level**

At the national level, the programme is once again a powerful instrument of transport integration and co-ordination. Logistic effects and networking effects have to be considered in order to exploit a sustainable national transport policy. The freight transport by road seems to fit better the new logistics requirements due to the restructuring process in the supply chain of production. The environmental and social impacts of the negative externalities the road transport mode generates are not completely internalised into its market price, The underestimation as well as the under-pricing of the road transport modality have a remarkable impact on the modal choice of the economic agents, due to the apparently higher efficiency this environmental unfriendly transport modality shows with respect to the others. A careful estimation of the real impact of the negative externalities on the national economic growth should be estimated in monetary terms to calculate the “green” GDP.

There are three possible different approaches in order to estimate and/or internalise the negative externalities that the transport activity generates, as follows: the consumer-pays approach, the taxpayer-pays approach, and the cost-benefit analysis.

#### *Consumer-pays approaches*

The consumer-pays approaches aim to internalise some or most external costs of pollution and resource waste into the market price of the transport activity. The initiatives are the following:

- a) *Set the harmful actions as illegal:* laws, ordinances, regulations might be put in force in order to fix the standard upper limits in the volume of the polluting emissions of the vehicles, to regulate the detrimental activities, to band the release of toxic chemicals into the environment, as well as to state the conservation of certain natural resources.
- b) *Penalise the hurtful activities:* taxes might be levied on each unit of pollution discharged into the air or water, as well as on each unit of superfluous natural resource wasted; polluters might be required to carry high levels of liability insurance; laws for controlling the pollution might be put in force; large automatic fines and automatic jail sentences might be carried.

- c) *Selling to the market the rights of polluting and exploiting the natural resources*: this initiative generates taxes and revenues paid in order to buy the right to pollute up to the legal level, as well as the right to harvest or extract a sustainable amount of natural resources owned by the state or any other public authority. Hence, the exploitation of such activities generally entails to face a quite remarkable level in the initial costs of productions.

#### *Taxpayer-pays approach*

The taxpayer-pays approach does not suggest any effective instrument in order to achieve the internalization of the external costs in the transport sector. On the contrary, the level of pollution and resource waste seems to be higher than the economic level of optimal pollution. The instrument proposed refers to the *reward of the beneficial actions*: subsidies by taxes might be granted to the entrepreneurs and firms for installing such equipment for the pollution control or prevention; for minimising the exploitation of the natural resources and wasting; for recycling and using again of resources. Furthermore, the financial supporting and promotion of innovative and more-efficient processes devices might stimulate the Schumpeterian entrepreneurship in the transport sector.

#### *Cost-benefit analysis*

The cost-benefit analysis is large used in the economic research. It compares the estimated short-term and long-term economic costs (i.e. losses) and economic benefits (i.e. gains) with reference to an economic decision. Any cost-benefit analysis outcome is fundamentally affected by the discount rate applied in order to forecast the value of the resources in the long run. The discount rate is generally a great source of disagreement between economists and environmentalists. The discount rate is defined in terms of an estimate of how much value a resource might have in the future if compared with its present value. A 10% discount rate is usually applied by most businesses and the U.S. Office of Management and Budget.

The application of a high discount rate might be justified if the growth in the inflation rate might reduce the future value of the profits, as well as to counteract the impact of both innovations and changes in the tastes of the demand side of the market, which might make a product or service obsolete.

Table 2.4 – The national level of decision.

Level of Decision	Key Issues	Critical Success Factors
<p style="text-align: center;"><b>National Level: Programme</b></p>	<ul style="list-style-type: none"> <li>• Logistics effects</li> <li>• Networking effects</li> </ul> <p>Including questions of:</p> <ul style="list-style-type: none"> <li>• Inter-modality</li> <li>• Interoperability</li> <li>• Interconnectivity</li> </ul> <p>Including the crowding out of investment.</p>	<ul style="list-style-type: none"> <li>• Regulation</li> <li>• Competition</li> <li>• Public and private financing</li> <li>• Companies</li> <li>• Integrators</li> <li>• New economic and spatial agents</li> <li>• Mergers</li> <li>• Alliances</li> <li>• Plans for implementing the transport infrastructure network</li> </ul> <p style="text-align: center;"><i>Adding value to the national network and communications of the country.</i></p> <p style="text-align: center;"><i>Sustainable economic growth of the nation.</i></p>

Environmentalists supports the idea that the natural resources are absolutely unique and scarce. Therefore, environmentalists point out that high discount rates encourage the rapid exploitation of the natural resources, as well as the accelerated degradation in the quality of the environment in order to receive an outcome in the very short run. It follows that only a discount rate at least equal to 0% or negative had to be applied in order to totally preserve the natural

capital. If the natural resources had to be exploited in a sustainable way, then the environmentalists accept the application of a discount rate that might swing between 1% and 3%. Certainly, a further problem in the cost-benefit approach is the identification of the economic agents who get the benefits and who are harmed by the costs of the polluting activity in economic terms. The Table 2.4 points out the main issues at the national level of intervention.

### **The Supranational, EU Level**

At the supranational, EU level, the policy instrument plays the major role. At this level of intervention, the supranational policy of the European Union is aimed to achieve the goals of balanced competition, spatial cohesion, social integration and inclusion, the improvement of both the accessibility between regions and the movement of people and goods (Map 3).

Within this policy framework, the environmental issues as well as the sustainability have to be harmonized and relating to the local, regional, and national priorities.

In fact, the transportation sector is one of the economic activities of production that more sharply depletes the natural capital. Moreover, it is a primary source of pollution and congestion.

The supranational policy tool has to fit both the global and local issues, as well as to meet both the Keynesian principles of social justice and welfare and the Schumpeterian principles of innovative entrepreneurship and competitiveness. Furthermore, both the environmental issues and the regional economic growth and development path have to be fit in a sustainable way.

The dynamic adjustment process has to be promoted through the global instrument of the supranational policy, as well as through the local management of the project instrument. The policy tool is necessary in order to give a solid basis of general values and goals.

The holistic approach to the different elements of the system may be helpful. The project instrument is essential in order to meet the concrete needs of the different geographical regions at the local level of action.

Following the demand led approach, investments in new infrastructures may be made in order to follow the forecasted regional economic growth. The interrelationship between investments for developing the infra-structure

transport network and regional economic growth was an interesting subject of analysis for a long time, but it has not been yet clearly proved.

The growing demand for transport services always implies an increasing demand for investments in the transport infrastructures. The expansion in the infrastructure transport network and the logistical restructuring process occurred to the transport chain during the recent years both led to a sharply rise in congestion and pollution, especially with reference to the road modality.

The major patterns of intervention at the supranational, EU level are shown in the Table 2.5.

Table 2.5 – The supranational, EU level of decision.

<b>Level of Decision</b>	<b>Key Issues</b>	<b>Critical Success Factors</b>
<p style="text-align: center;"><b>Supranational, EU Level: <i>Policy</i></b></p>	<ul style="list-style-type: none"> <li>• Competitiveness</li> <li>• Cohesiveness</li> <li>• Environmental issues</li> </ul> <p>But also:</p> <ul style="list-style-type: none"> <li>• Pricing competition</li> <li>• Liberalization</li> <li>• Open access policies</li> </ul>	<ul style="list-style-type: none"> <li>• Regulations</li> <li>• Competitive frameworks</li> <li>• Financial institutions</li> <li>• Governments</li> <li>• International agencies</li> <li>• Multinational companies</li> </ul> <p style="text-align: center;"><i>Adding value to the competitive position of the countries and the EU.</i></p>

## **Section 2**

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## **Seaports as Distribution Nodes**



## **3 The Spatial-Economic Agglomeration in the Maritime Sector**

### ***3.1 The Economies of Scale and Density in the Maritime Sector***

The maritime sector is historically characterized by a high degree of specialization and a sharply fragmentation of the service [Informare, 1997]. Therefore a set of specialized professional and well paid activities are recognizable, each of them perform a key role within the transportation cycle. Shortly, it is possible to mention the ship-owners, the international forwarding agents, the terminal operators, the pilots, the mooring operators, the ship brokers, the maritime insurance agents, the truckers, etc.

During the time, the high specialization degree of the maritime sector activities allowed both the development of a power point and the generation of high sectorial revenues. From point of view of the final client, these sectorial revenues bound both the economic efficiency and the limitation of the global costs of transport. As a consequence of the general patterns mentioned above, a restructuring process of the maritime transport sector took place.

Following this dynamic perspective, the companies are continuously looking for an equilibrium state, but this point of equilibrium is absolutely not static. The companies have to adjust their logistics system, reducing the number of their warehouses and the dimension of the lots handled, with the goal to achieve a higher delivery speed, punctuality and precision. Because of this restructuring process, the multi-modal transport services were created, and simultaneously the demand grew for the integrated distribution services.

From these considerations it follows that the volume of goods transported rose in terms of ton/km handled, because the transport activity occurs over larger distances. At the same time, the dimensions of the lots handled decreased. This cargo parcelling caused a more difficult management of the deliveries, since a higher specialization and professional level was required [Nuhn, 1994] [Informare, 1997].

Economies of scale or economies of density can occur in the transportation sector because of the external benefits generated by the improvement in the transport system [Forkenbrock, 1999]. The increasing dimensions of the vessels used by the shipping companies shows the economies of scale exploited in the maritime sector. Consequently the average cost of a unit of production may drop due to the reduction of the operative costs the firm has to face, and to the higher level of production offered on the market.

The competitiveness of the firm on the market can rise, but the beneficiaries of this cost reduction can be the producer itself or the final consumer. The market structure determines the economical actor who retains the cost savings. The economies of density in the maritime sector are shown by the spatial agglomeration of the maritime activities at few main ports per continent, such as in the European Northern Range<sup>19</sup>. For example, the industrial function and chemicals handling require more specialized structures, available just at few locations. The same reason may be referred to the availability of deep-sea terminals for the container vessels of the last generation.

#### **The External Economies of Scale**

The external economies of scale are defined as those economies of scale that appear at the level of the industry rather than of the individual firm within an imperfect competition market structure [Krugman et al., 1997]. On the contrary, internal economies of scale occur when the output unit cost is related to the size of the individual firm but is not influenced by the dimension of the industry.

The British economist Alfred Marshall identified the "industrial districts" as those geographical areas where a concentration of industry takes place without any relationship to the natural resources of that specific site. The industrial clustering formation process allows the exploitation of a higher level in the efficiency of the industry with respect to the efficiency of an isolated firm, due to the geographical proximity of the individual firms. Marshall argued three reasons to explain the more efficiency level within an industrial cluster [Krugman et al., 1997], as follows:

1. *Specialized suppliers*. This first source of external economies within an industrial district may be identified as the ability of the cluster of industry to stimulate a deep specialized division of labour along the production chain.

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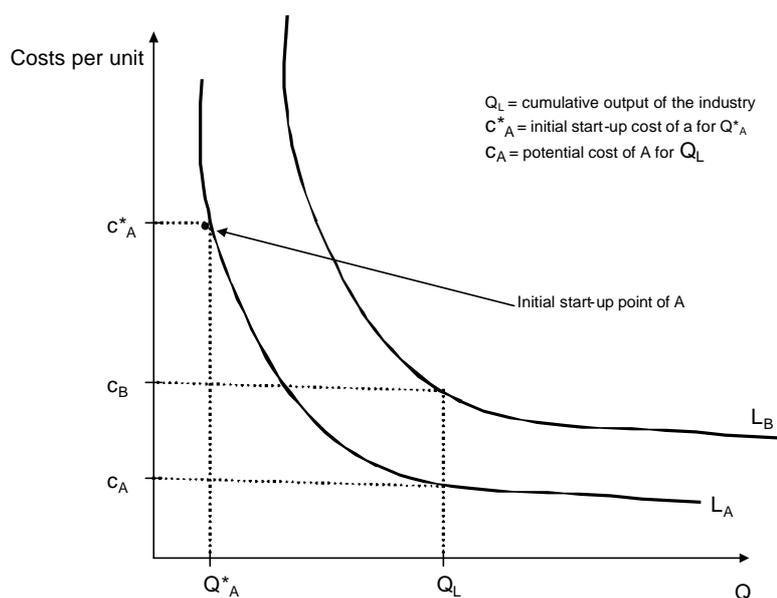
<sup>19</sup> See the chapter 9.2 at page 250.

The clustering of industry enables to reach a threshold for a set of high-specialized productions or services. The specialized supplier could not exploit the same favourable economic conditions if it has to operate outside an agglomeration of industry and to face firms geographically isolated.

2. *Labour market pooling.* The second source of external economies within an industrial district is the possible formation of a pool of highly specialized workers. A reciprocal advantage can be emphasised, both for the producers and the workers. The producer side is likely to avoid scarcity of high-skilled labour force, the workers are likely to avoid unemployment periods and to achieve better contractual conditions. The geographical concentration of the industry induces a high flexibility of labour in the sense of an extreme mobility of the workers when they decide to change firm.
3. *Knowledge spill-over.* The third source of external economies within an industrial district is the knowledge spill-over. In the modern economy it is considered as a fourth factor of production, as relevant as the capital, the labour force, and the raw materials. The exchange of knowledge is facilitated by the geographical proximity of firms within a cluster of industry because the opportunity for informal contacts between the workers is higher. The individual know-how can be improved by an interchange of information and ideas, common experiences, and discussion about similar problems. This is an informal networking process that increases the level of knowledge of the industry as a whole at that cluster location. Of particular interest are the innovative districts or regions, because of their innovative potential to be exploited through the creative entrepreneur figure.

At the level of a country, the external economies generated by a large industry operating at the national level can induce macroeconomic increasing returns [Krugman et al., 1997]. This may be due to the higher level of experience a country could have with respect to a certain industry that leads to a lower cost per unit of product. It is important to note that the external economies arising from the accumulation of knowledge differ from the external economies arising from the economies of scale, because the latter are referred to the relationship between industry cost and current output.

Figure 3.1 – The learning curve L of the accumulation of knowledge.



The impact of the accumulation of know-how on the economic structure of the industry can be singled out by the dynamic increasing returns that take place only if the costs of the cumulative production of the industry fall over the time rather than depending on the quantity of the production [Krugman et al., 1997].

If the case of accumulation of knowledge as source of external economies is considered, then the new relationship between industry costs and experience rises. The know-how is measured by the cumulative output of the industry. The relationship between unit cost and cumulative output of the industry can be graphically pictured as a downward learning curve L (Figure 3.1).

As the learning curve plot shows, although the country A may have a lower learning curve  $L_A$  because of, for example, lower wages, the country B may have a lower unit cost of production  $C_B < C_A^*$  due to the extensive experience of B in that industry.  $C_A^*$  is the initial start-up cost the country A has to cope with if it wish to enter in the market. But the country B is already operating in the market of the industry, which produces a cumulative output equal to  $Q_L$ .

Therefore the country B benefits of the external economies due to the accumulation of knowledge over the time. The country A can encourage the establishment of the infant industry by implementing protectionism

measures, such as subsidies or protecting it from the foreign competition, pursuing the goal to growth its long-term welfare. It is easier to make the following assumption: under a perfect competition framework, the lower the costs of an industry the larger the industry's dimension. Therefore, the larger the industry's output the lower the market price of the product supplied. The supply curve is consequently shaped downward.

### ***3.1.1 The Key Segments of the Inter-modal Transport System***

It may be useful to analyse the three key segments of the integrated system of the inter-modal transportation, as follows: 1) the ocean trip; 2) the transit through the seaport; 3) the inland transportation trip. This analysis may help to give a rational explanation to the spatial clustering at few main seaports per continent with respect to the container transportation.

About the ocean trip, the shipping companies had to reduce the number of stopping calls at the maritime ports because of the high daily maintenance costs of the big container ships, and because of the high wharf costs during the stopping of the ocean vessel at the seaport site. In particular for the bigger container ships this strategy imply the reduction of the total stopping time at the seaports for each trip, and also the reduction of the seaport costs.

Furthermore it makes possible to increase the number of annual trips that can give origin to an economic gain. Furthermore, the use of big vessels allowed to exploit the economies of scale in the maritime transportation. The large container ships make their stopping calls at few main seaports adequately equipped. This spatial concentration has boosted the use of the feeder service system by using trucks, trains or small vessels, especially on short-distance routes but scattered of secondary harbours. While the large container ships operate on the long-distance ocean routes.

Containerisation and inter-modality can suffer a failure in efficiency, if a parallel adequate inland transportation system is not developed in order to follow the seaport operations. In this sense, the factor of influence on the shipping company's choices is given by the total distribution cost, and this imply the management of a door-to-door service rather than a port-to-port service as in the pre-container age. With the aim to pursue the economies of scale in the movement of the containers, the maritime operators cluster their traffic on few main seaport locations with an appropriate accessibility to the major transport

routes towards the inland destinations of an economic area, a country or a continent. They aim to penetrate a region along a specific route, as much deep as possible. The instrument they use is a high volume of freight traffic.

During the pre-container age, the extension of the seaport hinterland was extremely limited by the sharply high land-transport costs to transfer the general conventional cargo towards the inland destinations, in comparison to the lower transport maritime costs. The incidence of the transport costs induced the cargo vessels to make their stopping calls by many closer harbours. The situation has taken a turn for the more competitiveness of the inland transport carriers against the ocean carriers, because of the improvement of the transportation system related to the seaport operations after the introduction of the containers.

For example, the infra-structural works related to the improvement of the Federal transport network in Germany have to be financed by the German Federal Government. Since the second after war, the Land of Hamburg sharply achieved the development of the links that spread out from the Hanseatic city towards the rest of the country.

The costs related to the financing of the development works of the road, rail and inland waterway networks are supported by the State Budget through the budget entries, therefore through the taxes paid by the citizens. In turn, the running costs of the large container ships are more expensive with respect to the operating costs related to the general conventional cargo ships, mainly due to the higher purchase costs.

This situation encouraged the development of the concept of inland distribution [Slack, 1990], due to the fact that the rail and road carriers were able to be competitive with respect to the high operative costs of the ocean vessels, both on the short and long distances<sup>20</sup>.

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<sup>20</sup> Within the inter-modal sector, it is interesting to point out the marketing alliance TARES, acronym for Trans Atlantic Rail Express between the ICF Inter-Container Inter-Frigo ICF is the pan-European rail operator for the National railways and the operators of the UIRR Cemat (Italy), HUPAC (Switzerland), and the U.S. companies Norfolk Southern and CPG Container Port Group. This alliance wish to achieve an American and European inter-modal combined transport service for the shippers, by using the existing inter-modal services and the EDI Electronic Data Interchange with the goal to supply a complete inter-modal one-stop structured

In the Table 3.1 the operating costs of the bulk ships for the year 1990 are reported. It is supposed a maritime navigation period equal to 270 days per year, and the speed is of 14 nodes [Nuhn, 1994].

Table 3.1 – The economies of scale in the maritime transport of bulk cargo.

Ship dimension (dwt*)	Operating costs (1.000 US\$)	Bunker costs (1.000 US\$)	Total costs (1.000 US\$)	Costs per 1 dwt* (1.000 US\$)
40.000	1.315	1.890	3.202	80
65.000	1.540	2.295	3.385	59
120.000	1.780	3.051	4.831	40
170.000	2.120	3.780	5.900	35

\* dwt is the acronym for dead weight tonnage. This unit of measurement indicates the maximum load cargo the ship is able to carry. Stores and fuel are included [Ente Autonomo del Porto di Trieste, no year]. The term bunker is commonly used in the maritime language to indicate the provision of the vessel in a more comprehensive sense.

## 3.2 *The Economic Impact of the Transportation Activity*

### 3.2.1 *The Imperfections in the Market Price of the Transport*

The major causes of the imperfections in the market price within the transportation sector are the following [Mayeres et al., 1996]:

- *The transportation policy of the governmental institutions.* The political bodies wish to achieve the general social goals, such as social equity, through the practise of re-distribution policies by using the more appropriate taxation instruments.

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transport service parcel. In particular, this was one of the steps the ICF took with the goal to hold its predominant position within the European inter-modal container transport.

- *The imperfection in the available instruments.* For example, it may be quite difficult to discriminate between peak traffic and off-peak traffic.
- *The pricing imperfection in the related markets.* The labour cost is the major component of the transportation cost. The imperfection of the wages paid in this related market might be passed to the transportation market. A multiplier effect on the transport sector could occur because of the amplification of the market price dis-equilibrium already present.
- *The technological inefficiency in the equipment of the transport operators.* The inefficiency in the technological quality of the transport vehicles such as trucks and lorries can be improved by adequate abatement of the investments. The external cost per vehicle/km may be drastically reduced, if the external information cost is expressed as a function of the externality problem in terms of per gram of the polluted staff.

Due to these causes, it seems difficult to apply the best pricing principle to the transport sector, and the reference per vehicle/km system is also unsatisfactory because the governments refer to the population of the state when they speak about any negative externality [Mayeres et al., 1996].

The EC emission directive 91/441/EEC stated that the gasoline cars had to be equipped with a catalytic converter, as well as that the diesel cars should be equipped with an oxidation catalytic converter. Furthermore, the engine technology has been improved by the use of the direct injection, the turbo charger, the charge cooling, as well as the exhaust gas re-circulation.

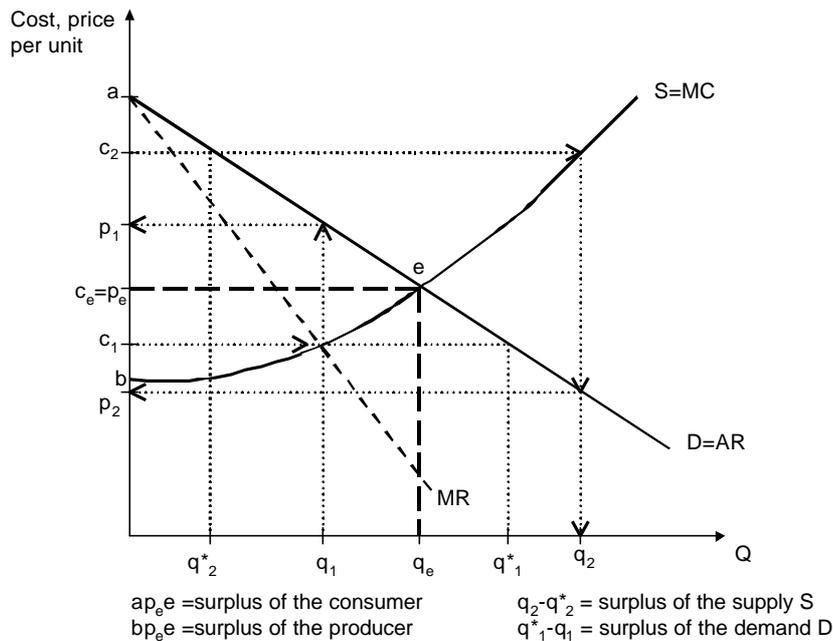
The pricing imperfection in the transportation market reflects the inefficient allocation of the resources typical of every imperfect market system. According to the neo-classical economic theory, the perfect competition market is the only one which allows the efficient allocation of the economic factors of production because in a state of equilibrium, the price  $p_e$  will be equal to the marginal cost MC of every sector of activity for the quantity  $q_e$ . The neo-classical economic theory is based on the law of supply S and demand D, which states that the quantity of the demand  $Q_D$  of an economic goods is a function of its market price P:

Equation 3.1 
$$Q_D = f(P)$$

The function of the demand D is supposed to be the average revenue AR, as well as to be a down ward slope. The function of the supply S is assumed to be

the marginal cost MC, as well as to be a up ward slope. Due to the neo-classical assumptions, it follows that the lower the price, the higher the quantity of the product demanded, and vice versa the higher the price, the lower the quantity of the demand.

Figure 3.2 – The allocation efficiency in the perfect competition market.



The competitive market trends towards a point of equilibrium where no surplus exists. A natural trend towards the point of equilibrium is supposed. At this point, the supply S has to be equal to the demand D, according to the pure competitive market paradigm:

Equation 3.2  $S = D$  or  $Q_D = Q_S$

At this equilibrium point, the supply slope S intersects the demand slope D, the quantity of equilibrium is  $q_e$ , and the price of equilibrium is  $p_e$ . The point of equilibrium of the competitive market is defined as the quantity of goods  $q_e$  that both producers and customers want to sell/buy for a given market price  $p_e$ . When the price of selling the economic goods is equal to the price the customers want to pay for buying a quantity of the product, than the quantity of equilibrium is found.

Equation 3.3  $q_e = f(p_e)$

If the producers are supposed to borne a marginal cost equal to  $c_1$ , then they supply the quantity  $q_1$  on the market. The demand side wishes to buy a larger quantity of the product for that price, therefore the price should be equal to  $p_1 > c_1$ . In this case, there is a surplus of the demand  $q_1^* - q_1$ , which is supposed to be neutralized through the natural adjustments typical in the perfect competition market system that lead towards the equilibrium point e.

If a surplus of the demand exists, than the price of the goods will rise from  $c_1 < p_e$  to a higher level than the current one, while simultaneously the quantity of goods demanded will decrease from  $q_1^*$  towards the quantity of market equilibrium  $q_e$  sold at the equilibrium price  $p_e$ . Consequently, the producers will offer a bigger quantity of the goods than  $q_1$  because of the higher market price  $p_1$  the customers are supposed to be available to pay for it. The movements along the supply and demand slopes will go further on till when, finally, the free market price of equilibrium will be reached at  $p_e$  for the quantity  $q_e$ .

If the supply side sustains a cost of production equal to  $c_2$ , then the quantity the producers will be glad to sell on the market would be equal to  $q_2$ . But for the quantity of goods  $q_2$  the demand side wishes to pay just the price  $p_2 < c_2$ . In this case, a surplus s of the supply  $q_2 - q_2^*$  is noted. The convergence towards the equilibrium point e is assumed to be reached through spontaneous adjustments both of the supply and of the demand sides.

If a surplus of the supply exists, then the customers would be available to buy the quantity of goods  $q_2$ , but for a lower price  $p_2$ , rather than the higher marginal cost of production equal to  $c_2$ . Therefore, because of the exceeding quantity of the goods supplied to the market, in a free market system the price will be adjusted at a lower level than  $c_2$  but greater then  $p_2$ . Therefore, the consumers will buy a smaller quantity of the goods because of the increased price. Due to these natural movements of adjustment along the two slopes supply and demand inside the free market, finally the quantity of market equilibrium  $q_e < q_2$  will be reached at the equilibrium price  $p_e < c_2$  and  $p_e > p_2$ .

The efficient allocation of the factor of production is assumed to be when both the surplus of the consumer and the surplus of the producer are maximized. The consumer's surplus is maximized for the area  $ap_e e$ . It is a measure of the difference between the value the consumers give to the use of a goods and the price they have to pay for it. The consumers are supposed to maximise their utility function. Hence, they are assumed to buy all the quantity of goods till when the marginal utility of the last unit of the goods will be equal to zero.

The area  $Op_e q_e$  shows the current entries of the producer, that is calculated by  $p_e$  multiplied  $q_e$ . The surplus of the producer is maximized for the area  $bp_e e$  between the MC slope and the price of equilibrium  $p_e$ .

### The Full Social Cost of Transport

From a societal perspective, each transport mode should pay the full social cost. It is calculated by the sum of the private cost and the external cost [Forkenbrock, 1999], as the Equation 3.4 shows.

$$\text{Equation 3.4} \quad \text{Full Social Cost} = \text{Private Cost} + \text{External Cost}$$

The private cost of transportation can be defined as the market cost a freight transport operator faces directly. The direct expenses a transport carrier bears may be split into the following two categories.

1. *The private investments in capital facilities and rolling stocks.* This cost category includes the fixed investment in the vehicle and the short-run financial immobility to wear out and to replace. This type of investments exploits its effects on the medium-long run.
2. *The private operating costs.* This cost category includes all the costs related to the amount of service provided, as the costs for fuel, wages, maintenance, user charges, depreciation, and insurance. This type of cost is performed in the short-run.

### The Average and Marginal Costs of Transport

The total cost TC of production is defined as the sum of the fixed cost FC plus the marginal cost MC [Forkenbrock, 1999]. It is a linear cost function upward sloped as the Equation 3.5 shows:

$$\text{Equation 3.5} \quad \text{TC} = \text{FC} + \text{MC}$$

The fixed cost is borne by the firm independently by its output, but the marginal cost  $c$  of the firm depends on the quantity produced  $Q$ . The Equation 3.5 can be rewritten as follows:

$$\text{Equation 3.6} \quad \text{TC} = \text{FC} + c \cdot Q$$

The marginal cost MC is obtained by the first derivative of the total cost TC with respect to the quantity  $Q$ , as follows:

Equation 3.7  $MC = f'(TC)_Q = c$

The average cost AC is usually derived from aggregate data, although its value lacks in precision. The average cost is defined as the total cost of production divided by the output, as the Equation 3.8 shows:

Equation 3.8  $AC = TC / Q = (FC / Q) + c$

Under the assumption of economies of scales, the average cost function of the production is downward sloped because the  $(FC/Q)$  ratio decreases when a larger output  $Q$  of product or service occurs. If the assumption of the average cost as a decreasing function of production is accepted, then the marginal cost is always less than the average cost.

It follows that if any economy of scale or any other variation occurs on the long run in the transport industry, then the marginal cost  $MC$  of the transport differs from the average cost  $AC$  of the transport production. In fact, the estimation of the marginal cost  $MC$  reflects the market price of the goods or services that covers the full social cost of production for a given function of production. In the Figure 3.2 the upward-slope  $MC$  represents the marginal cost of transport and gives the supply  $S$  of the transport service, while the downward-slope  $AR$  represents the demand  $D$  for transport or the traffic flow [Button, 1999] equal to the average revenue  $AR$ . The intersection point  $e$  gives the equilibrium point of the competitive market system at a certain time.

In the case of the transportation sector, the marginal social cost of the transport service is defined as the social cost of the last unit of freight transported [Forkenbrock, 1999]. If the transport provider is charged of a transport price equal to the marginal social cost of the transport service, then the efficient allocation of resources is reached through the market price system mechanism and no market failure takes place. This means that the private operating costs and the external cost are internalised into the market price.

The internalization of the full social cost of the transport service implies the adjustment of the quantity of service demanded at that market price and the adjustment of the level of capital investments.

### **3.2.2 The Marginal External Costs of Transport**

Adam Smith gave a justification to the law of supply and demand by the assumption of the existence of an "invisible hand" that makes possible the convergence of the free market forces towards the equilibrium point. Unfortunately the perfect competition free market model does not fit the reality of the market economy because a model, as a geographical map or whatever nature it can assume, needs a lot of necessary reductions and simplifications with respect to the higher complexity of the real world. The model of imperfect competition or monopolistic competition allows the explanation of a large variety of economic structures in the real world.

A lot of intervening factors can be given as the cause of interference that obstacles the "invisible hand" to operate. If the optimal point of equilibrium has not been reached by the market, than this is said to be a market failure because the economical resources could be better allocated rather than the present configuration. According to the marginal utility theory, the Pareto optimal allocation of given resources is fit when the individual  $i$  can not increase his own utility function  $U_i$  within causing a decrease of the utility function of all the other individuals  $n-i$ .

If an optimal allocation of given resources is not fit, than the market is facing an economic externality. Generally speaking, an externality can be defined as the direct or indirect consequence of an action of a subject, that is suffered by the rest of the community, which was not the intentional object of the action itself. The rest of the community is absolutely not able to escape to this consequence.

There are two kinds of externalities: positive and negative. A positive externality is an external benefit because it occurs when the consequence of an action increases the total benefit of the community. For example, the decision of an individual of not smoking brings a positive externality to the community because this action reduces the probability of suffering the diseases caused both by the direct smoke and by the indirect smoke of the subject. Therefore, this individual action reduces the marginal social cost of making use of the sanitary assistance in the future, which results into a higher benefit of the community.

A negative externality, instead, is an external cost because it gives origin to an increase of the total social cost of the community. The decision to smoke induces an increment in the social marginal cost of the community due to the higher risk of incurring into such diseases and therefore to the necessity of medical assistance both for the active smoker and for the passive smokers.

An economical explanation to the negative externalities can be given using the law of supply and demand (Figure 3.2). If an economic goods is supplied to the market at a lower price than the price of equilibrium (this means:  $c_1 < p_e$ ), then there is a surplus of the demand given by the quantity  $q^*_1 - q_1$ .

The consumers are available to buy a bigger quantity of the goods  $q^*_1$  than the optimal one  $q_e$  because of the cheaper market price  $c_1$ . This means that the product supplied is under-priced because the external costs are not internalised correctly inside the market price. An economical estimation of the external costs is not easy to calculate because their effects are spread out towards a pulverized passive multiplicity of individuals. They are usually referred to as hidden costs.

The transportation activity can be certainly pointed out as a font of such negative externalities. The relevance of the external costs generated by this economic market segment is particularly high because of the growing demand in terms of mobility of people and goods, as well as at different spatial scales. The different transport modalities generate negative externalities of various amplitudes.

#### **The Social Marginal External Cost**

The marginal external cost of a transport mode is defined as the cost caused by an additional vehicle added to the transport network but not borne by the user himself, but by others users [Mayeres et al., 1996].

The social marginal external cost (Equation 3.9) is defined as the sum of the private marginal resource cost the user pay and the marginal external cost [Mayeres et al., 1996]. In the Figure 3.3 the marginal external cost is given by the upward-slope  $MC^*$ .

$$\begin{aligned} \text{Equation 3.9} \quad & \text{Social Marginal External Cost} \\ & = \text{Private Marginal Resource Cost} \\ & + \text{Marginal External Cost} \end{aligned}$$

From a macroeconomic perspective, the market general equilibrium model is a dynamic equilibrium function rather than a static equilibrium point. In fact, the market equilibrium point changes depending on the variations of the social marginal external cost [Mayeres et al., 1996]. The present equilibrium point for a given market equilibrium function is reached when the marginal cost  $MC$  is equal to the marginal gain or revenue  $MR$ .

Equation 3.10                      Marginal Cost = Marginal Gain

Due to the fluctuation of the social marginal external cost in the equilibrium function, the point of economic equilibrium consequently changes. In the Figure 3.3 this equilibrium point is given by the intersection between the  $MC^*$  and the AR slopes at the point  $e^*$ . In this case, the demand for transport is  $Tr^* < Tr_e$ .

The price of the transportation service for a given equilibrium function is usually based on the average social cost of transport, rather than on the marginal cost. This is due to the difficulties to measure the marginal costs [Mayeres et al., 1996]. The average cost is easier to calculate. It is generally given by the ratio of the total cost to the total quantity of production.

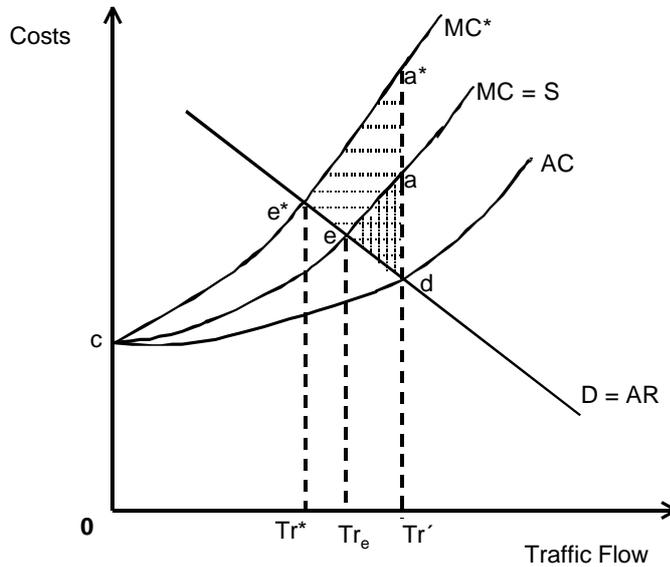
Equation 3.11                      Average Cost = Total Cost / Total Quantity of Production

At the present equilibrium point, the average transport cost is lower than the marginal transport cost. This situation gives origin to a failure in the market price, because of the under-pricing of the transport service. A graphical representation may be useful (Figure 3.3).

The downward demand slope  $D$  represents the demand of the transport service equal to the average revenue  $AR$ . The upward slope  $MC$  represents the marginal cost of the transport, which corresponds to the supply side of the transport sector. According to the competition market paradigm, the point of equilibrium  $e$  is given by the intersection of the two slopes  $S=MC$  and  $D=AR$  (see also the Figure 3.2). At the equilibrium point  $e$  the traffic flow is supposed to be equal to  $Tr_e$ . Unfortunately, the estimation of the marginal cost is not realizable. Therefore, the quantity of traffic demanded is usually based on the average cost of the transport service  $AC$  rather than on its marginal cost  $MC$ . The demand for traffic will be equal to  $Tr' > Tr_e$ . It follows that a negative economic externality occurs, as it is shown in the area  $aed$  of the Figure 3.3.

If the full marginal social cost of the transportation activity is represented by the upward supply slope  $MC^*$ , then the traffic flow should be  $Tr^* < Tr_e < Tr'$ . The amplitude of the negative externality seems to be quite larger, as it is shown in the area  $a^*e^*d > aed$  in the Figure 3.3.

Figure 3.3 – The transportation costs and the traffic flow.



Because of the under-pricing of the transportation activity, the higher the level of external costs generated by a modal transport the lower the price the users have to pay for with reference to its real full cost. This leads to a distortion in the market competition between the different transport modes because the transport modality with the higher external costs gains an advantage over the modes which perform lower external costs due to the hidden nature of these costs.

The negative externalities of the transportation activity have a relevant impact on the spatial, environmental and social structure of the society, because the market failure in the estimation of the full transport cost induces an over consumption of the under-priced transport service. The market seems to be at the equilibrium point, but it is not.

In the Figure 3.3 the point d shows the intersection between the average cost AC of transport and the marginal revenue MR at a certain time for the traffic flow  $Tr'$ . The area aed shows the dimension of this negative cost because of the higher level of traffic flow  $Tr' > Tr$  at the equilibrium point e.

According to the law of supply and demand, the behaviour of the economic agents influences the market price. If any imperfection in the market price system exists, then the market price system does not allocate the economic resources efficiently and give origin to a market price distortion. Therefore, a negative externality or external cost occurs. In this case, the marginal social cost is given by the upward-slope  $MC^* < MC$  and the point  $e^*$  shows the equilibrium point for the quantity  $Tr^*$  of traffic flow. In this case, the marginal social cost  $MC^*$  is higher than the marginal cost  $MC$  perceived by the users. It follows that the negative externality borne to the society is in fact wider, as it is shown in the larger area  $a^*e^*d > aed$  in the Figure 3.3.

### 3.2.3 The General Costs of Transport

The general transportation costs usually depend on the distance between the origin and destination of the cargo; the transport modality preferentially used for each kind of goods (roadways, railways, inland waterways, pipelines, or airways); the structure of the cargo handled; the rate of development of the infra-structural seaport network both at urban, regional and inter-regional scale; the problem of the unfair competition among different seaport locations, for example because special tariffs are offered for the railway cargo transportation along particular rail tracks<sup>21</sup>.

The rate of growth of the tonnage of cargo delivered is less than proportional with respect to the value of goods handled, due to the increase of the containerisation degree as the result of a shift away from the transport of the bulk commodities.

The cost of the transportation activity may be split with respect to the transshipment, the main transport movement, and the pre and post transport, for example if the shipment of a container from the main seaport Rotterdam towards the Central Europe is considered [van Ierland et al., 2000]. As the Table 3.2 shows, the costs of the transshipment, both at the seaport site and at the inland terminal, sum up to the 23% of the total transport costs. The same holds for the pre and post transport activity, equal to the 24% of the total transport costs. The closer destination the higher the costs share of the transshipment.

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<sup>21</sup> The Betuwe Line between the main port of Rotterdam and the Ruhr area is one example.

Table 3.2 – The shares in the transport costs.

Transshipment at the seaport region	14%
Inland terminal transshipment	9%
Pre and post transport	24%
Inland shipping transport	53%
Total transport costs	100%

Table 3.3 – The costs of the transshipment of containers for transport mode.

Transport modality	Maritime*	Continental*
Road	152,5	-
Inland waterway	242,5	450
Rail	267,5	490

\* US\$ per container.

Table 3.4 – The costs of the transshipment of bulk and packet cargo for transport modality.

Transport mode	Transshipment costs* for bulk cargo	Transshipment costs* for packet cargo
Road	6	8
Inland waterways	10	8
Rail	6	12

\* US\$ per ton.

The costs of the transshipment and of the pre and post transport per mode of transport per container shipped are shown in the Table 3.3, while the Table 3.4 shows the transshipment costs of the handling of bulk and packet cargo per transport mode [van Ierland et al., 2000]. The characteristics and the average

private costs (excluding any additional cost for storage and handling) by transport mode for The Netherlands are shown in the following Table 3.5.

Table 3.5 – Characteristics and average private costs by transport mode.

Transport mode	Use	Accessibility	Probability of transport without delay	Frequency	Speed	Price* per tonne-km (US\$)
Road	Average	Very good	Average	High	Fast	0.075
Inland shipping	Average	Moderate	Low	Moderate	Slow	0.015
Railway	Good	Moderate	Average	Low	Moderate	0.04

\* In the year 1987 1.0 US\$ = 2.0 NLG.

Several studies tried to estimate the external costs of the transportation activity with reference to the freight transport sector, as the Table 3.6 overviews [van der Land et al., 2000]. In particular, according to the study of Mejdani (1993) the social costs include the external costs of air, water and soil pollution, the noise interference, the safety, the landscape fragmentation, the use of the space, as well as the externalities derived from the energy consumption. The study of Janse defines social costs in terms of energy consumption, CO<sub>2</sub> emissions, air pollution, noise intrusions and safety. The study of Kågeson refers to social costs as the air pollution, the CO<sub>2</sub> emissions, the energy consumption, the noise interference, as well as the safety.

Table 3.6 – The external cost in the freight transport by transport mode.

Study	Road*	Inland shipping*	Rail*
Meisdani (1993)	0.04	0.004	0.0085
Janse (1994)	0.035	0.005	0.005
Kågeson (1993)	0.0125	-	0.005

\* US\$ per ton-km.

### 3.3 The Environmental Impact of the Transportation Activity

The environmental impact of the transportation activity is mainly due to the use of the vehicle (direct environmental impact), to the production, maintenance and ultimate disposal of these vehicles (indirect environmental impact), as well as from the production of building materials, construction, maintenance and dismantling of the transport infrastructure (indirect environmental impact) [van Ierland et al., 2000]. The direct environmental impact of the transportation activity is referred to the use of the vehicle and is the primary source of concerns. It may be expressed in terms of energy consumption; emission of green house gases like CO<sub>2</sub> and CO; air pollution (e.g. SO<sub>2</sub>, NO<sub>x</sub> and hydrocarbons), as well as noise and light disturbance.

The transport sector makes use of large amounts of energy, which in turn gives origin to polluting emissions. The inland shipping and the rail transport make use of a lower quantity of energy and create less emissions per ton-km than the road transport modality. The railway transport activity generates less CO<sub>2</sub> and NO<sub>x</sub> emissions than the inland shipping, but the emissions of SO<sub>2</sub> are higher, as well as a bigger amount of energy is requested. The road transport by trucks may appear cleaner in terms of emissions at the expense of the energy consumption, as the following Table 3.7 shows.

Table 3.7 – The emission factors and the energy factors for transport mode.

Transport Mode	CO <sub>2</sub> g/ton-km	NO <sub>x</sub> g/ton-km	SO <sub>2</sub> g/ton-km	Energy factors Mega-joule/ton-km
Road*:				
Truck 1	155	2.80	0.167	1.40
Truck 2	150	2.10	0.140	1.61
Truck 3	145	1.40	0.110	1.82
Inland waterways	39	0.62	0.035	0.45
Railway**	32	0.06	0.060	0.72

\* Road: Truck 1: present trucks; Trucks 2, 3 = with cleaner engines.

\*\* Railway: emissions for electrical traction only, not diesel-electrical traction.

The noise produced by the use of the transport vehicle, as well as the use of lights are causes of environmental intrusion. Both of them may have a sensible impact on the ecosystem, as well as they can cause nuisance to the people living along the transport routes. The road network contribute especially to the noise nuisance.

#### **The Non-Market Costs of the Transportation Activity**

In order to estimate the full cost of transportation, it is necessary to take into account the costs that are not reflected into the market price because they are external to the market mechanism. Two types of categories of non-market costs can be distinguished, that are the negative externalities and the un-recovered government expenditures [Forckenbrock, 1999].

The first category reflects the negative impact of the transport activity borne by agents different than the source of the externality. The external cost or negative externality can be defined as the action of an economic agent, which affect the environment of other economic actors, rather than influence the market prices, as it is usually supposed to happen in the economic model of the general equilibrium. Therefore, it leads to an economic market failure, in the sense that the interaction of the economic agents does not affect the market price of the product or service, but it is exploited by negative or positive (i.e. benefits) externalities outside the market framework. The negative externalities in the transportation sector may be split into three types, as follows [Mayers et al., 1996], [Forckenbrock, 1999]:

1. Emissions: air pollution, greenhouse gases, and trans-national health cost.
2. Noise, light, and vibration intrusions.
3. Congestion.
4. Accidents: fatalities, injuries, and property damage.

The second category embraces the use of the public transport infrastructures without paying the full cost of capital investment borne by the government. It refers to the un-recovered costs associated with the capital investment of the public bodies for the provision, operation, and maintenance of public transport infrastructures, such as roads and bridges, seaports facilities, etc.

Because of the nature of the negative externalities, the fractional variation in the private operating costs, as defined above, gives a suitable basis of comparison

for the estimation of the marginal social cost of transportation. If the external costs are greater than the external benefits, then an over-consumption occurs, due to the under-pricing of the product or service offered.

### **3.3.1 The Marginal External Cost of the Emissions**

The marginal external cost of the emissions is defined as the negative externality caused by the internal combustion engines that make use of fossil fuel. Air pollution and greenhouse effect are the two major impacts of the motor vehicles emissions on the environment. The negative impact of the polluting agents can be synthetically identified as:

- The *diffuse* impact of the acid rain formation due to the SO<sub>2</sub> emissions. This global impact of pollution affects the fauna, the flora, the human buildings and the human health on a world scale.
- The *regional* impact of the VOC and No<sub>x</sub> emissions because of the production of ground-level ozone O<sub>3</sub>. This impact of the fossil fuel emissions is more localized at the urban agglomeration sites where a more intensive transport activity takes place.
- The *localized* impact of the CO emissions along specific transit corridors running through rural areas. In this case the pollution is bound along well-defined transport links and the negative impact of the polluting agents on the rural area is mitigated by the scattering of the emissions through a large green space.

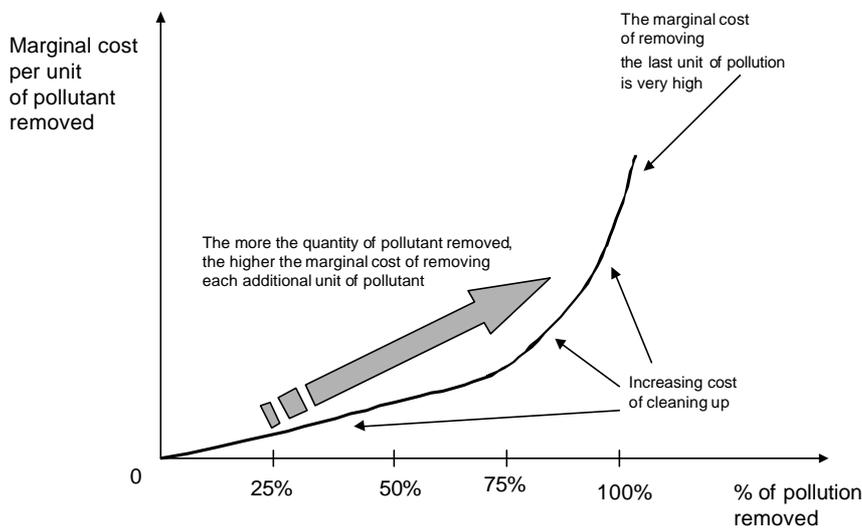
The cost of air pollution can be estimated on the basis of the existing data about the adverse effects on health, materials, agriculture, and aesthetic quality caused by a sensible concentration of air pollutants [Forckenbrock, 1999]. The increasing probability of premature death seems to be induced by the PM<sub>10</sub> emissions. Numerous studies identify other non-fatal death effects related to the period of exposure to air pollution, as well as damage to materials open to evaluation using a damage cost function for the agriculture production. The value of the general aesthetic damage can be estimated using a loss of visibility index, expressed in visual range/km. An indirect evaluation approach is the hedonic price model. By estimating the lower value of the housing, it is possible to induce the depreciation due to the lost in visibility.

### Air Pollution

The marginal external cost of the air pollution is defined as the cost the rest of the community borne because of the marginal increase in the emissions of air pollutants by the road vehicles [Mayeres et al., 1996]. The air pollutants generated by the road transport modality are carbon monoxide CO, nitrogen oxides NO<sub>x</sub>, sulphur dioxide SO<sub>2</sub>, lead Pb, volatile organic compounds VOC, and particulate matter PM<sub>10</sub> with a diameter of less than 10 µm.

In general, the marginal social costs of NO<sub>x</sub>, SO<sub>2</sub>, and VOC emissions are related to the environmental policy measures of the governmental institutions, at a national and supranational decisional level. National and supranational policy bodies are supposed to be rational entities, perfect informed and perfectly representing the willingness of the society as a whole.

Figure 3.4 – The marginal cost per unit of pollutant removed.



The cost of removing each additional unit of pollution rises exponentially. This explains why it is better to use an input approach that prevents a pollutant from reaching the environment or that keeps its concentration very low. Removing small percentage of pollutions in air, water, or soil is not too costly,

but the price per units multiplies if the quantity of pollution to remove is particularly high. Generally, the cost of removing pollutants follows a J-shaped curve of exponential growth, as the Figure 3.4 shows.

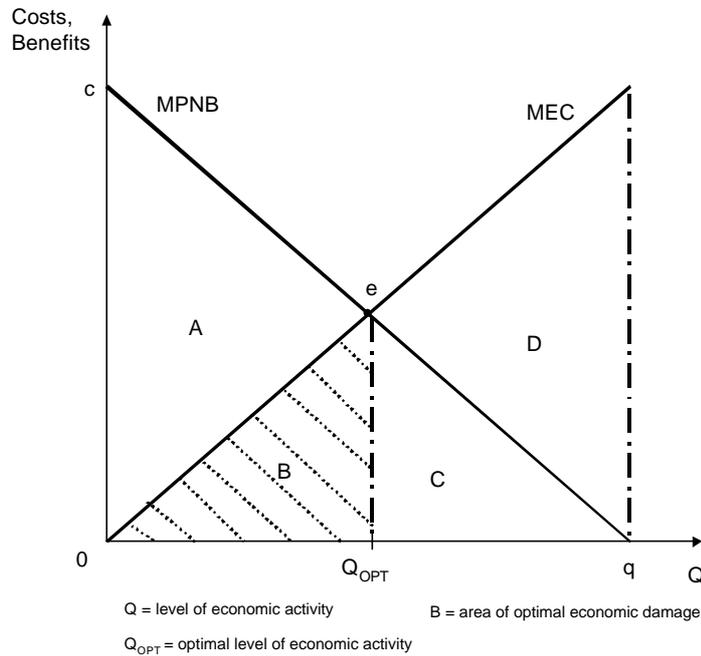
The effects of the air pollution on the health of the society may be expressed in terms of mortality and morbidity [Mayeres et al., 1996]. A wide literature embraces the estimation of the value of a statistical life VSL, that is defined as the discounted value attributed to the life of an individual over an average life time and under standard life conditions. The average VSL derived from various studies for the European countries is equivalent to a monetary value of 2.600.000 ECU in the year 1990. It represents the monetary value referred to the mortality risk due to the health impact on the population of the air pollution by  $PM_{10}$  and  $O_3$ .

The morbidity impacts represent a set of illness caused by the air pollutants. They embrace the major direct category of the respiratory hospital admissions (i.e. for respiratory infections, chronic obstructive pulmonary disease, asthma), the emergency room visit, the symptoms for chronic bronchitis and cough, the restricted and minor activity per day, the asthma attack and their shortness of breath day. The monetary value of the morbidity impact can be split into the following components, as following: 1) the VOT lost during the illness; 2) the individual value of the lost utility due to the pain and suffering; 3) the expenditure for averting or mitigating the effects of the illness; 4) the direct economic effects (net output losses); 5) the altruistic cost of pain, grief and suffering to relatives and friends. This equals to 40-50% of the private total evaluation.

Two remarkable observations has to be made, as follows: first, the distinction between the physical presence of pollution and the economic presence of pollution; second, the existence of economic pollution does not imply that it should be eliminated [Pearce et al., 1990].

By moving from the neo-classical economic theoretical approach, the optimal level of pollution may be found as follows. The Figure 3.5 puts on the x-axis the quantity  $Q$  that indicates the level of the economic activity that generates pollution, while the cost or benefits in monetary terms are put on the y-axis.

Figure 3.5 – The optimal economic level of pollution.



The marginal private net benefit MPNB is depicted as a downward slope. The private net benefit PNB is defined as the difference between the costs the economic agent who pollutes bears in order to exploit the production activity that gives origin to the pollution, and the benefits he gains in terms of monetary revenue. The marginal variation of the private net benefit MPNB is assumed to indicate the variation of the PNB for changing the production of one unit.

The marginal external cost MEC is given by the up ward slope in the graphic. It is defined as the variation of the damage caused by changing the economic polluter activity of one unit. A direct proportionality between the MEC and the quantity Q of production that gives origin to pollution is assumed to be.

The intersection point e between the two slopes MPNB and MEC gives the optimal level of economic activity  $Q_{OPT}$ . Since the MPNB slope and the MEC slope are two marginal functions, the area ABC under the MPNB slope shows the total private net benefit of the polluter agent, while the area BCD under the MEC slope gives the amplitude of the total external cost.

It follows that the area A shows the largest area of net benefit the economic agent could gain on the assumption of maximising the total benefits minus the total costs of the society. Therefore, the quantity  $Q_{OPT}$  indicates the optimal level of economic activity the polluter agent should perform. The level of physical pollution that corresponds to the optimal level of the production  $Q_{OPT}$  gives the optimal level of pollution.

The area B may be interpreted as the amount of optimal economic damage that corresponds to the optimal level of pollution for the production level  $Q_{OPT}$ . The area B is also defined in terms of the optimal level of externality.

### **Greenhouse Gas Emissions**

The marginal external cost of emissions that induce the greenhouse effect is defined as the negative externality generated by the carbon fossil fuel engines borne at a global scale because of the repercussions on the climate change [Forckenbrock, 1999]. The emissions of  $CO_2$  per unit of transport service provided is directly related to the energy consumption of the transport modality. Therefore improving the fuel efficiency can contribute to the reduction in carbon dioxide emissions, but it could also led to a growth in the consumption itself.

The impact on the environment due to the air pollution affects also the natural ecosystem in terms of damages to the vegetation, the agriculture, the forests and rivers. The environmental dis-equilibrium cause by the negative externalities in the transport sector has not to be under-evaluated. The global warming due to the increasing  $CO_2$  emissions is one of the most discussed problems related to the fossil fuel use in the contemporary era. Several studies give different evaluations of the marginal cost of 1 tonne of carbon emitted in the period 2000-2010. The monetary value of this marginal cost swings between the lower estimation of 7 US\$ per tonne of carbon and the higher estimation equal to over 150 US\$ per tonne of carbon [Mayeres et al., 1996]. The wide range of this estimation is due to the differences in the basic assumptions of each study on the discount rate, the rate of technical progress, and the development of carbon free energy resources.

### **Trans-national Health Cost**

The trans-national health cost has also to be taken in account. This is the external cost due to the impact of the emissions on the population of other nations. The ozone problem and the acid rains are the two most evident examples of this cost typology.

### 3.3.2 The Marginal External Cost of the Noise

The marginal external cost of the noise may be defined as the negative externality due to the impact of an undesired or noxious sound [Forkenbrock, 1999]. Within the transport economy, it is defined as the disturbance borne by the rest of the society generated by the last road vehicle/km added to the network [Mayeres et al., 1996]. The energy mean of the sound level is an indicator of the average sound level during a time period. The sound is usually measured using the decibel dB. In order to fit the human perception of the noise generated by trucks traffic, an adjusted sound decibel dB(A) measure has to be adopted. The dB(A) is an approximation of the human hearing obtained by weighting the high- and low-pitched sounds. The dB(A) scale is logarithmic shaped.

The finest sound a human can hear corresponds to the dB(A) equals zero. But if the impact of a 60 dB(A) noise is considered (i.e. an air conditioning unit), then the people perception of this level of sound seems to be twice than a 50 dB(A) noise (i.e. a clothes dryer). Furthermore, a 70 dB(A) noise level (i.e. a pickup truck) are heard as to be four times louder than the 50 dB(A) noise.

Usually the noise impact is measured in an urban area just at certain points along the urban road network, and no data on the urban area as a whole are available. The housing market can be supposed to be a surrogate market of the city noise externality. The value of a house does not depend only on its intrinsic characteristics, but also on a set of external relevant factors related to the environment [Mayeres et al., 1996]. The price of a house can be defined as the following function:

$$\text{Equation 3.12} \quad \text{House Pricing} = f(\text{Intrinsic House Characteristics and Environmental Peculiarity})$$

Among the environmental variables, the accessibility rate, the proximity to primary public services, the amenity of the site, the quality of the environment in terms of negative externalities to bear are all factors that, directly or indirectly, determine the market price of a building. Studies about the depreciation of the house due to noise externalities suggest a range of 0.4-0.5% per dB(A) referred to a standardized house value.

A further remark about noise is that its impact decreases more than proportionally with respect to the distance [Forkenbrock, 1999]. Therefore,

a triple relationships exists among the traffic volume, the noise generated, and the distance from the road. Further impact elements are the presence of green barriers (i.e. trees), or buildings, or the topography of the area.

Also the noise typology has to be noted, because intermittent noise may induce psychological effects to which a monetary quantification is very difficult to give. Noise can also reduce the market value of the housing. The average property value may tend to decrease per decibel increase.

### **3.3.3 The Marginal External Cost of the Congestion**

The marginal external cost of congestion is defined in the road transportation as the cost suffered by the other road users when an additional vehicle is added to the road network and it gives origin to a reduction in the speed of the other vehicles.

The impact of a marginal variation in the speed on the operating costs and on the air pollution costs seems to be not relevant. It is important to note that the marginal effect of the last vehicle added to the road network is strongly dependent on the congestion function at the specific link considered. The higher the value of the congestion function the higher the marginal external congestion cost the other users borne at those road stretch. It is more practical to consider an aggregate model where the urban area is supposed to have homogeneous traffic conditions. The average speed AS is a function of the traffic flow TF.

$$\text{Equation 3.13} \quad AS = f(\text{TF})$$

The traffic flow is generally measured by million of passenger cars units PCU/per hour. The PCU is a discrete indicator of the traffic intensity, which weights the different congestion effects of the various types of vehicles on the road [Mayeres et al., 1996]. Hence, a car is equivalent to one PCU, while a truck, a lorry, or a bus are each of them equivalent to two PCUs.

$$\text{Equation 3.14} \quad \text{TF} = \text{PCU} / \text{per hour}$$

If the different modal networks are considered independently, then all the factors composing the travel demand could be supposed to be fixed and independent with respect to the travel volumes. But in reality, the demand factors are function of the demand [Oppenheim, 1995]. The demand factors

include, among the other elements, the link and the destination travel costs. Hence, the higher the volume of traffic units on a given route, the lower the speed of each vehicle travelling on it. It follows that the travel time along that route will be higher, and therefore the attractiveness of that route will decrease and the demand for its use will be lower.

This spatial effect is supposed to influence the demand for the origin and destinations sites located on that congested route, and the demand for specific transport modalities serving the two locations involved. This modal choice could finally influence the origin and destination demand itself [Oppenheim, 1995].

The relationship between the average speed and the traffic flow as described above enables to express in monetary terms the time costs of the other road users suffered because of the marginal PCU added to the traffic flow. Many studies calculate the value of time VOT in different countries. It is generally supposed a direct linear relationship between VOT and income, but less than proportional [Mayeres et al., 1996].

The elasticity  $e$  of the VOT with respect to the income equals to 0,368. An estimation of the VOT for the freight transport in The Netherlands gave an average VOT of 25.8 ECU per hour in the year 1990 for different goods categories. It is quite a high average VOT if compared to car users (average VOT of 5.3 ECU/h for commuting, 17.5 ECU/h for business trips, and 4.2 ECU/h for other trips), and to bus users (average VOT of 4.5 ECU/h for commuting, 17.5 ECU/h for business trips, and 2.6 ECU/h for other trips).

### **3.3.4 The Marginal External Cost of the Accidents**

The marginal external cost of the accidents is defined as the cost of deaths, injuries, and property damage a further vehicle added to the transport network might give origin to [Forkenbrock, 1999]. The marginal external accident cost may be also defined as the difference between the marginal social accident cost and the marginal private accident cost [Mayeres et al., 1996]. The total accident cost TAC is calculated by the Equation 3.15, for each possible transport mode and weighted for the accident severity according to a severity range:

$$\text{Equation 3.15} \quad \text{TAC} = (\text{WBC} + \text{CBC}) * p * V$$

The warm-blooded costs WBC are given for each transport modality by the willingness-to-pay WTP to avoid an accident of a certain severity and the WTP of the relatives and parents to avoid an accident of a certain severity. The cold-blooded costs CBC are given for each transport mode by the pure economic costs, that are the net output losses, the ambulance costs, the medical costs, etc. which are borne by the rest of the society. The variable  $p$  indicates the probability of an accident for a given severity between two transport modes. The variable  $V$  represents the number of vehicles/km of the transport mode that suffers the accident. The marginal accident cost MAC can be calculated by the first derivative of the total accident cost with respect to the number of vehicles/km  $V$ , as following:

Equation 3.16 
$$\text{MAC}_v = f'(\text{TAC})_v$$

It is useful to determinate at least two points: 1) the relationship between the number of road users and the number of accidents; 2) the share of risk the road users internalise during their personal decisional process. The insurance premium a road user pays is a good indicator of the monetary value of the risk of accident internalised by a road user, although it represents the average accident costs and not the marginal one.

The prevalent approach in order to estimate the cost of accidents is known as the willingness to pay WTP. This concept focuses on the monetary value the people would pay to avoid or diminish the risk of an accident [Forkenbrock, 1999]. From an economic perspective, when the people would pay a more expensive price for a product than its market price, then it occurs a surplus of the consumer. Therefore the market price can be taken as an indicator to estimate the lower threshold value of the goods on the market.

A second estimation to be done about the cost of accidents is the compensation value. The monetary value paid by the trucking companies for compensation can be subtracted from the total societal cost, and the result gives the amount of the external cost. This payment may assume the following two forms:

1. *Payments of workers' compensation premiums.* In the USA these payments include injuries and diseases of workers related to their job activity and without any determination of the fault.
2. *Payments of personal liability and property damage insurance.* This kind of payments covers the injuries, deaths, and damages caused both to the people and the property that are involved in an accident.

## 4 The Inter-modal Links of the Transport Network

### 4.1 *The Multi-modal, Inter-modal and Combined Transportation Systems*

The notion of economic transportation activity can be specified according to the kind of transport exploited. The traditional classification of the economic activities refers to the following categories:

- Primary sector: agriculture, hunting, fishing, mining industry;
- Secondary sector: transformation industrial activities, semi-finished products and finished products manufacturing;
- Tertiary sector: no transformation activity in the strictly sense of the word is performed, but finished products are combined using both the manufacturing and the intellectual work. The production of services belongs to the tertiary sector.

The maritime transportation is defined as one of the various transport sectors or modes [Marchese, 1996]. The transportation activity is an economic activity of the tertiary sector. Its goal is to transfer people and goods through the space and time. The production of the transport vehicles and their components belongs to the secondary sector. The maintenance works and reparation of the transport vehicles belong to the tertiary sector if no manufacturing of products is required; while they belong to the secondary sector in the other cases. The constructions of the transport infrastructures and their maintenance belong to the secondary sector.

Four fundamental elements characterise the transportation activity, that is: the route; the stopping point(s), called terminal(s); the vehicle; and the motive power.

A network of functional and technical relationships among these four factors can be delineated. The maritime route is given by the sea, the ocean and the artificial inland waterways build by the human activity in order to allow the navigation of the different vessels.

Within this general picture, the seaport site plays the role of the terminal through which it is possible to access to the maritime transport network. The number of access point to the maritime network is limited.

The **transportation cycle** is defined as the set of operations to transfer goods and people from the place of origin to the final destination [Marchese, 1996]. The transportation cycle can be split as following:

- Simple, if only one loading/discharge cargo operation or only one entry/exit passenger transfer is made.
- Complex, if more loading/discharge phases take place; furthermore, between these operations they have to be waiting times.

In the case of the complex transportation, usually a change in the transport mode occurs between the passages. Due to this reason it is also called inter-modal transport or multi-modal transport or combined transport. In the latter sense, it is pointed out that within the transportation cycle different transport modalities interview and combine one with the others (rail mode, road mode, ferry, etc.).

According to the definition given by the European Conference of the Transport Ministers ECTM<sup>22</sup> [Confetra, 1994], the multi-modal transportation is defined as the transfer of goods by at least two different transport modalities.

The inter-modal transportation is defined as the transfer of goods by using various transport modes but making use of the same container and with no break of bulk.

A **break of bulk** occurs when the goods have to be transhipped or handled when passing from a transport carrier to another [Mayer, 1973]. The container can be a road vehicle or an inter-modal transport unit ITU as a container, a

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<sup>22</sup> The ECTM is an inter-government organisation defined by the Protocol in the year 1953. The Transport Ministers of 22 European states are member of the ECTM, as following: Austria, Belgium, Czeck Republic, Slovakia, Denmark, Finland, France, Germany, Greece, Irland, Italy, Luxembourg, Norway, Netherlands, Poland, Portugal, United Kingdom, Spain, Switzerland, Turkey, Hungary, Jugoslavia. Furthermore the non-European states of Australia, Canada, Japan, New Zealand and U.S.A. are associated members. Marok participates as observer state [Confetra, 1994].

swap-body or a semi-trailer. The swap-body is defined as a road or rail transport cargo unit but not enough strong to be placed one on top of the other cargo units during the loading operations [Confetra, 1994].

On the European continent, the combined transport is defined as the inter-modal transportation that is made mainly by rail, by inland waterways or by sea, while the initial routes and/or the terminal routes are made by road and on a relatively short distance. The terminal is defined as the place where it takes place a change in the transport modality.

In the broader conception of the term, the multi-modal transportation embraces a set of complex and extended activities in charge to the multi-modal transport operator, and that are not just limited to the mere operations of goods and people transfer. The basic conditions are that at least two different transport modes are involved, that no break of bulk occurs, and consequently that the same documentation is used [Ente Autonomo del Porto di Trieste, no year].

It is relevant to point out that a difference exists between the transshipment costs per unit and the loading/discharge operative costs if the maritime and land transport modes are taken in account [Marchese, 1996].

If the maritime transportation is analysed, the costs of loading/unloading the goods from the ship to the terminal and vice versa are the most incident, while within the land transportation the major incidence is given by the transfer costs from a location to another, especially if the road and rail transport modes are considered. In the case of the maritime transportation, there is a restricted number of seaports able to receive vessels of different sizes, and to give the availability of the appropriate terminal equipment. Therefore, the most relevant share of the costs regards the costs to keep the ship at the wharf. This means that the transshipment costs are higher. On the contrary, the land transportation is characterized by a great number of access points to the road and rail transport network. It remarks the lower incidence of the transshipment costs. This means that the costs of transfer are higher.

Therefore, if the aim is to keep the level of the costs at the minimum, the moment of the break of cargo has to be shifted to the land phase, where the transshipment costs are lower. The technological innovations within the transportation sector lead towards the cargo unification and the use of standard equipment in the whole world. Within the inter-modal transportation the containers are widely used, as well as trailer and semi-trailer, Ro/Ro vehicles [Mayer, 1973], barges, rail wagons and pallets. Ro/Ro is the acronym for Roll

on/Roll off. This transshipment activity is realized by the horizontal movement of the cargo from the land side to the sea vessel and vice versa [Borruso, 1971] [Ente Autonomo del Porto di Trieste, no year].

The two concepts of containerisation and inter-modal transportation have to be treated in a correlated way, because they have to be seen as the two indivisible components of a wholly integrated transport system [Hayuth, 1982]. It is useful to give some definitions, as follows.

### **Container**

It is an opening box shaped as a parallelepiped and built by a strong material. It can be filled and emptied more times with bulk cargo or packed goods. The filling operation is called cargo consolidation, while the emptying out operation is called cargo breakdown [Ente Autonomo del Porto di Trieste, no year]. A container may be easily handled both horizontally and vertically by using the appropriate terminal equipment [Confetra, 1994]. More precisely a container is a packing planned to allow the easy transfer of goods without breaking cargo during the transport by the different transport carriers [Borruso, 1971]. The containers must have a solid structure in order to make possible their superimposition, that is their stocking one above another. From an alternative point of view, the container is defined as a transport vehicle, or a transport material, a frame, a fixed tank, or an appropriate equipment to transfer goods without any transshipment operations or any intermediary handling [Borruso, 1971].

The American Standards Association ASA fixed in the year 1961 the standard dimensions of the container. They were successively adopted by the International Standard Organization ISO in the year 1965. A standard container is 8 feet wide and high, that are equal to 2,44 meters, while the length as well as the maximum cargo weight may be various [Borruso, 1971], as follows:

- (a) 40 feet = 12,19 meters for the container type 1A, maximum cargo weight equal to 30 tons.
- (b) 30 feet = 9,13 meters for the container type 1B, maximum cargo weight equal to 25 tons.
- (c) 20 feet = 6,06 meters for the container type 1C, maximum cargo weight equal to 20 tons.

(d) 10 feet = 2,99 meters for the container type 1D, maximum cargo weight equal to 10 tons.

The conventional standard unity of measurement of the container is the TEU, that is the acronym of Twenty-foot Equivalent Unit. It is equivalent to a 20 feet long container. It follows that 2 TEUs are equal to 40 feet, that is a container type 1A, or two containers type 1C, or the combination of a container type 1B and a container type 1D.

An interesting type of container is the collapsible container [Borruso, 1971], that is a container that may be dismantled. It allows a considerable reduction of the occupied space when an empty unit has to be sent back to its origin.

### **Containerisation**

It is a handling cargo mode by using standard containers which can be transferred from their point of origin to their final destination by different transport modality systems (by sea, by inland waterways, by rail, by road or by air) and by sophisticated loading/discharge technologies for the handling of the goods [Borruso, 1971] [Hayuth, 1982]. The containerisation era officially begun in the year 1956.

Within this context it has not to be forgotten the role of the Ro/Ro ship developed during the Second World War by the U.S. Navy and broadly diffused after the end of the conflict in the civil sphere [Borruso, 1971]. This vessel is based on the principle of the horizontal transfer of the cargo, that is typically used by the ferries [Ente Autonomo del Porto di Trieste, no year]. By the Ro/Ro mode and the use of the container, the incoming/outgoing unitised cargo are directly transferred into the hold of the vessel passing through an entrance usually located at prow, or at stern, or at both sides. The containers are loaded on the trailers or semi-trailers; on board of these vessels, rail wagons and auto-vehicles of every dimension may also be loaded.

A further cargo movement system is the so called Lo/Lo, that means Lift on/Lift off. It is only referred to the container transshipment. The container are vertically lifted by using specific terminal equipment, and they are loaded/discharged from the container ships and ferries [Ente Autonomo del Porto di Trieste, no year].

The relationship between the two concepts of containerisation and inter-modality is clear [Mayer, 1973]: the use of the standard container simplify the loading/discharge operations of the vessels, because it allows to apply the

unified handled modes to the containers at the land side, without consider their specific content. It follows that the inter-modal transfer is promoted because it has a good economic basis both for the ocean operators and for the terminal operators. The total transit time is reduced; the labour costs are reduced too, due to the fact that it is possible to apply a high degree of mechanization on the terminal operations. Consequently the stopping time of the vessels at the seaport wharves are reduced and the terminal and harbour costs are also diminished. The cargo handling operations are reduced to the minimum; this kind of operation could damage the goods during their packaging.

As the use of the containers and the inter-modality concept are two faces of the same medal, the co-ordination between the ocean transportation and the transport operations generated at the seaport site and directed towards the inland final destinations has been a natural consequence. For this reason, the ocean carriers often begun to operate also the land transport operations towards the seaport hinterland, overburden themselves of the responsibilities that during the pre-container age were split among the various competent transport carriers. This situation gave subsequently origin to traffic clusters, boosted by the necessity to co-ordinate the whole transportation system so defined with the goal to ensure the efficiency of the inter-modal transport operations. Then, the so called load centres emerged [Slack, 1990]. Within the European continent, the load centres are geographically located at the few main container seaports of big dimensions spatially located along the well known Northern Range. This geographical area embraces the maritime seaports of Le Havre, Antwerp, Rotterdam, Bremen-Bremerhaven and Hamburg (Map 2 and Map 4).

#### ***4.1.1 The Impact of the Containerisation on the Labour Productivity***

A stimulating promoter of the restructuring process in the seaport economy was the introduction of the containers. The unified procedures of cargo handling brought a loss of employment in the central area of the seaport labour.

From an economic perspective, the spiral-shaped productivity of labour leads towards an increasing productivity of work, hence to a decrease of the employment. Considering the containerised handling system of goods, each worker handles a considerable higher quantity of cargo tonnage per working hour with respect to a traditional cargo handling system [Borruso, 1971]. The increase in the speed of the handling operations implies the growth of the

labour productivity, as well as the more rapid terminal operations. Consequently, the container ships reduce their stopping-time at the seaport quays. This economy of time induces the rise in the total carrying capacity of transport within the whole year with respect to the non-containerised vessels.

Depending on this forced changing in the logistics, the seaport sites became container floodgates, as well as logistic channels for the cargo transit. The container technology has been accepted as a technological basis for the transport of the general cargo, due to the increasing division of labour between Europe, North America and East Asia. The following development of new technologies within the seaport and transport sector led to the loss of employment, as well as to the decrease of the potential added value associated to the seaport activities, although the total flow of transport increased.

With the attempt to counterbalance the decline in the number of employment in the operative functional sectors usually managed within the port economy, many seaports developed the supply of services called value added logistics.

The coming of these functional changing within the port economy induced a restructuring in the relationships between seaports and regions. A first expression of this changing was the negative curve in the number of direct links of the seaports and the maritime industries. The decentralization of the economic activities exploited in proximity of the seaport site until now has been undoubtedly favoured by the technical and informational transport innovations.

Before the improvements in the transport network infrastructure during the last decades, many physical obstacles influenced the choices of the location of the industries. The transit function of the seaport site was stressed in order to attract the economic goods incoming/outgoing from/towards the inland industrial clusters. Due to the higher efficiency in the transport links, the physical embedment was overcome. The industrial activities seem to be not tied up anymore to the closer seaport location, for the transit of their materials and production. In fact, they may choose between a set of different seaport sites. This is possible because the physical distance, between the maritime location and the inland industrial cluster of production, plays now a secondary role in the diversified economic and social relationships in the transport and logistics sectors.

Within the EU, the goal of the European Commission is to realise a transport network that achieve the following three characteristics: inter-connectivity, inter-

modality and inter-operativity. The current restructuring process has to take into account these fundamental aspects.

The structure of the labour market can be analysed using for example the following indicators: the number of employees in the seaport sectors; and the rate of professional training of the seaport workers with respect to the maritime functions. The age structure of the population and the migratory movements of the people split between natural movements and social or migratory movements towards/from a seaport region as well as at the national level are relevant in particular for the peripheral regions of the transition economies.

## **4.2 Other Types of Combined Transportation**

It is quite useful to define three other important concepts with reference to the combined transportation, that are implemented in the U.S.A.: the Sea-Land-Sea movement, the Only-Sea-Land movement [Hayuth, 1982], and the Micro-Bridge [Kuby et al., 1992]. Finally it is mentioned the wholly maritime route so called Round-The-World service, that is not an inter-modal transportation example in a proper sense but it seems to be appropriate to mention within this context.

### **4.2.1 The Sea-Land-Sea Movement: the Land Bridge**

This concept, known as North-American Land Bridge, may be defined as the freight transportation by land along a stretch usually transit as a wholly oceanic route, that is an All-Water route [Kuby et al., 1992].

The shipping companies are responsible for the whole trip and pay to the railways agent a lump-sum tariff for using the rail services (in the U.S.A. and Canada). Usually the ocean carriers choose the cargo route and the seaport sites where making their stopping calls. According to the principle of seaport equalization [Bird, 1971] in force in the Northern America, the same rail transit tariffs are applied from every seaport site in order to reach the opposite coast of the continent.

The first land bridge was organized from Los Angeles to New York in order to allow the freight transit incoming from the Southern-Eastern Asia and from the Pacific Ocean area that could not be transited through the Panama Canal due to the large dimension of the ocean vessels, which exceeded the dimensional

limits of the canal itself (more than 6.000 TEUs) [Mayer, 1973] [Slack, 1990] [Marchese, 1997].

#### **4.2.2 The Only-Sea-Land-Sea Movement: the Mini-Land Bridge**

This second concept is known as mini-land bridge or simply as mini-bridge. It is defined as the container movement by a single ocean bill of lading. The bill of lading is defined as the receipt of the goods sent by sea, undersigned by the person (or his agent) who assumes the responsibility for the cargo transfer, and which fixes the terms of the transport itself. In this case the vessels ply between the Far East and the Western coast of the North America on the Pacific Ocean. The transport is completed on the American continent by rail. Then the cargoes are loaded and sent from the Eastern coast of the North America on the Atlantic Ocean towards the European continent, the Mediterranean Sea, and the seaports of the Near and Middle East [Mayer, 1973]. If the combined sea-land route (by rail) and the whole sea route are compared, then the transport costs of the mini-bridge are more or less equivalent, while the adoption of the combined ship-train transport gives origin to a relevant economy of time (the case of the U.S.A.) [Slack, 1990].

#### **4.2.3 The Micro-Bridge**

A third way of inter-modal transportation is the so called micro-bridge [Kuby et al., 1992]. The co-ordination between the land transportation towards an inland terminal and the maritime port site is assured. Often the hinterland of other seaports may be eclipsed by offering more efficient rail or road services.

#### **4.2.4 The Round-The-World Service**

The whole sea route of the Round-The-World service RTW was largely used when the maritime transport costs were lower with respect to the land transportation, and the transport speed was not a relevant factor as in the contemporary days [Kuby et al., 1992]. The shipping companies used their vessels in order to realise a one-way turn around the world [Kim, 1987].

This transport combination flourished since the year 1988, especially after the building of the giant post-panamax container ships [Kuby et al., 1992], which

can not pass through the Panama Canal due to their large dimensions. The limits of the Panama Canal are the following [Hayuth, 1982]:

297 meters long - 32,2 meters bright - 12,2 meters depth.

But the problem of the adequate depth of the landing places and of the accessibility to the maritime port site appeared after the two closing of the Suez Canal in the years 1956 and 1967, and the following building of the super-tankers, which draught exceeds both the limits of the Panama Canal and the Suez Canal [Mayer, 1973]. The draught of a vessel is defined as the vertical distance between the water surface and the deeper point on the keel of the ship [Ente Autonomo del Porto di Trieste, no year].

About the post-panamax container ships, it has to be noted that their major wideness allows the positioning of the containers without taking into account their weight. This factor enables the simplification of the loading operations at the seaport terminals and cut to a half of the operative time necessary for the terminal operations by using automatic cranes [Confetra, September 1997].

The Table 4.1 shows a briefly overview on the container vessels since the ships of the first generation to the last giant of the ocean [Wirtschaftsbehörde, Strom- und Hafengebäude, 1997].

Table 4.1 – The structural characteristics of the container ships.

Type of the vessel	Load capacity (TEUs)	Dimensions (meters)			Year of building
		Length	Bright	Draught	
1 <sup>st</sup> Generation	1000	137-192	28	10	1960
2 <sup>nd</sup> Generation	2000	213,5	28	11,5	1970
3 <sup>rd</sup> Generation	3000-4000	262-289	32,2	12,5	1980
4 <sup>th</sup> Generation	4000-5000	274-295	32,2	13,5	1990
Post-panamax	5000-6000	284-318	39,2-42,0	13,5	1992

If the container ships class with load capacity exceeding the 2500 TEUs is analysed, it has to be mentioned the restructuring process of the world fleet structure occurred during the last decade due to the changing of the fleet composition, as the Table 4.2 points out for the years 1986, 1990, and since the year 1993 to 1996 [Wirtschaftsbehörde, Strom- und Hafenbau, 1997].

Table 4.2 – The structure of the world fleet of the container vessels.

Year	Class of the vessels in TEUs		
	2500-3500	3501-4500	over 4500
1986	59,8%	25,5%	14,7%
1990	46,2%	34,1%	19,7%
1993	42,0%	31,6%	26,3%
1994	40,0%	30,3%	29,7%
1995	38,6%	30,3%	31,1%
1996	36,6%	30,0%	33,4%

The Table 4.3 shows the load capacity of the container ships, split according to the load class, on the 1<sup>st</sup> January, 1996 [Wirtschaftsbehörde, Strom- und Hafenbau, 1997].

Table 4.3 – Classification of the container vessels and their load capacity.

Container ship category	Load capacity in TEUs
From 2500 to 3500 TEUs	111.000
From 3501 to 4500 TEUs	156.000
Over 4500 TEUs	195.000

#### **4.2.5 The Tran-Siberian Land Bridge or Asian Land Bridge**

From a broad perspective, the Tran-Siberian land bridge [Hayuth, 1982] or Asian land bridge [Mayer, 1973] has been suggested as a possible transit route between the European continent and the Far East during the last years.

In fact, both St. Petersburg and Kaliningrad-Königsberg have the goal to make use of the Tran-Siberian railway as an inter-modal bridge, and at the same time the American shipping company Sea Line pursued its realization as a strategic goal. Russia had plans to build a new and more accessible seaport site a 100 km West from St. Petersburg.

Furthermore the seaport of Kaliningrad-Königsberg and the maritime port site of Baltisk-Pillan are waiting for new maritime and commercial relationships. The achievement of these betterment works could have in a long term perspective an impact on the trade traffic between Hamburg and the Far East [Informare, 1998].

In fact, the distance between Hamburg and St. Petersburg is equal to 1.630 km. On such long distance, the maritime transit exploits the higher economies with respect to the transport costs, rather than the feeder services by road or rail.

The maritime transport modality is nowadays the cheaper one, and the shipping companies wish to reach the inland distribution centres as deep as possible using their vessels.

The Tran-Siberian land bridge, that covers the ancient Silk Route, may be split into three segments, as follows [Nuhn, 1994]:

- The container ships leave from the Japanese seaport sites and reach the Russian seaport site of Nakhodka.
- The containers are transferred by the Tran-Siberian railway towards the Western boundary of the former URSS.
- The trip goes on from the Soviet border towards the European and Middle East final destinations. This last transport segment involves the three different transportation modalities (road, rail and inland waterway navigation).

From these Central and Eastern European sites, about the 60% of the containers continue their trip by rail, although there is a change of track gauge at the Czech border; the 30% of the container are transferred towards the seaports of St. Petersburg, Riga and Odessa, and then they are loaded on the vessels directed towards the European continent or the Mediterranean Sea. While the remaining 10% is transferred by road from Moscow or Brest to the Central- and Western Europe. Obviously the same happen when the back transfer route is considered.

About one quarter of the container traffic along this route has been captured, according to the status in the year 1976, by the Tran-Siberian land bridge, with 29 shipping companies operating the trade relationships between Europe and the Far East.

It is useful to give the definition of track gauge, that is the distance between the inner sides of the rail along a rail track [Confetra, 1994]. The problem of the change of gauge is quite relevant due to the fact that a diversity between the former Soviet countries and the European Union exists. In this case, the transshipment of the cargo units or the change of the wagons are necessary.

Three different types of rail gauges are operative within the European continent [Degrassi, 1997/98], as follows:

- The unified gauge Union Internationale des Chemins de Fer UIC equal to 1435 mm.
- The gauge of the former Soviet countries equal to 1524 mm.
- The gauge used in Spain and Portugal equal to 1672 mm.

At the Helsinki rail station it is operative a special equipment for the automatic change of the adaptable rail wagons, which are shipped in particular from Germany and Poland. Once the change of gauge is made, the trains continue their trip towards the CSI states.

If the distances are observed, a relevant advantage exploited by the utilization of the Tran-Siberian land bridge is quite clear, as following:

Distances between Kobe and Rotterdam:

- Tran-Siberian land bridge: 13.770 km
- Through the Panama Canal: 23.800 km
- Through the Suez Canal: 20.100 km
- By Cape Town: 26.300 km

Although the sensible reduction of the travel distance, the travel time are longer using the Tran-Siberian land bridge, as follows:

Before the petrol crisis in the year 1976:

- Through the Suez Canal: 21 days
- Tran-Siberian land bridge: 45 days

After the petrol crisis (due to the economies of fuel and the reduction of the navigation speed):

- Through the Suez Canal: 28 days
- Tran-Siberian land bridge: 35 days

## 5 The Spatial Scale of the Seaport Competition

The seaports and harbours compete with each others at various spatial scales. The two concepts of hinterland and foreland have to be carefully analysed. The collapse of the space constraint due to the improvement of the inland transport networks, the diffusion of the innovative concepts of inter-modality and containerisation, as well as the logistical integration of the transport chain allows the evolution from the static towards the dynamic spatial model of hinterland.

The geographical distance between the seaport region and its hinterland lost of importance due to the diminishing transport costs. The Just-In-Time JIT requirements of the global economy lead to the definition of a temporal space boarder by isochrones lines. The isochrones defines the hinterland of the seaport regions with refer to the time necessary to reach the inland destination.

The competition between ports and harbours is an interesting aspect strictly correlated to the two concepts of:

- 1) *Main ports*. These are the principal seaports within an intercontinental flow of goods.
- 2) *Hub ports*. These seaports exploit a central function for a bigger area as well as they supply the hinterland partly by feeder services.

Kreukels and Wever point out two different spatial scales for the maritime port competition [Kreukels et al., 1996]:

- A continental scale of competition for the main seaports;
- A regional scale of competition for the hub seaports.

A seaport site may exploit the gateway function only when the following two conditions are satisfied. First, if the adequate infrastructure and superstructure equipment are available at the maritime location. Second, if the most appropriate approaches of innovative management are performed by the seaport regional management, with respect to the volume of traffic and the seaport functions [Nuhn, 1994].

The success of the economic and commercial activity of a maritime site depends also by the efficiency of the maritime, inland, and air inter-modal links, as well as by the quality of the logistic services performed at the seaport location.

Within the competition between seaport regions, the supply of the maritime equipments and services to the shipping companies and to the industrial producers, as well as the problem of the unfair competition between seaports are two remarkable patterns to consider [Kreukels et al., 1996].

### **5.1 *The Accessibility to the Economic Hinterland***

The meaning of the concept of seaport hinterland has been constantly adjusted during the past decades due to the economic, political and technological changes of the transportation and logistics environment. It seems appropriate to give a classification of the most commonly used definitions of hinterland.

According to Sargent, the hinterland is simply the area a seaport serves. This territory may approximately define a real district which could be a coherent whole related to an outlet or a set of outlets [Sargent, 1938].

According to Boermann, the seaport hinterland is the combination of both the hinterland and the transport links. This should be the key to understand the commercial growth of the seaport region, as well as the development of the seaport industries. An indissoluble mutual bond between the seaport structure and its hinterland exists [Boermann, 1952].

According to Morgan, the elementary interpretation of the concept of hinterland in terms of the land behind the seaport site is quite inappropriate. He affirms the multiplicity of hinterlands a seaport site may have. Every seaport hinterland may be depicted by different areas and structures. According to Morgan, the three main discriminating factors are the following:

- a) *The nature of the goods*, although the bulk cargo and the general cargo are the most important, or a combination of them.
- b) *The structure of the maritime transportation*, with respect to the ship typology, the number of line shipping companies, the frequency of the stopping calls, the quality and quantity of the seaport equipment.

- c) *The influence of the economic policies*, expressed for example by the kind of control and the destination of use of the inland waterways, as well as by the rate of structuring of the inland waterways and railways.

On the basis of these three elements, Morgan defines as follows the hinterland hierarchy, according to the growing complexity of the inland spatial structure:

*Primitive hinterland*: the seaport has a total control over this area, without any sort of competition with respect to other seaports. A simple example of primitive hinterland may be an island where no others maritime outlets exists because there is only one seaport site. Alternatively, the area could suffer, for different reasons, of a lack in the lateral traffic towards any other maritime port.

*Hinterland of the raw materials*: generally, it involves the bulk cargo traffic and frequently the tramp shipping movements, as well as the special ships as the tankers.

*Sectorial seaport hinterland*: this hinterland presents a complex structure. It embraces a wide range of cargo typologies, both bulk and general cargo. A set of diversified services has to be supplied. With respect to this hinterland category, Morgan refers to the two classical concepts of :

*Primary hinterland*: Ullmann made use of this concept in his study of the year 1943. He defined the primary hinterland as the area where the seaport is well settled [Harris et al., 1945] [Ullmann, 1968] [Ullmann, 1980]. Morgan puts a limit to this hinterland when he fixes that the volume of the incoming/outgoing cargo received/delivered to/from the seaport site have to be equal at least to 50.000 tons in the year 1937 and for each direction.

*Secondary hinterland*: (if a clear distinction might be possible to define) in this geographical area the competition between the seaports is free-for-all.

Morgan puts in evidence as the concept of hinterland can not be bound just by a line drawn on a geographical map. The cartographic geographical method may be defined as a direct way to find spurs of territorial regularities within the distribution of elements on the territory [Jelen, 1988]. The boundaries of the hinterland have to be seen as a grading area or region, rather than as a simple line. Furthermore, the seaport hinterland may be better described as a set of boundaries according to the classification of the cargo handled, rather than just a single fixed boundary. Morgan defines the *marginal hinterland* as the most peripheral area related to the seaport site by the lowest volume of cargo

handled through the seaport. Morgan arbitrary fixed this cargo volume as equal to 10-15.000 tons in the year 1937.

The Morgan's classification of the hinterland concept presents some limits. In fact, other important factors seem to be underestimated, such as the efficiency of the inner transportation system, as well as the agricultural, industrial and urban development both of the seaport hinterland and overseas. Furthermore, an overlapping of the structural patterns of the three categories of hinterland previous described may occur (i.e. extension, complexity, etc.).

The French School is absolutely far from this conception of hinterland. Lemierre states the fundamental aspect of the seaport hinterland as the development of the maritime relationships of the seaport site, clouding all the other factors. He proposed the following classification:

- a) *Regional hinterland*: it is defined by the natural hinterland and the functional area of development. Natural or physical are assumed to be synonymous of geographical or static according to their definitions (although many geographers disagree). Functional or dynamic area of development is supposed to be the sphere a seaport gains against other seaports.
- b) *Super-regional hinterland*: a seaport site becomes regional when its functional development area over-crosses its natural hinterland. The maritime space becomes relevant for these seaports. In other terms, a maritime determinism can be observed, rather than a territorial determinism. The following step is the classification of the seaports into two major categories, as follows:
  - Seaports dependent on the organization of the continental space.
  - Seaports dependent on the organization of the maritime space.

The organization of the maritime space can be split into:

- i. *Tramp shipping*: this maritime service is given just on request. The ocean space is not organized. The choice with respect to the stopping calls of the tramp vessels is made absolutely independently by the quality and quantity of the seaport equipment. The bulk cargo is the typology of goods usually shipped.
- ii. *Line shipping*: on the contrary, the maritime space is organized according to specific structures. Furthermore, an interdependence

exists between the continental organization of the land space and of the oceanic space. The tramp shipping seems losing of importance, while the oceanic space becomes more and more structured. Because of the rigidity of the maritime network, due to the characteristic of the limited number of access point to it, the organization and requirements of the maritime space seem to lead the adjustment of the more flexible transport network organization on the territorial space. In this sense, the oceanic space has a remarkable influence on the organization of the land space.

A further set of definitions of the concept of hinterland may be given, as follows:

1. *Immediate hinterland*: it is the seaport area itself and the seaport city [Elliott, 1969].
2. *Primary hinterland or Umland*: it embraces the immediate hinterland as well as the area where the seaport and the seaport city perform a managerial role on the life of the region involved.
3. *Secondary hinterland or competitive hinterland*: it is difficult to make a clear distinction between the primary hinterland and the competitive hinterland. For practical purposes, the following definition may be given: if the incoming/outgoing traffic of a seaport from/towards an area is less than 70% of its total volume of cargo, then this zone is defined as the secondary hinterland of the seaport site.
4. *Advantage hinterland*: this area may embrace the sphere of influence of the seaport traffic because of the non linearity of the internal tariffs with respect to the other seaports in competition.
5. *Commodities hinterland*: it is based on the direction of the maritime cargo traffic with respect to particular goods or commodities.
6. *Functional superimposition of the hinterland*: it occurs when the hinterland of a big seaport lies over the hinterland of a small harbour in relation to specific categories of goods, due to the wider range of seaport functions, for example because of the greatest number of departures from a major port.
7. *Spatial superimposition of the hinterland*: it happens when a competition between seaports of comparable dimension take place with respect to the same cargo typology and the same geographical area.

Weigend supported the thesis of the prevalence of the territorial organization of the space with respect to the maritime spatial organization [Weigend, 1956] because this situation was the reality of his time. Nowadays, the structure of the contemporary world economy is quite different, and the maritime space is managed and controlled by the big shipping companies and holdings which hardly influence the structure of the territorial space.

An other author, Bird, proposed a further set of definitions of the concept of hinterland [Bird, 1971]. Usually the concept of hinterland has been perceived as a continuum space behind the coast or the river band. Later on, the significance of this term has been extended till to embrace the region from/towards the seaport, which receives/delivers passengers and goods.

The Urban Geographers make use of the terms urban hinterland or Umland, if the seaport is a big city or a city-region. Sargent limits the concept of hinterland to the area that makes use exclusively of one seaport to send/deliver the larger volume of its commercial traffic. He defines the image of a continuous area served by a seaport site [Sargent, 1938].

According to Weigend [Weigend, 1956] [Weigend,1958] and Morgan [Morgan, 1958] a seaport site may have a large number of hinterlands depending on the criterion of discrimination adopted with respect to the cargo typology: imports and exports, bulk or break-bulk cargo, or hinterlands for group of commodities or single goods.

Weigend defines the concept of hinterland as a structured and developed territorial space linked to the seaport by transport connections. The economic goods are send/delivered to/from this area passing through the maritime site [Weigend, 1956]. The same geographical area can be described as the hinterland of many seaports. Therefore, only under particular assumptions a territorial area may be referred to as the exclusive hinterland of a seaport site.

The extension of the hinterland may change if the imports/exports cargo in transit through the seaport location is considered. The distinction between the imports and exports, as well as the further split of the goods handled according to the cargo typology with respect to the total cargo volume of the maritime site makes the analysis much more interesting. The imports/exports are referred to the maritime transit of the incoming/outgoing economic commodities that the seaport has received/delivered, rather than the foreign trade of the country. The foreland may be within the same country or continent, as well as overseas. Therefore, the import hinterland can be defined as the destination area of the

incoming goods in maritime transit through the seaport. The hinterland of the exports is defined as the area of origin of the maritime cargo traffic loaded and outgoing through the seaport site. The hinterland of the exports of a seaport site can be simple or complex.

Certainly both the organization and the rate of development of the seaport hinterland are of fundamental importance. Easy and speedy connections to the seaport site, the structure and policy of the tariffs applied to the commodities, the economic structure of the hinterland, the seaport equipment, the efficiency of the terminal operations, as well as the structure of foreland itself are all discriminating patterns that influence the hinterland extension, as well as the spatial area related by the frequency of the arrivals/departures of the seaport.

A further methodology, in order to define the seaport hinterland, stresses the modal accessibility to the maritime location. It depends on the modal agglomeration, according to the transport modality in use. The most easy way to penetrate a territory from the harbour site is given by "at an angle" link with respect to the coast [Bird, 1971]. For example, a river link may be used during the first phase of transport penetration. Then, the first railway link might be developed. According to Mayer, the hinterland can be defined first of all on the basis of the rates of rail transport shipped from the seaport towards the inland locations [Mayer, 1957].

The dead-end main lines seem to play a remarkable role in comparison to a complex railway system [Wallace, 1958]. The dead-end main railways are the links between the seaport site and its hinterland. The external and foreign trade play a relevant role at the inland areas reached by the traffic generated from the seaport site, although the local trade at these inland locations could be not much intensive. Gradually, the number of rail tracks from the seaport site should increase following a radial shaped net. The last development should be the construction of a rail track parallel to the coast. It should have origin from a flourishing seaport site and cross the hinterlands of the other seaport locations by road or rail links build along the littoral, or by feeder services, for example for the container transport.

The important remark to be made regards the relevance of the dynamic approach, rather than the static approach, of the concept of seaport hinterland. The static approach implies the spatial delimitation of the tributary seaport area within a fixed and circumscribed sphere. This represents an anachronistic and limited approach in particular if the impact of the technological and

organizational changes of the inter-modal transport sector, as well as the political-economic dynamics in the New European context are evaluated.

Therefore, it seems more appropriate to point out the dynamic spatial aspect because it allows the definition of a probabilistic geographical range of the possible hinterland areas of a certain seaport site. The dynamic approach should give the opportunity to determine an indeterminate system continuously changing within a probabilistic framework [Jelen, 1988]. The Christaller's theory of the central places [Christaller, 1933] [Pagnini, 1973] could be dynamical explained in such a way.

Therefore, the seaport hinterland might be described as its tributary area, economically characterized by a direct link that depends on the seaport activities, and as the whole of various sites linked to the seaport itself that form a region in a functional sense. Following the functional concept, the links spreading on the inland areas towards the functional sites supplied by the transit traffic passing through the seaport site are the most important connections, rather than the limited area that could define the static seaport hinterland.

The spatial analysis of the flows of the seaport relationships should take in consideration the terrestrial segment of the transport flow as a segment of a continuous flow [Robinson, 1970], rather than as a flow between the seaport and the hinterland, as proposed by the traditional model of hinterland.

The concept of hinterland has a wider meaning than the simple portion of a territory, which is more or less broad [Patton, 1960]. Patton studied the hinterland of the port of New Orleans. The space related to the seaport may be split according to: 1) the different nature of the flows that have origin or destination at the seaport site, hence with respect to the cargo typology, the cargo volume and its seasonal characteristics; 2) the different intensity of the supply-demand at the inland sites; 3) the structure of the hinterland.

There is no study where the hinterland model has been defined according to the distribution of the supply-demand sites at the inland space, especially in terms of orientation of the territorial space towards the sites of origin, as well as to the external or foreign markets [Robinson, 1970]. This is an undesirable conceptual and methodological lack, probably due to the absence of analytical studies on the spatial structure of the link flows of the seaport, to the different impact of the price policies on the models of hinterland, to the costs of the maritime segment

of the sea-land continuum space, as well as to the mutual relationship of cause-effect in a much broader sense.

### **5.1.1 The Spatial Variations of the Hinterland of the Seaport**

The hinterland has been defined in a static manner as a continuous space behind a seaport. The previous explanation of this concept enlarged its perception till to embrace the functional relationships between the maritime site and its functional locations outside the seaport (i.e. industrial sites, load centres, spoke seaports, etc.).

The dynamic concept of the seaport hinterland makes possible to point out the factors of influence on the likely, sometimes sudden, expansion and reduction of the dimension of the seaport hinterland [Hayuth, 1982].

#### **Natural causes**

The seaport activities can be submitted to the weather or seasonal conditions. For example, an unexpected extreme cold weather could restrict or stop the maritime operations as well as the maritime accessibility to the seaport site because of the ice formation. A clear example is given by the particular climatic conditions in Central America due to the influence of El Niño, an unusual warm water current of the Pacific Ocean that altered the hydrological asset of many regions in that area. The maritime economic impact of this phenomenon was the reduction of the level of water of the Panama's Canal.

The Panama's Canal was built 87 years ago as a 80 km physical link between the Pacific and the Atlantic Ocean. It is required a quantity equal to 52 million gallons<sup>23</sup> of fresh water for each transit vessel. If the weather conditions are regular, the transit mean of vessels is equal to 38 ships per day. Due to El Niño, the Panama's Canal Commission put restrictions on the draught of the ships in transit. The draft of a ship may be reduced if a smaller cargo or fuel quantity is carried. Consequently, the shipping companies decided to modify their maritime routes and to make use of alternative transit ways.

The spatial impact of this natural phenomenon has been very clear: the land bridge and the mini bridge has been used to cross the American continent

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<sup>23</sup> A decalitre is equal to 2,64 gallons.

by rail. At the same time the shipping companies charged their clients of higher costs because it was necessary to make use of a greater number of cargo vessels in order to transit through the Panama's Canal, despite the relatively low maritime tariffs applied by the shipping companies because of the sharp competition within the maritime sector. The American corn industry particularly suffered of this situation.

### **Political Events**

The political changes occurred in the European continent as the Berlin Wall Fall in the year 1989, the restructuring process of the former planned economies of Central and Eastern Europe after the impact with the Western capitalistic economies, are good examples of political factors capable to exploit a spatial impact on the seaport hinterland.

### **Exogenous Economic Factors**

These can be explained as the economic control a centralized government may exercise over one or more states by planning and regulating every economic activity according to the strategic object of the regime. Within the former Socialist states, two cases can be quoted. The former DDR government set as a purpose the restructuring and economic launching of the seaport of Rostock as main port of the German Democratic Republic. In Poland, the investments fixed at the Bromberg's Conference in 1946 were distributed among 17 Polish seaports following political rather than economic criteria in order to assign their seaport functions. The conference signed a functional division of the maritime activities among the 17 Polish seaports. Every seaport site was appointed to handle a specific cargo typology, to receive a certain amount of investment, and to be more or less favourite by the planned infra-structural developments. As a consequence of the Bromberg's Conference, the seaports of Gdansk and Gdynia exploited the transshipment function for general and bulk cargoes, while the seaport site of Stettin became a specialized bulk cargo maritime site.

### **Technological Developments in the Maritime Transport Sector**

These developments are easy to describe, in terms of the restructuring process within the global transportation sector, which followed the introduction of the two innovative concepts of containerisation and inter-modal transportation. These twins factors had a relevant impact on the spatial definition of the seaport hinterland. In fact, it was due to the spatial enlargement of the traditional concept of hinterland, which was usually defined by the transport of the general

and conventional cargos. The traditional approach defines the immediate hinterland of the seaport in terms of the primary area supplied by the seaport traffic. This approach gives obviously a spatial limitation to the concept of hinterland itself.

Furthermore, such technological developments turn out into the impact on the competitive dimension of each seaport site due to the inescapable spatial superimposition of the seaport hinterlands. In fact, the main container seaports enlarged their spatial area of influence of the cargo traffic handled till to embrace a whole country or continent. Hence, the geographical proximity of the seaport site lost of importance within a competitive spatial framework. A further consequence was the formation of dynamically and geographically complex inland distribution systems, as the land bridge in the U.S.A., as well as the through-rate practices.

To begin again the Bird's study [Bird, 1971], the trade of a seaport could be greater due to its hinterland's reduction. The reduction of a seaport's hinterland might occur because of the shift of the cargo typology handled, for example from the general cargo to the bulk cargo, due to the local decision to supply the industry at the seaport site. Usually, the general cargo traffic is concentrated at few seaports which cover a wide hinterland. The next step should be the vertical integration of the transport chain between the maritime and land carriers along their routes. Hence, the spatial extension of the hinterland of the seaports involved should be enlarged. The ship owners should receive the cargo from the inland area much closer to the maritime site of delivery, then they should bring the shipment as closer as possible to the inland final destination passing through the seaport site of arrival.

There are two indicators of such spatial enlargement of the hinterland dimension, as follows: 1) the equalization of the through-rates, when the cargo are handled at different sites at various distances from the container terminals; 2) the distribution centres, which exploits three main functions: i) the transit routes may start and end much deeper in the hinterland, because for example a single train may dispatch the cargo on the long distance to the nearest distribution centre of the seaport site, then the short distance haulage may be performed by road; ii) there are area for customer's declarations; iii) they exploit the consolidation function, both with reference to the single cargo trains, and to the collection of the less-than-a-container traffic. The cargo consolidation is necessary because on certain routes up to the 70% of the consignments are less than 5 tons.

Some basic reasons may be suggested about three likely different locations where the operations of consolidation of the cargo could be exploited and the distribution centres could be located [Schäfer, 1988], as follows: 1) cargo wharf along the bank side (for the part of the cargo the forwarder agents do not consolidate); 2) territory beside the seaport site (it could be managed by individuals or by a consortium of forwarders); 3) at the hinterland (where a compact area of generation of export break-bulk cargo exists, often at a transport node site).

If a big port is also a large city, the modal agglomeration can be relevant. The road and rail traffic from and towards the seaport, as well as the traffic that supply the city as a regional centre may be source of mutual diseconomies. This certainly means that distinct links between seaport and city external to the city-region exist [Bird, 1971].

#### **Models of Analysis**

According to Bird [Bird, 1971], three dynamic models of analysis can be mentioned. He points out the extreme importance of the concept of great inertia, great momentum, according to the observation of Kenyon on the advantage of the old seaport sites well established in the seaport hierarchy [Kenyon, 1970]. Among the characteristics of this favourable position, he points out the commercial, financial and organizational structure of these well consolidated seaport sites.

The first model (1963) prove the role of the well developed transport links to the hinterland on the concentration of the trade on a successful seaport site against the seaport neighbours [Taaffe, Morrill, Gould, 1963]. Hence, the study is focused on the development of the land communication network [Slack, 1990] [Rimmer, 1967] [Mayer, 1978]. The second theoretical dynamic model is based of the shape spatial development. It analyse the spatial organization of the hinterland but it is far away from the reality. The third model is based on the hexagonal shape of tributary territorial area with respect to the central localities. This is the basis of the seminal theory of the central places of Walter Christaller in 1933 [Christaller, 1933] [Pagnini, 1973].

If the cargo volume handled by a seaport site is assumed as indicator of the seaport dimension, than the following two concepts may be formulated [Bird, 1971]: 1) the concept of gradient of cargo generation: the less cargo volume directed towards a certain seaport site, the longer the distance between the seaport site and the location where the cargo is generated; 2) with respect

to a given location, the larger the seaport, the wider the cargo volume attracted from a certain inland site against the cargo volume a smaller harbour is able to attract. This is true independently by the distance between the seaport and the location where the cargo is generated.

In order to verify these two suppositions, it is possible to apply the radial analysis method: a set of circles of incremental ray centred on the seaport site are drawn, then the calculus is made on the proportion of cargo handled inside the seaport that are originated from the area limited by each circle. Secondary, it is considered the proportion of cargo generated inside each area handled at a particular seaport site. If the circles are centred on the location where the cargo are generated, than it is possible to calculate the quote of cargo that transit through the different seaport locations. This methodological approach introduced the basic notion that the seaport dimension and the distance between the seaport site and the area where the cargo is generated influence the cargo volume that the seaport handles.

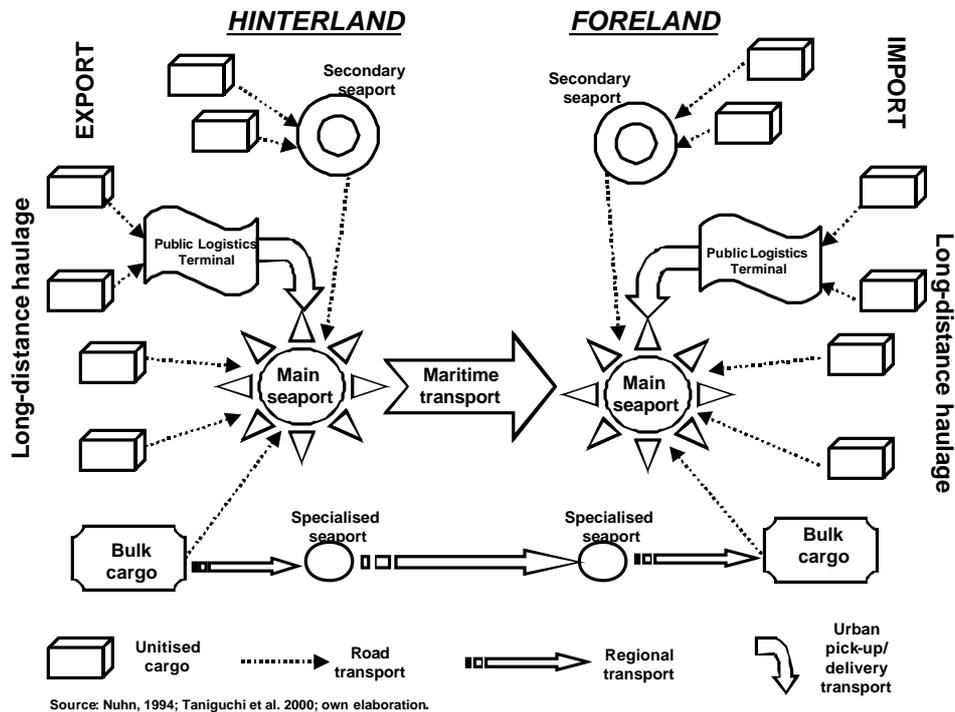
A further model about the study of the hinterland is the gravity model [Ullmann, 1954], that should be predict the flows between agglomerations. It is also known as Reilly's law of retail gravitation [Reilly, 1931], or as interaction or interaction theory<sup>24</sup> [1950]. It is generally assumed that the intensity of the link between hinterland and seaport is inverted proportionally to the distance between them [Weigend, 1958]. This model proves the following two suppositions: 1) the longer the distance from a seaport site, the less is the proportion of export goods it is able to attract from the region; 2) the larger seaports proportionally attract goods from further neighbours area rather than the smaller harbours. This enforce the second supposition: given an export region, the larger the seaport the wider the export share they attract with respect to the smaller seaport, and despite every given distance. It is necessary to stress that the margin of error of the forecasts of the two interaction and gravity models is quite broad, and is equal to 14%.

The Figure 5.1 shows the concept of a continuum space that is formed by the foreland space, the seaport region and the hinterland space.

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<sup>24</sup> It follows the physic law of gravitation, that is: "the gravitational energy between two masses divided by the first power of the distance between them":  $V=gM_1M_2/r$ .

Figure 5.1 – The hinterland-foreland continuum.



### 5.1.2 The Problem of the Unfair Competition

The problem of the unfair competition is a further relevant consideration to take into account when the role of a seaport site is discussed [Kreukels et al., 1996]. At a political and economic sphere, a wide range of regional and local authorities are involved into the seaport activities. These bodies are interested into the prosperity of the maritime locations under their sphere of influence. The strategic instruments urged to pursue the local interests are directed to the improvement of the economical attractiveness of the maritime site, and this way of acting could drive to the unfair competition.

Two examples of unfair competition may be cited at the European level: the Betuwe Line and the preferential tariffs applied by the German Railways.

The Betuwe Line (Map 4) is a railway track between the main seaport of Rotterdam and the German industrial cluster of the Ruhr area [van Ierland et al., 2000]. The Dutch Port Authority built this railway track and support the whole cost of running. No payment is required to the clients for the use of

this rail track to transfer the cargo from/to the main seaport of Rotterdam towards/from the German Ruhr area [Kreukels et al., 1996].

The second example of unfair competition regards the German Railways and the application of special preferential tariffs on the rail tracks which link the German Northern European seaports to the Bayer and Austria. These two Central European geographical regions have been always supposed to be the natural hinterland of the seaport of Trieste. In 1998 the European Commission sentenced this unfair competition<sup>25</sup>.

## **5.2 The Accessibility to the Economic Foreland**

The foreland concept may be defined as the territorial space that receives the cargo flow embarked from a certain seaport, or as the land space of origin of the cargo flow that a maritime site receives. The foreland is therefore the territory of origin or destination of the cargo related to a specific maritime port site. These two terrestrial locations must be kept distinguished from the maritime space (ocean or sea).

If a main seaport site as Hamburg is considered, which is involved in a intercontinental competition among the other seaports of the European Northern Range, the foreland concept may be explained as the geographical territorial space opposite to the seaport and divided by a maritime space; the connections between the two land spaces are realized by the ocean carriers (for example: the seaports of Singapore or Hong Kong). If the regional scale of competition of the seaport Hamburg has been considered, it is necessary to define a different foreland space connected by feeder services, for example towards the Baltic Sea Region. Hinterland and foreland can be defined for each maritime seaport within a regional analysis.

There are many useful indicators to define the foreland of a seaport site: one is the number of calls of the shipping companies; and another one is the number of sailing; a third one, but less satisfactory, is the net tonnage delivered towards a certain destination. To define both hinterland and foreland of a maritime location, hence to investigate the spatial scale of the seaport competition, it is useful to analyse the flow of goods and their fluctuation trends inside the region

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<sup>25</sup> Interview with dott. De Lorenzo of the Port Authority of Trieste on the 29<sup>th</sup> September, 1998.

of study, as well as and towards the other countries. These data can be split according to the lands of origin and destination of the cargo handled, as well as with respect to the cargo classification (bulk cargo: liquid, suction, grab, etc.; general cargo or break-bulk cargo: conventional, containerised, etc.).

The concept of foreland may be assumed as the space where the cargo flows spread out from the seaport of origin, as well as the space from where the maritime cargo flows are originated and directed to a seaport [Ente Autonomo del Porto di Trieste, no year].

Weigend makes use of the expression foreland to indicate the terrestrial geographical area that lie over the maritime space in front of the seaport site, and that are linked to the seaport by the ocean carriers [Weigend, 1958]. The maritime space is assumed to be organized. This spatial structure is functionally organized with the goal to link intercontinental territorial spaces. From this point of view, the main function of the organized maritime space is to give an organized traffic way between continental spaces. In this sense, the maritime space is submitted to the needs both of the hinterland and foreland, because in this particular sense its spatial organization might be more flexible adapted with respect to the land spatial organization. The territorial spatial organization is sharply influenced by the political, economical and social changes.

It is absolutely not useful to treat separately the two concepts of hinterland and foreland, because a strictly relationship between them exists in particular when the cargo and passenger traffic in transit through a seaport is considered. Hinterland and foreland are the two faces of the same medal.

The fundamental factor in order to discriminate these two concepts is given by the transport modality used for the incoming/outgoing cargoes through the maritime site. The seaport geography science speaks about foreland exclusively when the ocean carriers operating on the intercontinental routes are involved. When the cargo are transhipped from an ocean vessel to a feeder vessel, not capable to navigate on the open sea, and the goods are transferred towards an other maritime site, then the latter is classified as hinterland of the seaport under study, rather than foreland. The same assumption is made when a river vessel is used rather than a maritime service.

There are two possible approaches to the study of the foreland, that is: 1) in terms of the number of maritime links of the seaport under analysis. These are the number of the line shipping companies, the number of

departures, as well as the net tonnage directed towards a certain destination (the latter indicator is the less satisfactory); 2) the origin and destination of the cargo in transit through the seaport site can be taken into account.

In the same way, it is possible to collect information about the relationships between arrivals and imports, or between the total volume of traffic of the seaport and the foreland. Considering the primary transit function of a seaport site, it is reasonable to understand as the tonnage of the goods handled at the seaport site plays a remarkable role to analyse the foreland. It assumes a most important role with respect to the number of departures or the number of arrivals, and to the net tonnage. It is useful to split the cargo according to their nature (coal, bananas, etc.) and their typology (bulk cargo, general cargo) when the foreland is analysed.

If a detailed analysis is conducted, it is useful to classify the foreland according to the geographic area of the traffic. A further distinction could be made between national foreland, foreland on the same continent and trans-ocean foreland.

According to Robinson, the flow of the economic goods originated from the foreland and directed towards the seaport hinterland may be seen as a continuum flow, although they are in transit through a maritime segment and a terrestrial segment of space, and through two different seaport sites [Robinson, 1970]. Certainly the operative framework of the maritime operator is hardly influenced by the maritime technological changes and by the quick interchange between the inter-modal flows, which are under the constraints of the global economic system and the pressure of the minimising the total distribution costs.

Mikolajski, in his study about the Polish ports and their natural hinterland given by the Czechoslovakia [Mikolajski, 1964], inferred that the limits of the hinterland and the characteristics of the foreland are absolutely interdependent variables that can not be split. It follows that the different models of hinterland with respect to the various traffic intensity and cargo typology have not to be separated by the structure of the external flows.

In all the studies about the hinterland and foreland, both the foreland origins and destinations, i.e. both the single seaport site and the states, have been seen as relevant aspects of the analysis. When Elliott defines the relationships with the foreland [Elliott, 1969], he points out the importance of the volume of vessels expressed in terms of Net Registered Tonnage NRT, or in terms of number of

vessels, or as frequencies of the stopping calls of the line shipping companies, or as concentration of the cargo, or as cargo typology and trade area, although if he does not make any quantitative dis-aggregation between the different models.

### **5.3 The Competition between Integrated Transport Routes**

The transportation activity can be described as the movement of people and goods between two geographical sites called origin and destination. The spatial movement takes place along a traffic route on a specific transport network according to the respective transport modality used. The spatial structure may be represented by a system of aggregated origin zones and traffic zones. Each geographical aggregation can be represented by its centroid [Oppenheim, 1995], that could be defined as the average point of aggregation of the individual travellers belonging to the specific origin or destination area.

Each aggregated area has its peculiarity in terms of physical, economic and social structures<sup>26</sup>. Every urban transport system is composed by various transport modal networks, such as the road and street network, the inland waterway network, as well as the local rail network. A single modal transport network is made up of a number of nodes and links connecting them. The nodes of each transport network may include the centroid as previously described, as well as other agglomeration points located at the beginning or at the end of the transport links [Oppenheim, 1995].

According to the geographical scale assumed, a transport link may be described in different ways, such as the length of a street, or a rail track, or a maritime connection between two seaports. The transport link is one of the most important elements that influence the general transport costs. They include the travel time, as well as the payment of tolls and charges along the route. From the individual travel point of view, the route costs are the most relevant. Therefore, the individual economic agent<sup>27</sup> is supposed to choose the

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<sup>26</sup> For example in terms of number of residents, size of parking facilities at the destination site, economic activities exploited at the two locations, commuter movements, etc.

<sup>27</sup> That is a multi-modal transport operator, as well as a shipping company, or an inland transport operator.

transport modality that enables him to minimise his route costs. The route costs are defined as the travel costs the individual economic agent has to sustain when the transport activity from the origin to the destination site is performed. The connection between links and nodes can be variously described [Oppenheim, 1995], as follows:

- The nodes may be represented as the beginning and ending points of the transport links.
- The transport links may be described as the incoming and outgoing connections towards and from a certain node of the transportation network under analysis.
- The relationship between the link volume and the costs sustained to travel along them may be related to the physical characteristics of the links of the transport network. They include the length of the link, the time spend to travel along the transport link under specific conditions, as well as the transit services regularly performed along the route.
- It is possible to describe a certain number of different sets of sequential links between two nodes, and each of them may be referred to as a potential preferential route or path connecting the two sites of origin and destination.

If the choice between two transport systems has to be made, then the attractiveness of each transport modality should be evaluated and compared with respect to the alternative transport modes available. If the percentage of travellers diverted from the use of a truck mode is represented by  $P_t$ , the attractiveness of the truck mode is given by  $A_t$  and its costs by  $C_t$ , the attractiveness of the rail mode by  $A_r$  and its costs by  $C_r$ , then a diversion curve can be draft as a S-shaped curve similar to the logistics linear function expressed by the Equation 5.1 [Oppenheim, 1995], and as the Figure 5.2 shows.

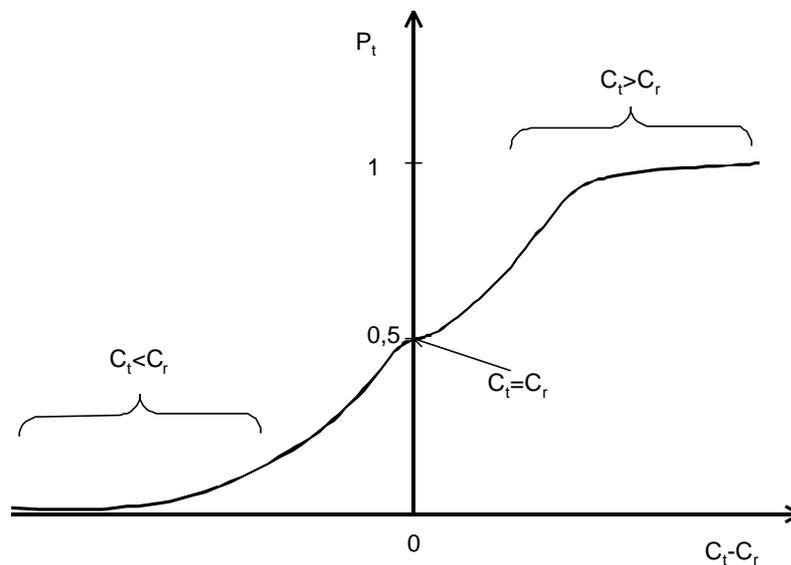
Equation 5.1 
$$P_r = 1 / [1 + e^{\beta/(A_t - A_r)}]$$

The variables of this function may be empirically described as the general transport costs, the level and quality of the freight transport service, as well as the peculiar characteristics of the transport operators. They can be the structure of the supply side of the transportation activity, the inter-modal co-ordination

between transport modes, and the logistical integration within the whole transport chain. The parameter  $\beta$  gives the curvature of the plot.

A transport route may be defined as a multi-modal transport system where the movement of the shipment takes place using the different transport modes available in order to perform a point-to-point service rather than a door-to-door service in the best way. Hence, the better combination of the most suitable integrated transport modalities should be achieved by the Multi-modal Transport Operator MTO.

Figure 5.2 – The diversion curve for modal split of transport.



The MTO is the economic agent who performs the strategic choice about the adoption of the most efficient transport route. A transport route may be defined as the sum of all the paths used within each transport network involved into the transport route. A path in a transport network is defined as the sum of all the links used to exploit the movement of a transport share from the node of origin to the final node of destination.

If we consider the container transport from the port of Hamburg towards the Czech Republic, at least four alternative transport routes are recognizable,

but competitive only with reference to the hinterland site of the maritime-land transport, as follows:

Combined transport route 1: Maritime-Long distance road-Short distance road.

Combined transport route 2: Maritime-Railway-Short distance road.

Combined transport route 3: Maritime-Short distance road-Inland Waterways-Short distance road.

All of three transport routes involve at first the maritime transport by container vessels approaching the main port of Hamburg from its foreland, and all of them make use of the short distance road transport by trucks to complete the point-to-point supply chain of the distribution activity.

The first transport route involves the distribution of the containers by using trucks on the long distance. This preference is expressed both on the short and long distance transport activity because of the extremely high flexibility of the road transport modality. This is due both to the wide extension of the road infrastructure network and to the sharp degree of pulverization of the access points to the road network itself, especially in the Western European countries. Because of this attribute of the road network, a truck may follow different paths in order to exploit the transport of a container, that is the share, from Hamburg to the Czech destination.

The second transport route refers to the delivery of the containers by rail mainly by the block-train services. The block-train service is a fixed and planned rail service, both in terms of physical and time-scheduling paths to follow. This is mainly due to the physical rigidity of the rail infrastructure network, as well as to the requirement of a reliable transport service supply. Hence, in this transport system the paths are fixed both in terms of the geographical transport route and in terms of the time dimensional paths.

The third transport route is the new born inland waterways container service recently developed and promoted as an efficient alternative to the rail container transport as well as to the road. The link between the maritime modality and the inland waterway modality is performed by the road services on short distance by trucks. The local Ministry of Economy of Hamburg wishes to improve the efficiency of the third transport route bypassing the road transport on short distance through a direct interconnection between the two transport networks in terms of a direct transshipment from the container ship to the inland waterway vessels, and vice versa. It is important to highlight the observed competition

between the transport system 2 and the transport system 3 with respect to the alternative rail and the inland waterway path rather than with reference to the long distance truck service, whose attractiveness seems unfortunately to be unquestionable.

The new figure of the specialist provider of the logistics services seems to realise the integration of the maritime and land space in a continuum space. The supply of the transport service should be assumed to be a proper economic activity of production, rather than a derived demand as usually happens.

The logistics system requires more and more to fit the JIT rules as well as the customer orientation. The improvement in the efficiency of the transport chain may be realized at the best if a single economic agent is entrusted for the delivery of the cargo along the entire route. The official economic figure of the Multi-modal Transport Operator MTO should be capable to supply a specialized logistics service by the provision of an integrated point-to-point transport and distribution activity.

### ***5.3.1 A New Economic Actor: the Multi-modal Transport Operator***

The official definition of Multi-modal or Inter-modal Transport Operator MTO has been given at the International Convention of O.N.U. at Geneva in May 1980 [Marchese, 1996], as follows:

when a single economic agent assumes the task to organise a set of consecutive transfer and transshipment operations within a complex transportation cycle, by the involvement of different transport modalities

both in the case that the single transfer, loading/discharge, stopping, etc. operations are directly wholly or partially produced by this economic agent, and in the case that the economic agent submits to a third party the execution of the single operations.

Since the 1<sup>st</sup> January, 1992 the Regulations on the Inter-modal Transportation Documentation came into force. They have been drafted by the International Chamber of Commerce and by the Committee on Shipping, that is a specialized agency for the transportation sector within the United Nations Conference on Trade and Development UNCTAD. The UNCTAD is a body of the United Nations Organization UNO, that is in charge for the improvement of the economic

relationships between the industrialized countries and the developing countries. The following definitions can be pointed out:

1. The multi-modal transport contract is a unique contract concerning the transport of goods by at least two different transport modes.
2. The Multi-modal Transport Operator MTO is anybody who signs a multi-modal transport contract and assumes the responsibility for its execution as a haulage contractor.
3. The haulage contractor is the operator who carries out, or undertakes to execute, the transportation or a part of the transportation. The haulage contractor can be more or less equivalent to the MTO.

The MTO enters time to time into many simple-modal transport subcontracts with the various carriers in order to fulfil the contract signed with the client who placed the order of transport itself. The MTO is burdened of a wide legal responsibility. The function of the MTO is to transfer the commodities assigned to him from the origin location to the final destination. During this transport operation, the MTO has the responsibility for damages on the goods, for the broken consignment of the goods, as well as for the incidental operations which are mentioned in the contract, i.e. custom operations, payment of goods, etc.

On the contrary, the forwarder has no legal obligation for the damages on the goods or for any other occasionally inefficiency occurred during the transportation. The client has to have recourse to the single carriers chosen by the forwarder on his own behalf and on behalf of the principal. Furthermore, the forwarder does not act for the transport operation himself (art. 1737 Codice Civile Italiano) [Patti, 1994].



## **Section 3**

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## **Seaports as Logistics Nodes**



## **6 The Impact of the Logistics at the Seaport Region**

### **6.1 *The Freight Transport and the Economic Growth***

The seaport location is a potential pole of regional growth because of the multiplier effects that the maritime activities spread out to the region surrounding the maritime site.

According to Perroux, the economic space is defined by the economic relationships among economic factors [Perroux, 1950]. In a broader sense, the spatial location of each economic element with respect to the others loses of importance. Within the seaport region, the economic relationships between the economic agents nest a network space in which the economies of scope are exploited at the local regional level. When a seaport network is considered, the functional relationships among the seaport location, and the other maritime or inland functional sites, become of primary relevance. The space constraint, given by the physical distance between the seaport and the final destination at the hinterland, seems to become weaker and weaker. This is due to the reduction of general costs of transport towards the inland destinations. This reduction is due to the improvements in the transportation networks on the land side, thanks to the application of the two mutual concepts of inter-modality and containerisation, as well as to the integration of the logistics network.

By moving from this point of view, it might be defined a functional network of seaport related activities between the maritime port sites and their own hinterland. The economies of networking within the seaport network might derive from the economies of scope that each seaport region performs. In order to set the function of every seaport site, it should be defined the seaport typology with respect to the cargo handled at each seaport node.

The classification of the seaports depending on the cargo typology defines the maritime locations as universal seaports (i.e. Rotterdam, Hamburg), or as specialized seaports for particular cargo typologies (i.e. oil, container, etc.). The seaports of the potential network may be classified depending on the scale of competition (i.e. regional seaports, main seaports, etc.), or depending on the function performed (i.e. communication seaports, etc.) in the transport network.

In order to compare seaports, the rate of containerisation is usually calculated, although sometimes it should be more appropriate to apply of other kind of indicators depending on the typology of cargo each seaport site usually handles.

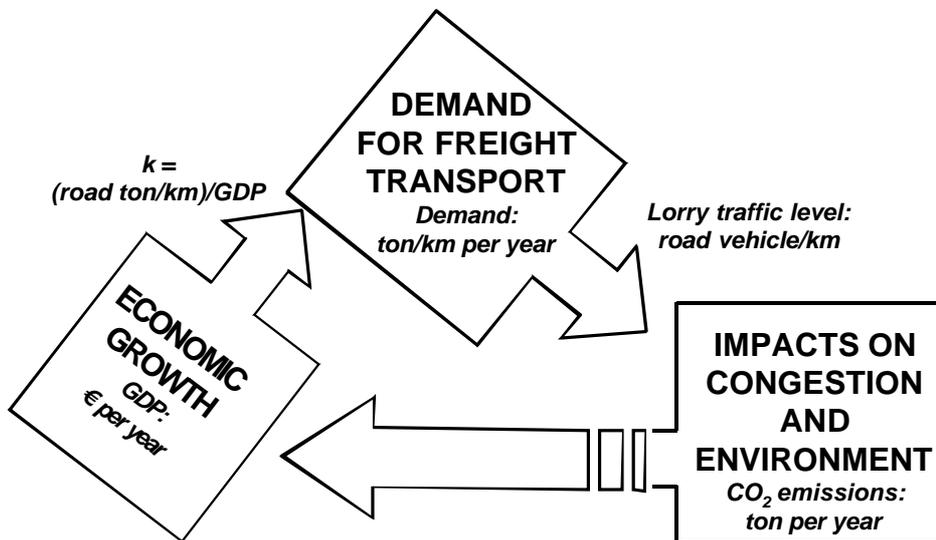
The distribution centres located outside the seaport area play an important role in the seaport network when the functional space has to be defined. The function of these load centres gained of importance after the application of the inter-modality concept and the use of the containers. In this way, the seaport site has externalised certain “unpleasant” functions, and has become a gateway for the cargo handled outside the seaport region.

At the same time, the local port administration achieves the implementation of certain activities in order to generate added value and to induce both direct and indirect effects on the labour market inside the seaport region. If a free port area exists, as in Hamburg, the goods in transit through the port can be elaborated in order to produce added value. This is an economic instrument of endogenous economic growth. The transit of goods inside the free port area is exempted from any tax or imposition as long as the goods are stored inside the area, because the free port area is considered, from a jurisdictional point of view, as a territory outside the boundaries of the customs of the European Union. The EU puts more and more restrictions to the free ports, hence it might be useful to consider the existing free port areas outside the EU and to investigate the opportunities that might be exploited at these other nodal points. This should be an opportunity of economic growth for the transition economies that makes use of the local economic potential and resources in order to promote the economies of scope at the most peripheral seaport regions of the network.

In general, three components are related to the freight transport: the economic growth, the demand for freight transport, and the impact on the congestion and environment [Taniguchi et al., 2000], as it is shown in the Figure 6.1.

The growth of the road freight movements is usually measured in ton/km for academic purposes and public policy-making. The most commonly accepted indicator of the economic growth of a region is the Gross Domestic Product GDP. It is desirable to achieve the economic growth with the less impact on the environment as well as on the congestion. Hence, the demand for the freight transport should not substantially increase with the economic growth, and the congestion as well as the environmental impact should not increase with the rising demand for freight transport [Taniguchi et al., 2000].

Figure 6.1 – The mutual causation between economic growth, demand for freight transport, and impact on the environment and congestion.



The gross domestic product is usually accepted as an economic indicator of the economic growth of a region. In particular, the GDP per person is a most significant measure of economic growth because it takes care of the population of a country. It should be useful to consider the GDP pro person both inside the administrative seaport region from a static point of view, as well as outside the seaport region, i.e. inside the nation and at the other seaport functional sites in a dynamic holistic perspective.

The growing of the trade traffic volume should not necessarily lead to a proportional, or more than proportional increase in the volume of the transport, because the physical volume of the cargo traffic is supposed to rise less than proportionally with respect to the growth of the cargo value [Jäger-Roschko et al., 1996]. In fact, the elasticity  $\xi$  of the international freight traffic is equal to 0,7. This value means that the Gross Domestic Product GDP rises more than proportionally with respect to the productivity, or capacity of the transportation sector, because of the increase in the value of the goods transported. It follows that:

$$\Delta\text{GDP} = +10\% \rightarrow \Delta\text{Transport} = +7\% \rightarrow \xi = 0,7$$

where:  $\rightarrow$  = it follows;  $\Delta$ GDP = variation of the Gross Domestic Product;  $\Delta$ Transport = variation of the productivity or capacity of the transportation sector; and  $\xi$  = elasticity of the international freight traffic.

The logistics system can not afford the proportional development of the infrastructures following the growth of the GDP. The feasible alternative is to adapt the transportation system to this change by implementing the level of flexibility of the transport carriers, of the transport routes, as well as of the schedules. From the point of view of the seaport site, this alternative implies the necessity to overcome the existing bottlenecks with the aim to ensure the fundamental flexibility along the whole logistics transport chain. The essential elements to achieve the logistical flexibility are the follows: 1) the collaboration between the seaport operators; 2) the development of appropriate communication and information systems; 3) the promotion of an advanced system for the interchange of information between the production and distribution centres and the traffic nodes; 4) a broader accessibility towards the hinterland of the seaport, in order to ensure the transport of the cargo to the final destination at the inland without any delay.

By considering the environmental impact of the economic activity on a region, the environmental economists wish to define a so called "green GDP" in order to give a more realistic evaluation of the economic growth of a region. The main problem of this approach is the difficulty to attribute a real economic value to the environment because usually the environment is not considered an economic goods and the environmental impact is usually explained in qualitative terms. It would be useful to apply a standard evaluation system of the environmental impact of the economic activities to the GDP, in order to transform the qualitative factors into quantitative weights of (probably) depreciation of the GDP.

The relationship between the growth trend of the Gross Domestic Product GDP and the road ton/km ratio is generally stable [Taniguchi et al., 2000], as the ratio  $k$  shows. The positive correlation between GDP and the road ton/km ratio on the long run allows the use of this variable  $k$  in order to forecasting the lorry traffic trends in the future on a solid basis.

Equation 6.1 
$$k = (\text{road ton/km}) / \text{GDP}$$

Therefore, although any variation in the GDP growth in the long term is likely to occur, the ratio  $k$  is assumed to be constant [McKinnon et al., 1996]. The range of growth of the road freight traffic may be supposed to swing within

a certain interval of confidence  $c$  on the long run predictions; the high and low estimated values of the future road traffic give its two limits.

Equation 6.2  $c(\text{road freight traffic}) = f(\text{variation GDP, } k)$

After the determination of the interval of the road freight traffic growth, it is necessary to forecast the level of traffic of the lorries, measured in vehicle/km.

Equation 6.3  $\text{lorry traffic level} = \text{road vehicle/km}$

The forecasts on the consolidation of loads in larger road vehicles up to 38 tons has to be carefully evaluated because of the spontaneous deduction about the decreasing lorry traffic level. This implication has to be carefully evaluated because of its influence on the investments for transport infrastructures. This is due to the fact that the commercial vehicle benefits have been estimated to be about 20-30% of the economic returns on major road schemes.

## **6.2 The Impact of the City Logistics on the Urban Freight Transport**

The freight transportation within urban areas suffers of many problems such as traffic congestion, negative environmental impact, high-energy consumption, and labour cost [Taniguchi et al., 1999].

The JIT requirements in the transport of goods lead to a spatial restructuring process of the freight traffic flow because of the needs of more frequent and smaller deliveries in order to reduce the inventory costs and to satisfy the customer demand. The spatial impact reveals an increase in the number of trucks and lorries along the road network, therefore a growth in the traffic intensity. The road infrastructures are supposed to be fixed in the short run because of the high budget required, as well as the long run nature of this kind of infra-structural investments. The traffic congestion may induce the rise of the transport costs especially inside the urban areas.

A further negative externality the freight road transport generates is the negative environmental impact due to the supplying system of trucks and lorries, mainly by diesel engines. The under-pricing of the freight road transport cost does not include the noise and light intrusions, the air pollution, as well as the vibration generated by the freight vehicles.

Therefore, the economic system is not able to allocate efficiently the economic resources through the adjustments of the market price of the transport service sold. The shadow social costs should be fully internalised into the road transport price, in order to reflect the real full cost of the transport activity, as well as to enable the users to choose the most efficient transport modality.

The high-energy consumption of the freight vehicles is a problem that can be solved by the technical innovations, as well as the development of new environmental friendly engines. The technological innovation and development in the transport sector lead to a higher efficiency of the commercial vehicles both in terms of decreasing the fuel consumption and reducing the negative environmental and social externalities. The labour cost obviously plays a major role when the road transport modality is taken in account.

The urban freight transport has become an important component of the urban planning. The rationalization of the urban freight transport is essential for achieving a sustainable economic growth. The spatial dimension of the urban logistics system may be structured according to the assumption that the movement of goods is split into two phases [Taniguchi et al., 2000], as following:

- *A line-haul movement.* This is defined as a long-distance freight transport exploited by large trucks on motorways outside the urban area.
- *A local pick-up/delivery movement.* This is defined as a short-distance freight transport by small lorries on urban roads within the urban area.

Therefore, two spatial dimensions are taken into consideration: the urban space and the not-urban space. The public logistics terminals PLT performs the role of interface between the two geographical spaces and their traffic movements.

The PLT are supposed to be the attraction poles of both the line-haul movements of the trucks within the not-urban space, and the pick-up/delivery movements of the lorries inside the urban space.

The structure of the not-urban space can be defined as a network of centroids and long-distance transport links between them. Similarly, the structure of the urban space can be defined as a network of centroids and short-distance transport links between them. A centroid is assumed to be a geographical location where the freight is generated and attracted.

### **6.2.1 The Public Logistics Terminals for Freight Transport**

The nodal centres for goods are one of the essential elements of the Trans-European Network TEN for the inter-modal transportation. They are also called "nodal centre", "freight nodal terminal", or "freight villages" (United Kingdom), as well as "plateformes multimodales/logistiques" (France), "interporti" (Italy), "Güterverteilzentren GVZ" (Germany), or public logistics terminals PLT (Japan).

The inter-modal or multi-modal terminals forms the principal component of the nodal centres for goods where the transshipment of the cargo from one mode to an other takes place. However, a nodal centre should be more than just a terminal. It has to provide the auxiliary facilities such as warehouses, grouping activities, customs, maintenance workshops, banks, insurance offices and other services [Tsamboulas et al., 1999].

The concept of public logistics terminals PLT was formulated in Japan as an instrument of transport policy useful to mitigate the social problems of the freight road transport within urban agglomerations [Taniguchi et al., 1999].

A public financial source for the provision of low-interests funds was thought to be the most favourable solution. The public logistics terminals PLT are defined as complex facilities with multiple functions, or as multi-company distribution centres. The set of functions exploited at the PLT embraces the transshipment operations, warehousing, wholesales markets, information centres, exhibition halls, conference rooms, etc.

The three main goals that a PLT is supposed to achieve can be summarized as follows [Taniguchi et al., 1999]: 1) to establish a more efficient logistic system; 2) to facilitate the implementation of advanced information systems; 3) to promote co-operative freight systems.

The PLT has to be seen as a meeting point for both public and private urban logistics operators. The consolidation of the urban logistics activities can be realized at this freight transport node of the transportation network by the application of the most advanced information systems.

The efficiency in the routing and scheduling of the pick-up/delivery system may be improved by the most appropriate software packages after the subscription of co-operative freight transport contracts among third-party logistics providers or companies [Taniguchi et al., 1999].

The relevant spatial impact on the road transport induced by this restructuring logistics co-ordination is the reduction of the freight traffic intensity in terms of the reduction in the number of commercial vehicles used for the pick-up/delivery operations within the urban area.

The transport contract of co-operative logistics involves small and medium size entrepreneurs, and gives them the chance to improve the efficiency of their road operations for freight transport through the mechanization and automation of the materials handled.

Therefore, an efficient co-operative freight transportation system can be implemented at the PLT location. This co-operative system enables a large number of shippers or freight carriers to share a jointed system of freight vehicles, jointed terminals, as well as common information systems in order to exploit the synergy effects the spatial agglomeration of the logistics operations spread out.

The individual economic agent should be able to reduce the costs for collecting and delivering goods, due to the exploitation of the economies of space at the PLT. The spatial agglomeration enables the co-operative performance of the logistics operations jointly with other entrepreneurs, as well as the supply to the customer of a level of services of better quality.

Therefore, through the establishment of a spatial multi-function cluster the entrepreneurship of the logistics transport sector may be promoted, and at the same time the negative externalities generated by the road transport modality may be reduced [Taniguchi et al., 1999].

The establishment of public logistics terminals in the area surrounding a seaport city can be helpful in promoting the co-operative freight transport systems [Taniguchi et al., 2000].

For example, in Munich a platform for the city distribution is provided by the government and operated by a private freight carrier for delivering goods towards the city areas. This company is subsidized by the government in order to provide a delivery service with cheaper prices than the normal. This system helps to reduce the required number of trucks used for delivering the goods within the urban area.

In Japan, the first multifunctional logistics terminal has to be built in Seki near Nagoya. This logistics terminal is referred to as a logistics town and has to exploit a set of various functions, such as the transshipment of goods, the

assembling of the products during the distribution activity, the availability of warehouses and wholesale workers. It is supported by a group of industries, with the help of the national governments, the prefectures, as well as the municipal governments.

#### **The Two Main Problems of the Optimal Geographical Location and the Optimal Spatial Physical Size of the PLT**

The two main problems to solve are the optimal geographical location and the optimal spatial physical size of the PLT [Taniguchi et al., 1999]. The location choice among different potential sites has to evaluate the trade-off between transportation cost and facility cost. The facility cost is defined by sum of the construction, maintenance, land and truck operation costs at the PLT site.

The land price plays a major role when the potential nodal location is settled nearby the urban agglomeration. In this case, the lower transport costs the logistic operators had to bear for the pick-up/delivery activities between the PLT and the urban centroids might compensate in such a way the more expensive fixed investments necessary to buy the land as well as for building the infrastructure.

The public planner should have the role to perform a macroeconomic decision about the more suitable geographical location and dimension of the PLT [Taniguchi et al., 1999]. His aim is to minimise the total cost of the PLT. It follows that the accessibility patterns are absolutely relevant.

Among all the potential proper places, the location choice of the public planner should be addressed in favour of the geographical site closer to the major inter-modal transport links which connect the urban agglomerations that had to be served by the new settled PLT. If any congestion problem already exists, then an inappropriate location decision of the traffic policy planner might induce a worsening in the road traffic conditions within the region.

The improvement in the efficiency of the road network can significantly help to mitigate the negative economic impact the spatial traffic congestion induces, which is reflected by the increase of the transportation costs.

The public planner has no influence at the microeconomic level of decision, when the distribution and assignment of the freight traffic is considered.

At a micro level, where the individual transport operator decides to use his own freight vehicle, the choice of make a stop call at a certain PLT rather than

another is supposed to be determined by the behaviour of the single transport operator or company [Taniguchi et al., 1999]. At this level of choice, the goal is to minimise the transport costs.

Table 6.1 – The public logistics terminals and the two levels of decision.

Level of Decision	Kind of Decision	Goals
<u>Macro level:</u> Public planner	Location choice, and optimal size of the PLT	Min the total cost = Min (transport cost + facility cost)
<u>Micro level:</u> Every entrepreneur, each company and freight vehicle	Choice of the PLT, and optimal routing	Min the transport cost

### 6.2.2 Other Environmental Sound Initiatives of City Logistics

The city logistics criteria in order to estimate the most appropriate freight transport policy the regional public planner had to adopt should embrace the impact of the freight traffic on the environment and the effects on the congestion within the urban region [Taniguchi et al., 2000]. For example, the most suitable indicators to use should be the total travel time of the lorries, as well as the measure and the estimation of the CO<sub>2</sub> emissions, that the pickup/delivery trucks exhaust within the urban region.

The structure of the transportation sector has not to be forget. The freight transport is generally undertaken by individual entrepreneurs and private companies, which operate within a competitive market framework. Hence, the control and regulation measures put in force by the regional public planner should not excessively interfere with the activity of the transport sector.

Besides the transport policy instrument of the PLT, several others city logistics initiatives have been proposed [Taniguchi et al., 2000] in order to overcome at the best all the negative externalities that the urban freight transport generates.

The freight transport carriers are expected to provide the JIT services, that should be economical efficient. This means that the minimising of the transport

and logistic services should be achieved. At the same time, some urgent problems had to be solved, such as the traffic congestion, the environmental impact of the transport activity, as well as the problem of the energy conservation.

The crucial role played by the public-private partnership is always stressed when speaking about the city logistics initiatives. Besides the PLT, the regional public planner had to consider and properly evaluate also the following potential instruments of transport policy: a) the implementation and diffusion of progressive information systems, in order to organise the routing and scheduling of the consignments in advance; b) the promotion of co-operative freight transport systems; 3) the control of the load factor for the pick up/delivery activities; 4) the planning of the most innovative underground freight transport systems.

#### **Advanced Information Systems**

The improvement of advanced information systems are one of the most relevant instruments in rationalising the logistics activity. The efficiency of the transport system is effectively improved by planning the routes and schedules of the consignments in advance.

The advance information systems enable the drivers of the trucks and the control centre to communicate to each other, to provide the information on the traffic conditions in real time, as well as to store detailed historical data about the pickup/delivery truck operations. In particular the last function plays an important role to rationalise the logistics operations.

#### **Co-operative Freight Transport Systems**

The performance of co-operative freight transport systems may have a positive impact on the environment as well as on the minimising the transport costs. In fact, they enable the reduction in the number of trucks, which are necessary for collecting or delivering the same volume of goods [Taniguchi et al., 2000].

For example, in Kassel a neutral freight carrier collects goods from five different freight carriers and delivers the shipment to the shops in the inner city. The spatial impact of this instrument of freight transport policy shows the sensible reduction in the total time travelled by trucks within the urban area, the cut in the queues of the lorries for waiting on the streets in order to deliver the consignments, as well as the abatement in the work-hours per person and in the total costs.

**Controlling Load Factors**

The control of the loading of pickup/delivery lorries is a relatively new initiative with respect to the conventional regulation instruments of transport policy, such as the vehicle weight limits, the designated times for trucks to enter the city centres, and the control of the vehicle emissions [Taniguchi et al., 2000]. Since the year 1998, two European capital cities, Copenhagen and Amsterdam, enforced a certificate system for the freight carriers who carry the goods within the inner city areas.

In Copenhagen, only the freight vehicles endowed with the proper certificate (i.e. a green sticker) are allowed to use public loading/unloading terminals inside the inner city. The conditions prescribed are the following: 1) the load factor has to be greater than 60%; 2) the vehicle has to be not older than 8 years. Furthermore, the transport companies which own any freight vehicles are required to produce a monthly report on the load factors of their vehicles. In order to maintain the certification, they must prove an average load factor greater than 60% during the previous month.

In Amsterdam, only the freight vehicles less than 7,5 tons weight are allowed to transit through all the streets of the inner city. The freight lorries heavier than 7,5 tons weight are allowed to transit exclusively through the main streets. They may ask for a special certificate under the following conditions: 1) the load factor has to be greater than 80%; 2) they have to be more than 9 meters long; 3) the engine must satisfy the Euro II emission standards. The urban police inspects the load factor of specific vehicles on the road. This initiative assumes that the higher the load factor the lower the environmental impact.

**Underground Freight Transport Systems**

The underground freight transport systems are a really innovative instrument in order to solve the urban freight transport problems [Taniguchi et al., 2000]. Koshi et al. (1992) estimated the impacts of building an underground freight transport systems in the central area of Tokyo.

The results indicate that the NO<sub>x</sub> and CO<sub>2</sub> emissions would be reduced by 10% and 18% respectively, that the energy consumption would be reduced by 18%, as well as that the average travel speed would be increased by 24%. Oiski (1996) studied the ecological feasibility of the underground freight transport

systems in Tokyo and concluded that this project performs an internal income rate equal to 10% when the public sector provides the infrastructure.

The Dual Made Truck DMT was developed and tested by the Public Works Research Institute of the Ministry of Construction, Japan. This new type of automated electric truck can travel through an exclusive guided lane in an underground tunnel supplied by an external source of electricity, and can also travel on normal streets, if it is operated by a driver and supplied with batteries.

In The Netherlands a similar idea was proposed, and then it was investigated the feasibility of an underground system for freight transport between Aalsweer and the Schipal Airport for carrying flowers. A group of private companies also developed and tested an automated guided truck named the Combi-road system.

### **6.3 The Restructuring Process of the Logistics Supply Chain**

The tonnes/lifted statistic gives a measure of the weight of the consignments loaded onto road vehicles at the beginning of a journey. The process of the logistical restructuring in the production system caused the supply transport chain to be split into a set of several journeys, in order to link one with another the various sites of production, where the different stages of production takes place. Therefore, a better indicator to be used is the ratio of the tonnes/lifted statistic to the weight of products consumed or exported, that is the so-called handling factor [McKinnon et al., 1996].

$$\text{Equation 6.4} \quad \text{Handling factor} = \frac{\text{tonnes/lifted statistic}}{\text{the weight of products consumed or exported}}$$

The positive trend of the value of this ratio may be explained by the following three developments:

- The increase in the number of the links that are added to the supply chain<sup>28</sup>.

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<sup>28</sup> The case study is referred to the drink and food sector. It puts the relevance to the rise in the consumption of pre-prepared and processed foods as the main reason for the increasing number of routing through factories [McKinnon et al., 1996].

- The change in the weight loss (or gain) of the product handled during the production process can give origin to a distortion of the handling factor. There is no way to measure this inflating lost.
- The change in the weight of packaging due to the use of lighter materials.

The increase of the handling factor is mainly due to the higher complexity of the logistics network of the supply chain of the production. Therefore, two main reasons may be pointed out:

- The increase in *the number of the links* that are added to the supply chain.
- The increase in *the length of the links* of the logistics network of the production chain.

This two kind of increases can be referred to two spatial restructuring processes, such as the geographical concentration of the production and inventory, as well as the expansion of the market areas. In the case of the seaport regions, it can be referred to the spatial variations of their hinterland.

A further remarkable pattern to consider is the structure of the supply side of the freight transportation market. For example, in the USA it is shaped according to the two different services the motor carriers offer: the truckload service TL and the less than truckload service LTL [Forkenbrock, 1999]. The TL category embraces the freight transport services operated by line-haul combination trucks from one single shipper to one or more receivers, without any handling of goods and using the same vehicle during the transport. This market share is quite easy to enter because of the narrow capital investments required to be able to offer a TL service. Therefore this market sector is characterized by a highly pulverization rate due to the extreme fragmentation among a lot of small and medium size transport carriers. The deregulation of the trucking industry in 1980 in the USA furthermore promoted this process.

On the contrary, the LTL service operates by line-haul combination trucks operating between terminals strategically located. This service is characterized by a multiply set of shippers and receivers, and small lorries have the function to bring the freights to the terminals and to distribute the goods from the terminals. The entry barrier to the LTL service sector is given by the large capital investments required to establish and to operate a distribution terminal.

It is argued that previous of the deregulation of the trucking industry there were increasing returns to scale, but after 1980 essentially constant returns to scale were exploited. The technical economies of scale in TL operations do not seem to appear clear. On the contrary, the differential managerial skills may be singled out as a relevant factor of success within a competitive market. Therefore the average private operating costs in the TL service market fits quite good the marginal external costs per unit of service provided.

The causes of the growth of the road traffic levels for the freight transport may be explained by pointing out four factors [McKinnon et al., 1996], as follows:

1. *The total volume of sales S.* An increase in the sales volume may be a relevant cause of road traffic growth because of the JIT requirements.
2. *The nature of the product P.*
3. *The logistics factors L.* The logistics factors can be split into non-managerial and managerial factors, as following:
  - *Non-managerial factors* (ton/km): a) the structure of the logistics system; b) the pattern of sourcing and distribution.
  - *Managerial factors* (road vehicle/km): a) the scheduling of the product flow; b) the management of the transport resources.
4. *The external factors.* The transport policy of the external political and economic agents is stressed.

The following paragraphs focus on the logistics factors L, as well as on the transport policy issues that have an impact on the transportation sector.

### **6.3.1 The Logistics Factors: the Geographical and the Managerial Patterns**

The logistics factors L may be distinguished between the non-managerial logistics factors (ton/km), such as the structure of the logistics system as well as the pattern of sourcing and distribution, and the managerial factors (road vehicle/km), such as the scheduling of the product flow and the management of the transport resources.

### Non-managerial or Geographical Logistics Factors

The geographical concentration of production and inventory is potentially a spatial factor that may induce both a growth or a decrease in the handling factor and therefore in the road traffic growth. The non-managerial factors are usually expressed by the ton/km ratio. This variable is commonly used by the academics for their researches, and by the public authority for the activity of transport policy.

The first non-managerial logistics factor is *the structure of the logistics system*. The logistical network of production facilities, warehouses, and distribution centres, their number, location, and capacity is determined at a high strategic decision level. The movement of the goods has to be submitted to this structure, relatively stable in the short term. The structural items are the following: 1) the relocation of the warehouses; 2) the relocation of the production; 3) the production/stockholding centralization; 4) the production/stockholding decentralization.

There are three cases in which the spatial concentration of the production and inventory does *not* generate an increase in the road traffic [McKinnon et al., 1996], as follows:

- *When a replacement from a multi-focal form of centralization to a single-focal system takes place.* In this case, a firm takes its location choice by concentrating the manufacture and storage of a particular class of products at a single location rather than at several sites of production, that would be spatially scattered. The single-focus site would be consequently located at a most favourable central location than the spatial location of each single node in the previous decentralized multi-focus system. This geographical restructuring of the production chain towards a single-focal specialized system allows the process of consolidation, therefore the possibility to reduce the road traffic flows.
- *When the spatial concentration in the number of production and warehousing facilities induces a sharply reduction of the number of inter-haulage between them.*
- *When the regional stockholding depots are converted into transshipment facilities.* The creation of such distribution centres enables the management of the inventory at those locations without any impact on the road traffic level.

The *geographical expansion of the market area* has been noted as a potential factor of spatial restructuring of the producers sales operations that may induce a growth in the road traffic levels [McKinnon et al., 1996]. The second non-managerial logistical factor is given by *the pattern of sourcing and distribution*.

It is possible to recognise two restructuring factors in the demand-supply trade off, as follows. The *first* factor is the shift from a push-logic to a pull-logic of production, from a fordist system of mass production, that is based on the economies of scale, to a post-fordist system of specialized production, that is customer oriented and it is based on the economies of scope. According to the push-logic of production, it is the supply side that determines the demand of the market. On the contrary, according to the pull-logic system, it is the demand side that leads the market supply. Because of the shift towards a pull-logic of market, the *second* restructuring factor is the application of the Just-In-Time JIT logic. The JIT system is aimed to satisfy the needs of the consumers, both with reference to the quality of the products handled, and the economies of time. The needs of outsourcing of many production activities and the consequently sub-contracting practices generate a more traffic intensive production system. These pattern are the change in the market area, as well as the change in the sourcing of materials.

The growth in the number and length of the links of the supply chain may be translated into an increase in the ton/km ratio although the traffic growth of the commercial vehicles has not been proportional because of the increase in the average consignment size. Two reasons can be mentioned:

- The increase in the dimension of the lorries and in the maximum weight they are allowed to carry. In the year 1983 the maximum weight allowed for the lorries was increased from 32 tonnes to 38 tonnes. This had obviously an influence on the average consignment size.
- The consolidation of the products into bulk loads at the distribution centres and the following channelling towards the customers-retailers. This spatial and logistical restructuring process also affected the road traffic flows.

Because of the observation of marked inter-sector variation in the ratio of industrial output to tonne/km, the adoption of a sectorial dis-aggregated approach has been suggested in order to compile more reliable forecasts of the road traffic levels for the future demand of freight transport. The short-medium

term provisions on the freight road traffic may be distorted due to the cyclical fluctuations in the economic activity level.

#### **The Managerial Logistics Factors**

The managerial logistics factors are those logistical patterns that are sharply determined by the decisions of the management of a company and that can be measured by the road vehicle/km ratio. The two following items can be pointed out:

The first managerial logistics factor is *the scheduling of the product flow*. What from a macroeconomic level appears to be a flow of goods moved between the production facilities nodes of the supply chain network, can be analysed at a microeconomic level and split into its components given by discrete vehicle movements. The interface between the freight flow and the discrete variable is settled by the scheduling of the product flow turned to meet the JIT logic of frequent deliveries of small consignments. These factors are:

- 1) the change in the customer requirements, including service and reliability;
- 2) the adoption of low inventory strategies;
- 3) the consolidation of loads;
- 4) the increase in JIT, more frequent and smaller deliveries.

The second managerial logistics factor is *the management of the transport resources*. This enables the managerial board of a firm to influence the level of road traffic depending on the transport modality choice, the planning of the deliveries, the routes preferred, the transport carriers and vehicles used. These factors are:

- 1) the change in the nature/availability of alternative transport modalities;
- 2) the change in own-account/third party split;
- 3) the change in the responsibility for the transport service;
- 4) the change in the method of the vehicle routing;
- 5) the consolidation/planning of loads;
- 6) the shedding responsibility for the transport to the customers;
- 7) the taking responsibility for the transport from the suppliers;
- 8) the contracting-out of the transport activity;
- 9) the night deliveries.

#### **6.3.2 The Exogenous Factors: the Influence of the Transport Policy**

The *external factors* are external to the company. Their sources are mainly the local, national government, the EU bodies, and the supranational authorities. There is a policy trend to shift the freight transport from the road to the rail modality in order to meet the principles of sustainable development and growth.

From a macroeconomic point of view, the rail mode generates a lower level of negative externalities if it is compared to the road modality. For this reason, it is quoted as an "environmental friendly transport modality". Where a network of inland waterways is available, the modal shift is desired in favour of the transport by barges.

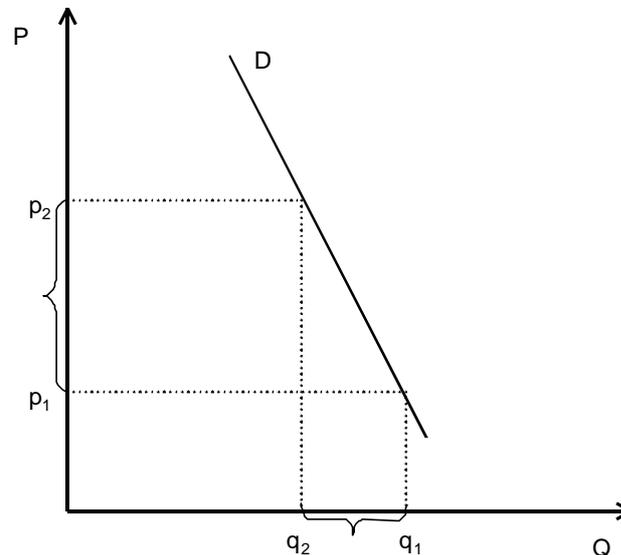
A second external development regards the cost of the road transport both in terms of increase fuel cost and of the pay roads. The rigidity of the price elasticity of the demand for the road transport service makes the taxation instrument a weak tool to counteracting the growth in the transport demand. The increase in the price for the road transport service from  $p_1$  to  $p_2$  induces a less than proportional decrease in the quantity demanded from  $q_1$  to  $q_2$  as the Figure 6.2 shows.

A third external item is the increase in the weight and dimension of the lorries by the EU legislation. This development enables the producers to exploit the economies of scale and therefore to mitigate the operative costs.

A further external factor is the improvement of the road infrastructures in order to increase the efficiency of a congested network through a higher transport capacity of its links. The environmental issues are taken into account especially at the EU policy level because of the consciousness that the road modality does not fully pay its social, economic and environmental costs. Because of the poor responsiveness of the firms to the increase in the cost of transport, alternative policy tools have to be used. The range of policy instruments available to induce a reduction of the road traffic level are the following: 1) the tax imposition on the lorries; 2) the setting of favourable conditions for a modal shift towards the more environmental friendly transport modes such as rail and inland waterways; 3) the restructuring of the logistical operations at the supply transport chain level.

The transport costs have an incidence of about 4,7% on the total sales revenue of the manufacturer firms [McKinnon et al., 1996]. If a 50% increase of the transport costs is supposed to occur, and if it is supposed to be entirely passed to the customers, then it would inflate the selling price of the product by around 2,4%. The increase would be partially absorbed by the company by reducing its profits. The efficiency of the logistics system of the firm should be improved and alternative transport modes should be considered.

Figure 6.2 – The inelastic demand for the road transport.



The externalisation of the transport costs by sub-contractors practices might induce an increase in the road freight traffic level. This spatial impact is due to the fact that the producers are not intentioned to alter their external links towards the consumers, hence the internal restructuring process of the logistics supply chain has to be kept transparent to the demand side.

The external factors may be summarized as following: 1) the cost of the road transport; 2) the increase in the vehicle weights; 3) the changes in the legislation; 4) the motorway charges; 5) the environmental issues and legislation; 6) the road congestion, the road works, etc.; 7) the provision of new road infrastructure.

It has to be noted that the growth trend of the freight traffic levels can be mitigate through the logistical and technological innovations, such as the improvement of the delivery routing of the lorries, as well as the betterment of the load consolidation rate. This kind of development has to be promoted at the managerial level of the decision making.

Therefore, the innovative entrepreneurship plays a major role at a microeconomic level of action, where the efficiency of the supply transport network can be improved on the short term.

The development of an infra-structural network of good level for the road transport, as it is in the Western Europe, is a prerequisite for the decentralization of the production facilities. The high rate of accessibility due to the high density of the road network enables the spatial fragmentation of the several supply activities at the sites that appear to be the most economically efficient. The diminishing relevance of the cost of transport and the rising value of the time factor for the consignments of products allows the spatial disintegration of the physical territory and the formation of a new logistical economic space bounded by the JIT logic.



## **Section 4**

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## **Hamburg as Trans-port Node**



# 7 The Spatial-Economic Location of the Seaport of Hamburg

## 7.1 *The Patterns of Accessibility*

### 7.1.1 *The Geographical Location*

The seaport city-region Hamburg is usually classified as a main port, which performs both seaport-related activities and high-level functions typical for a metropolitan region. These activities have a direct impact and a indirect impact on the spatial structure of the seaport region itself on different levels, such as the transport networks (railways, roads, inland waterways), the commercial, economic, financial relationships, as well as the social and cultural aspects of the region of Hamburg (Map 1).

A metropolitan area is defined as a geographical cluster of centres connected by a set of functional links [Marchese, 1996]. Every centre performs a various group of activities, such as business, financial, trade, transportation, recreation and others. In this sense, a cluster is a territorially defined area where the necessary activities of an advanced urban civil society are performed. It is useful to remark that there is a sort of interdependence among the different functions performed by each centre of the cluster, as well as the benefits of the functions realized by each centre spread out to the others and brings a positive influence to the cluster as a whole.

This characteristic can be defined as an holistic property of the cluster itself and can help to explain the success or the decay of an agglomeration through the time. An other remark to be made regards the concentration of the industrial and economic activities of the tertiary sector inside a metropolitan area and its specialization towards the service sector.

Every metropolitan area has got at least one focal centre. At this particular site, the most advanced functions are performed, such as managing, supervision, financial control, etc. With refer to the theory of central places of Christaller, the importance of a certain location may be defined by the number of functions it performs.

This functional structure depends on the brightness of the tributary area and therefore by the number of inhabitants that may be involved in the cluster activities, as well as by the complexity of their different needs.

Therefore, a metropolitan region may be defined as a metropolitan area and its area of influence. A functional region may be defined as a geographical area characterized by a network of mobility links among the inhabitants. These links are referred to the economic activities, the job-related movements, as well as to the more every-day-life. In order to define the boarder of a metropolitan region, it is useful to consider the movements of the commuters from/to the location under study.

The focal centre of the seaport metropolitan city-region Hamburg is equal to 755,3 km<sup>2</sup>. The region of Hamburg covers a total surface of 7.303,6 km<sup>2</sup>. It embraces the districts of Pinneberg, Segeberg, Storman, Herzogtum Lauenburg, Harburg and Stade<sup>29</sup>. According to the classification of the Statistisches Landesamt Hamburg, the metropolitan region corresponds to 10.696,8 km<sup>2</sup>. It includes also the districts of Lüneburg and Rotenburg (Wümme)<sup>30</sup>.

The focal centre has got a population of 1.704.731 inhabitants (31/12/1997) with a density of 2.257,3 inhabitants/km<sup>2</sup>. The region Hamburg has got 3.030.792 inhabitants (31/12/1997), and a density of 415 inhabitants/km<sup>2</sup>. The metropolitan region has got a population equal to 3.291.356 inhabitants, and a density of 308 inhabitants/km<sup>2</sup> (31/12/1994).

The impact of the port related activities on the seaport region is generally stable, and equal to 1 directly to 3 indirectly port related jobs.

The Ministry of Economy of Hamburg refers to the regional function that the seaport of Hamburg exploits towards the metropolitan city-region and its hinterland in terms of the structure of the labour force employed into the seaport economic activities.

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<sup>29</sup> These districts directly confine to the geographical administrative borders of Land of Hamburg.

<sup>30</sup> These two districts have no geographical boarder with the Land of Hamburg.

The number of jobs directly and indirectly related to the seaport activities of Hamburg are estimated to be 142.500, split as following:

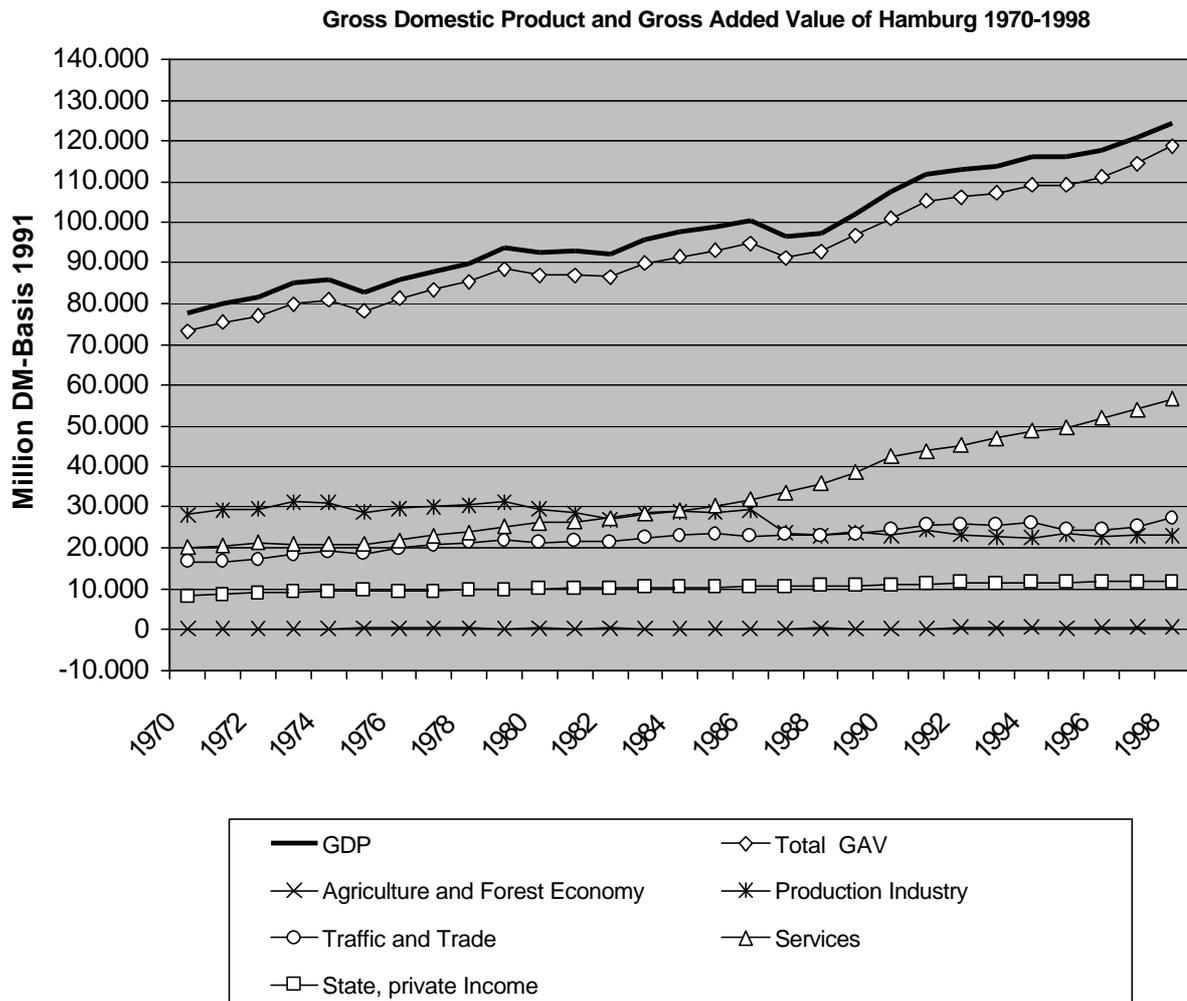
- 46.500 jobs are strictly related to the seaport activities, as follows:
  - 22.500 jobs in the sectors of the forwarders and warehouses.
  - 10.500 sailors.
  - 5.500 stevedores.
  - 8.000 jobs in other maritime sectors.
- 47.500 jobs are indirectly related to the seaport activities. They are referred to the building and traffic activities of production, as well as to the public building activities which are related to the seaport investments for the expansion and maintenance works of the seaport.
- 20.000 jobs are related to the seaport industries.
- 22.000 jobs are related to the trade, banks as well as insurance sectors.
- 6.500 jobs are related to the public administration, customs, railways, etc.

The seaport activities of Hamburg exploit a relevant role both on the level of the regional employment, and on the regional economic growth. In fact, the GDP the seaport related activities generate is proportionally higher than the quote of the GDP related to the other economic sectors of the Hamburg city-region.

Two main trends are notable with reference to the development of the employment in the maritime city-region Hamburg, i.e. a strong trend to the suburbanization, as well as the reallocation of the logistics functions towards the hinterland, that is towards the larger spatial agglomerations of industries and population. It follows that the volume of freight transit through the city-region is supposed to grow, but at the same time the net product had to decrease.

The Figure 7.1 shows the parallel growth of the GDP and the GAV of the city-region Hamburg during the period 1970-1998. The impact of the service sector on the local economy seems to follow the same trend.

Figure 7.1 – The GDP and the GAV of Hamburg 1970-1998.



### 7.1.2 The Process of Functional Restructuring of the Seaport Area

The extension of the whole seaport area of Hamburg (Map 1), the Upper and Lower Elbe included, is equivalent to about 8.700 hectares, which correspond to the 11,5% of the total land area of the Free and Hanseatic City of Hamburg. The total seaport area is equivalent to 7.425 hectares. They are split between 4.307 hectares of land area and 3.118 hectares of water surface. The extension of the utilized area of the seaport is equal to 6.506 hectares. They are split between 3.428 hectares of land area and 3.078 hectares of water surface.

The Free Port covers an area equal to 1.620 hectares. They are split into 960 hectares of land area and 660 of water surface. The extension of the water surfaces available for the maritime vessels corresponds to circa 2.052 hectares inside the utilized port area, of which 490 hectares are located inside the Free

Port area. The extension of the water surfaces available for the inland waterway vessels corresponds to circa 1.020 hectares inside the utilized seaport area, of which 170 hectares are located inside the Free Port area.

The share of destination of use of the utilized seaport area has been calculated for the year 2001 as the ratio of the extension of each seaport sector where different economic activities are settled to the fix total land area of the utilized seaport area (equal to 3.428 hectares). Then, the ratio obtained have been compared to the ratio of the year 1996 [Degrassi, 1997/98], as the Table 7.1 shows.

Table 7.1 – The ratio of destination of use in the utilized land area at the seaport Hamburg 1996, 2001.

Economic sector	2001 area	2001 ratio	1996 ratio
General cargo	704 ha	21%	21%
Bulk cargo	307 ha	10%	11%
Row material, oil industry	644 ha	19%	22%
Industries and business	528 ha	15%	15%
Transport infrastructures	488 ha	14%	16%
Altenwerder	205 ha	8%	-

A share of 21% is dedicated to the general cargo handling, containers included (704 hectares in the year 2001, 663 hectares in the year 1996, but the ratio did not change). A share of 10% is referred to the bulk cargo handling (354 hectares in the year 1996 and a share of 11%, 307 hectares in the year 2001). A share of 19% is dedicated to the row material and oil-processing industry (695 hectares in the year 1996 with a ratio of 22%, 644 hectares in the year 2001). A share of 15% is referred to other industrial and business enterprises (528 hectares in the year 2001, 483 hectares in the year 1996, but the ratio did not change). The transport infrastructures cover the 14% of the area (488 hectares in the year 2001, 495 hectares in the year 1996 with a ratio of 16%). The logistics centre Altenwerder under construction covers the 8% of the utilized area of the seaport, that is equivalent to 205 hectares [Nuhn, Oßenbrügge et al., 1983].

## **7.2 The Institutional Organization of the Port of Hamburg**

The maritime German ports are owned by the Municipality, which is the territorial body of the Land. For example, the two main seaports of Hamburg and Bremerhaven, which are the two major seaports of the Federal Republic of Germany, are directly administrated by their respective Land bodies. It has to be remarked that there is no port authority which has the competence for the administration of the port as a whole.

In general, in Germany the activity of the seaport is not seen from a microeconomic perspective, as it is in Great Britain. Around 70% of the British seaports are managed by a private administration [Scorza, 1994]. Therefore, the administration of a port is considered as any other entrepreneurial independent activity. On the contrary, in Germany the seaport is considered as an essential component of the regional economic infrastructures, because of the positive effects on the whole community. It follows that there is no port authority in the German seaports, because it is the local Government itself to be appointed to the port policy.

The Municipality of Hamburg exploits the management of the Hanseatic seaport within a regional framework. The aim of the Senat of Hamburg is to achieve the higher feed-back from the port activity and from the port-related activities, in terms of benefits for the whole region itself.

The local Land authorities of the port of Hamburg have a completely autonomy and independence in the financial and administrative matters on the port itself with respect to the Federal Government. In fact, there is no kind of port planning at a Federal level in Germany. The Federal Government is responsible only for the maintenance of the transport accessibility to the seaport, such as the deepening of the river Elbe, as well as for the great works on the transport network, such as the building of highways and railways.

Therefore, there is a clear separation between the activities of the different ministries of the Land for the planning and co-ordination of the port, for the managing of the maritime infrastructures and of the port area, for the administration of the public services, as well as for the guarantee of the competition between the various private operators of the port.

At Hamburg, the responsibility for the development and maintenance of the port infrastructures and superstructures is divided between different bodies. In fact, the administrative organization of the port of Hamburg has no vertical structure,

but there are several bodies, each of one exploits different degrees of responsibilities. There is no hierarchical dependence between these bodies, nor administrative, nor functional.

The Ministry of Economics of Hamburg has the responsibility for the daily administration of the port, within a regional framework of economic policy. The Ministry has the financial responsibility for the development of the port, for the construction and maintenance of the port infrastructures, for the determination of the port taxes and rents on the territorial properties of the Land, for the management of the traffic, as well as for the control of the seaport as a whole. The investments are made with the aim to promote the regional economy.

The terminal operations are managed by the private terminal operators of the port of Hamburg. In fact, there is a high degree of pulverization of the supply within this maritime sector, that is a remarkable factor for the promotion of the competition. The Convention UNCTAD on the responsibility of the transport operators on the international interchange defines the terminal operator as the operator of port services who has the right of use, also not exclusive, of a terminal, and who has a real control on the spaces for the deposit and warehousing of the goods [Confetra, 1997].

In Hamburg, the terminal operators manage the loading/unloading operations, the inter-modal and distribution activities. In the port of Hamburg, there are around 65 terminal operators and 436 forwarders. They have the competence about the building and maintenance of the superstructures of the seaport. The superstructures are defined in terms of all the terminal equipment that is necessary in order to exploit the terminal operation, and that is not provided by the competent Ministries of the Land of Hamburg. The terminal operators are responsible for the provision and the maintenance of the superstructures, such as cranes, warehouses, footropes, cranes for containers, lorries, rail tracks, roads, and other equipments, on the port areas they rent from the Land of Hamburg.

The current organization of the port of Hamburg was due to the restructuring of the port in the year 1970 following the promulgation of the Port Regulations - Hamburger Hafenordnung by the Parliament of Hamburg. Before the year 1970, the HHLA - Hamburger Hafen- und Lagerhaus AG was the only terminal operator in the port of Hamburg. The private firms of the port was obliged to sub-contract their activities from the HHLA, according to its tariffs. The Port Regulations of the year 1970 transformed the HHLA into a holding society. The Senat of Hamburg owns the 100% of the shares of its capital. The Port

Regulations is aimed to assure the fair competition between the port operators; defines the different responsibilities between the State and the port economy; splits the financial competences. Due to the fact that the Senat of Hamburg has the wholly ownership of the capital of the HHLA, it follows that it is directly involved into the commercial operations of the port. This ownership has been seen as an instrument of port policy in order to elude the influence of any foreign terminal operator, or any international shipping company, on the development of the port of Hamburg, which could be against the economic interests of the port itself. The HHLA is the major terminal operator of the port of Hamburg. It handles around the 70% of the container traffic of the port. The second larger terminal operator is the private company Eurogate, that handles around 25% of the container traffic of the port of Hamburg.

### ***7.2.1 The Strategies of Regional Policy of the Senat of Hamburg***

The location choice of the shipping companies on their stopping calls are influenced by many different factors, such as the geographic accessibility to seaport site, the availability of modern port equipment, the presence and the stage of development of the links towards the hinterland. In fact, the location of the port of Hamburg after the end of the war was not favourable in order to attract the maritime traffic towards the European continent [Hoyle et al, 1981]. From the point of view of the transport economy, the building of the infrastructures<sup>31</sup> is the first stage, or essential stage, for the production of the transportation activity. The second stage is the real supply of the service [Marchese, 1996].

The geographical location of a port is just one of the many elements of influence that the shipping companies, and the land operators of the transport sector evaluate when they perform the location choice for the stopping calls or the building of their industrial and commercial complex.

The oceanic freightage includes the transport costs, the costs of loading/unloading of the cargo, and the port fees that are borne by the transport operator. They have an incidence of around 62% on the total cost of transport. The inland freightage, instead, are around 28%, while the port fees and the

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<sup>31</sup> The infrastructures are for example the parts of the way that are used for the transport activity, as well as the parts of the terminal points.

other costs are around 10% [Bird, 1971]. It follows that the ports are not able to compete with each others on the local fees. The competition between seaports has to be more qualitative. Every maritime site has to renew continuously its port equipment and infrastructures by following the most recent technological innovations in the sector, in order to stay in competition with the others.

The main aim of the port policy of the Land of Hamburg after the year 1945 was the re-launching of its seaport. In order to attract the port users, the Senat pointed out the nature and the quality of the port services that was supplied, as well as the competitive costs for their use. Two fundamental approaches was used, as follows:

1. The necessity of minimising and counterbalance the negative effects due to the disadvantageous geo-political location, with the aim to attract the traffic of the European Community [Hamburger Senat, 1967].
2. The strong object to build the port of Hamburg as a nodal point for the transit of the cargoes towards the non-European Community countries [Behörde für Wirtschaft und Verkehr, 1966].

The Senat of Hamburg promoted a set of initiatives at the regional level, in order to counterbalance the geographical unfavourable location of its port, as it is explained in the following paragraphs.

#### **The expansion of the inter-regional transport network**

The development and improvement of the inter-regional transport network was the priority step for the Municipality of Hamburg. It is important to notice that this objective of regional policy exceeds the specific competences of the Land of Hamburg, because the works to be made are out of the administrative borders of the Land. Therefore, it is the Federal Government to be competent for these works.

The Senat asked for these development works during all the 50s, and just in the 60s the Federal Government started a program of investments which remarkably improved the transport links of Hamburg to the rest of Germany. At the end of 70s, the following highways were completed: the A5-A7 Hafraba (acronym for HAMBURG-FRANKFURT-BASEL), the A7 Röhn Linie (Hersfeld-Fulda-Würzburg), and the A1 Hansa Linie (Hamburg-Osnabrück-Ruhrgebiet). Therefore, the time of access by road towards Hamburg was sensibly reduced.

Furthermore, the port area was linked to the highway system, and it was implemented the number of transit points over and under the Elbe. On the land side, the transit under the river Elbe through the Elbtunnel and over the river through the bridges, remains a bottleneck for the whole urban transport system.

The railways network towards the Ruhr area and the Southern Germany was progressively electrified. Its efficiency grew up of 20%. On the contrary, there is a lack in the electrification of the tracks towards North, that is towards the Land of Schleswig-Holstein.

The development of the inland waterways was quite difficult. The Lateral Canal of the river Elbe was completed in the year 1976. The Land of Hamburg gave a financial contribution equal to one third of its cost of construction. The Lateral Canal is 113 km long, and it links directly the Hanseatic City to the Mittelland Canal a few kms West from the city of Wolfsburg. The European standard barges till 1350 tons of loading capacity can navigate through the Canal. The Lateral Canal links Hamburg to the Lower Saxony and to the whole European system of inland waterways through the Mittelland Canal. It cuts off 40 km the link towards Magdeburg with respect to the transit on the river Elbe.

#### **The construction of advanced port equipments**

The second strategy of the Senat of Hamburg in order to attract the port users is to guarantee the supply of the most technologically advanced port equipments and infrastructures [Bird, 1971]. This port policy can be realized in two ways: a) the financial availability of the Land of Hamburg, that operates according to a long-term planning of the infrastructures; b) the necessary complementary investments in the port superstructures, that have to be made by the private port operators.

As Bird remarks, there is a temporal divergence between the investments in the infrastructures and superstructures. The planning for the infrastructures requires a long-term approach (many years, decades). In fact, the planning activity has to forecast the future needs of the seaport according to the technological changes in the maritime sector, as well as to the economic developments in the sector of the freight transport at a global level. The long-term approach requires a huge amount of financial investments for the construction of big parts of the port infrastructures.

On the contrary, the investments in the port superstructures are much more elastic and flexible during the time. They can be realized in a relatively short

time, while the financial forecasts are referred on the short-medium term. Therefore, the capital availability for investments is sensibly lower.

The Land of Hamburg had strongly invested its financial capital in the port infrastructures. Therefore, the Senat had a relevant role for the development of port, and for the promotion of its economic activity at the international level.

The port site is both a transit node for the freight traffic, and a site where the value added can be generated by the port industries, and where the logistics activities are performed, such as the distribution activity [Richter, 1996].

The Senat chose to develop the logistics function at the port of Hamburg [Senat, Hafenentwicklungsplan, 1997]. The volume and quality of the investments needed in the port hinterland are dependent on this choice. Two elements influence the evaluations on the investments for port infrastructures, the improvements in the accessibility to the port by the river Elbe, and the transport links towards the hinterland.

The first element regards the variations in the qualitative structure of the other German seaports in competition, as well as the spatial influence of them on the regional hinterland. These changes implied a reorganization of the demand of the transport services of the maritime sector, according to the forecasting of growing volumes of goods handled at those terminal sites.

The second aspect refers to the transshipment function at the seaport. In fact, it has been noted the growth in the number of the entrepreneurial relationships, due to the restructuring of the foreign trade, as well as of the foreign production. This higher intensity of inter-relationships had obviously a relevant impact on the maritime transport sector.

#### **The availability of free lands for the future expansions**

A third instrument of port policy, in order to attract the port users, is to assure the availability of free areas for the expansions of the seaport in the future. The Senat of Hamburg plans this kind of activity in the very long-term (few decades), in order to have a flexible administration of the port area that it owns, as well as to be able to have a prompt reaction to the exogenous changes of the competition in the international market.

The Free and Hanseatic City of Hamburg is entrusted by the Port Development Act – Hafen Entwicklung Gesetz-Hafen EG, of the public duty to use durably the available lands of the port area, with the aim to pursue the economic interests of

the port itself. At the same time, this Act fixes the administrative boundaries of the port area. Exclusively the port area falls within the competence of the administration of the Land of Hamburg [Wirtschaftsbehörde, 1997].

In fact, the Senat always kept care the availability of large territories for port expansions along the riverside of the Norderelbe. The more recent territorial expansion of the port of Hamburg is the new logistic site of Altenwerder, under construction. This is a good example of an irreversible impact on the environment of the transport activity, but that is supposed to be sustainable for the economic growth of the region.

### **7.3 *The Dynamic of the Labour Market of the Maritime Sector at the Port of Hamburg***

#### **7.3.1 *The Characteristics of the Port Labour***

The port labour is distinguished from the others sector of the economy because of some peculiarities, as follows:

1. *The high degree of instability.*

It is noticed both at the macroeconomic level, within the port sector globally, and at the microeconomic level, within the single firms. There are, in fact, variations in the short time (weeks, days), as well as in the very short time (hours). These temporal uncertainty are correlated mainly to the arrival schedules of the vessels.

2. *The discontinuous temporal distribution of the port labour.*

Because of the nature of the port services, no stock of the port service can be made. It follows that the port services must be supplied just when there is the demand for them.

3. *The difficulty of planning the employment of the factor of production labour.*

Due to the huge and growing mechanization of the port activities, during the last year the demand for specialized workers by the firms of the port sector is sensibly grown. Anyway, there is a low availability of port

workers with an adequate degree of professional training. This lack of specialized personnel did not avoid the escape from the port sector, first of all because of the seasonal character, hence unstable, typical of the demand for port labour.

### **7.3.2 The Restructuring Process of the Port Labour at Hamburg**

With reference to the sector of the port labour of Hamburg, it is remarkable to note that it does not exist a specific body responsible for it. In fact, there is no precise data on the number of workers of the maritime sector of the Hanseatic City. The only precise data that are available refer to the Gesamthafenbetrieb-Gesellschaft mbH Hamburg GHBG. The GHBG can be seen as an economic subject which acts as a buffer between the workers and the port companies. By the jurisdictional side, the GHBG takes the form of a limited liability company. By the economic side, it is able to response to the variations of the market, because: a) on one side, it gives a permanent position to the port workers, hence it assures the employment; and b) on the other side, it absorbs the problems of the single terminal operators that are related to the flexibility of the labour market.

In the year 1936, the total number of the port workers of the port of Hamburg was equal to 16.705 units, of which:

- Port workers of the terminal operators:  
Hafeneinzelbetriebsarbeiter HEB: 53,8%  
It is equal to the quote of the port workers that have a permanent position at any of the private terminal operators of the port.
- Port workers of the GHBG:  
Gesamthafenarbeiter GHBG: 46,2%  
It is the quote of the port workers that is used to cover the demand for temporary workers from the different terminal operators.

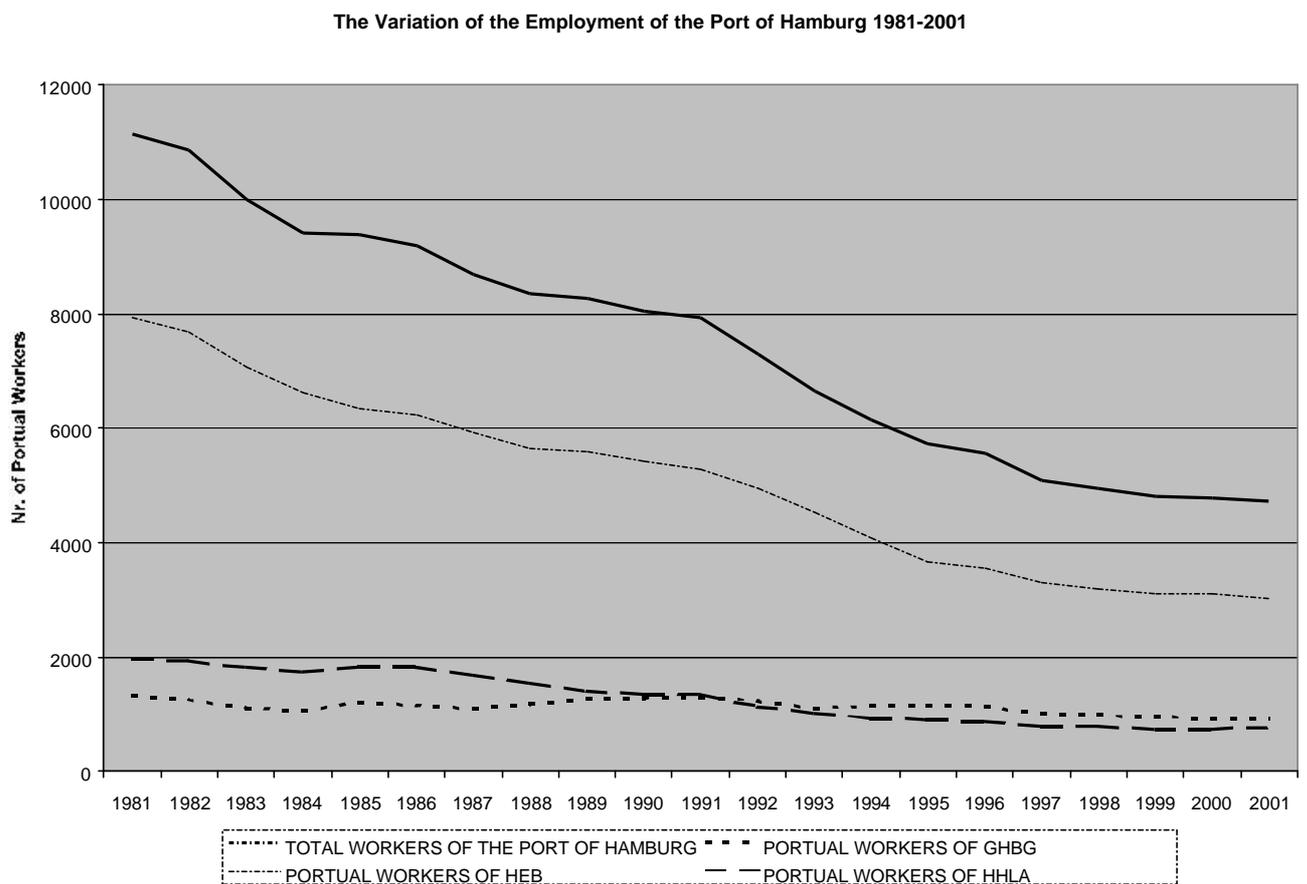
On the 3<sup>rd</sup> August, 1950 it was issued a Federal law for the restructuring the sector of the port labour. In the year 1951, thanks to this law and an agreement between the Transport Unions ÖTV and the private terminal operators, the Gesamthafenbetrieb Hamburg GHB was founded in its actual form. Similar associations was founded in the ports of Emden, Bremen-Bremerhaven, Lübeck, and Kiel. At the moment, only two of them are still operative, that is the GHB of Hamburg and of Bremen-Bremerhaven.

The number of port workers of the transshipment sector of the port of Hamburg has been constantly declining during the past few decades, as the Figure 7.2 and Figure 7.3 shows.

In the year 1981, the number of workers of the transshipment sector of the port of Hamburg was equal to 11.225 units, of which the 11,83% of the workers was employed in the GHBG, the 17,57% in the HHLA, and the 70,60% in the HEB.

After ten years, the total number of port workers fell of 29,43%, equal to 7.921 units. In the year 1991, the quote of the GHBG was of 16,37%, of the HHLA of 16,94%, and of the HEB of 66,68%.

Figure 7.2 – The dynamic of the labour market of the port of Hamburg 1981-2001.



In the year 2000, the number of total port workers was 4.797, that corresponded to a reduction of 39,82% with respect to the year 1991, and of 57,53% with respect to the year 1981. In the year 2000, the 19,66% of the total port workers was employed by the GHBG, the 64,82% by the HEB, and the 15,52% by the HHLA.

The data of the year 2001 are referred to the 30<sup>th</sup> September. The number of total port workers was 4710 units, of which 915 workers of the GHBG, 3.026 of the HEB, and 769 of the HHLA.

Figure 7.3 – The percentage variation of the port workers of Hamburg 1981-2001.



The negative trend of the labour sector of the port of Hamburg is shown in the Figure 7.3, where the percentage variation of workers are almost negative, with the exception of the GHBG and HHLA for some years. It has to be noticed as these data reflect the definition of port worker according to the statute of the GHBG of the year 1969, not yet revised. The statute defines precisely the fundamental concepts of “port activity”, of “private terminal operator”, and of “port worker”. In particular, they are port workers all the personnel who exploits the following port activities: stevedores; personnel working for the terminal operators; warehouse keepers; tallymen; staff employed for the cleaning of the holds and stokeholds, and for the painting of the vessels; personnel for the maritime transport within the port; staff employed for the mooring at the berths.

Afterwards, the technological and managerial innovations in the maritime sector induced the changing in the structure of the port labour. Therefore, the formal definition of “port activity” and of “port workers” of the statute lose of meaning. In the year 1989, the Federal Tribunal of Labour - Bundesarbeitsgericht pointed out the presence of a quote of “non-port workers”. These workers exploited the new economic activities of the maritime sector, but they were not legally protected by the law of the GHBG, because their activity was not embraced into the formal definition of “port activity” of the statute.

During the following years, the forwarding agents and the personnel of the storehouses were included into the statute. Furthermore, in the year 1990, the workers of the sector of the transshipment of the container, and of the maritime sector of the distribution of the imported/exported cargo, were absorbed into the statute of the GHBG.

During the last decade, the new sector of the logistics and distribution emerged, a further “non-port activity” with respect to the definition of the statute. The GHBG proposed the definition of three sectors of port activities, as follows: “transshipment - container services - logistics and distribution”. The inclusion of the container services in the statute is supposed to have such synergic effects between the transshipment and the container sector, because of the positive impact on the personnel, the organization, and the administration. Alternatively, the division in two sectors, such as “transshipment – logistics and distribution”, would be probably a less clear and comprehensive definition.

## **7.4 The Regional Economic Role of the Local Entrepreneurship**

### **7.4.1 The Foreign Trade of the Enterprises of Hamburg**

The main port Hamburg exploits the gateway function both at the international level for the Baltic Sea Region and the Central and Eastern Europe, as well as at the local level for the seaport city-region Hamburg. The foreign trade generated by the local enterprises of Hamburg is an interesting and useful indicator of the impact of the entrepreneurship of Hamburg on the city-region (Figure 7.4).

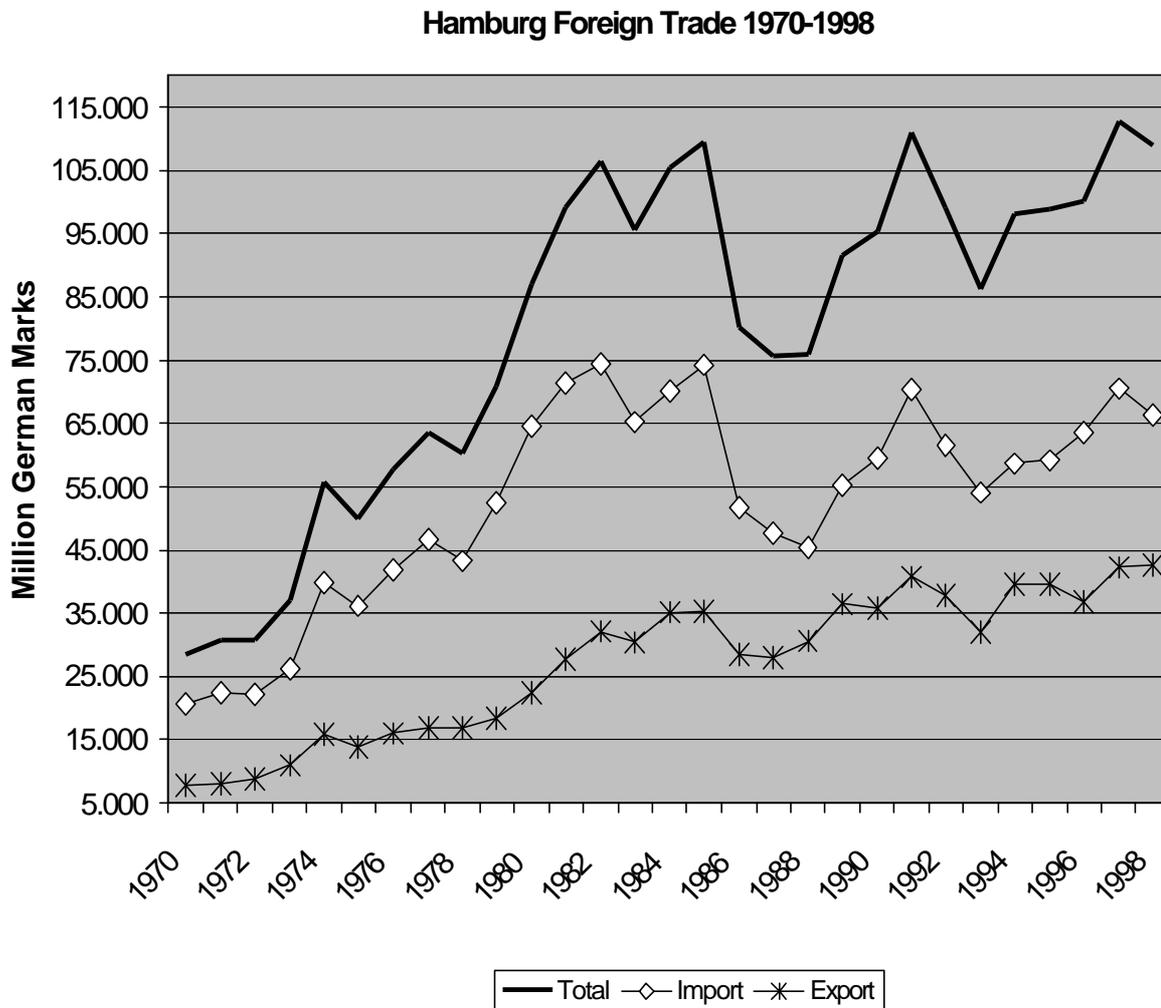
According to the methodology in use by the Statistisches Landesamt of the Free and Hanseatic City of Hamburg, the Hamburg foreign trade is defined as the commodities exported or imported through the custom houses of the Hanseatic city exclusively by Hamburg business enterprises. It is made no differentiation between commercial business and producers.

Two kinds of statistics are available: a) statistics with reference to the volume of the cargo, expressed by the net tonnage; and b) statistics which report the monetary value of the goods. The monetary value of the cargo is usually expressed in million of German marks. It is estimated according to the monetary value of the goods on the basis of the customs declarations.

The Hamburg foreign trade is defined in terms of general trade. The general trade is split into imports, which show the monetary value of the cargo that a local Hamburg enterprise receives from a foreign country; and exports, which show the monetary value of the cargo that a local Hamburg enterprise delivers towards a foreign destination, which is located outside the boundaries of the Federal Republic of Germany. The monetary value of the cargo is comprehensive of the free cargo traffic and the storage of freights.

The Figure 7.4 shows the Hamburg foreign trade since the year 1970 until the year 1998 [Statistisches Landesamt, 1999]. It is split into imports and exports of the local Hamburg enterprises. At a regional level, the import function of the seaport Hamburg for the local commercial and production operators is plain, both in terms of monetary value, and in the long-period trend between the total foreign trade and the imports.

Figure 7.4 – The foreign trade of the enterprises of Hamburg 1970-1998.

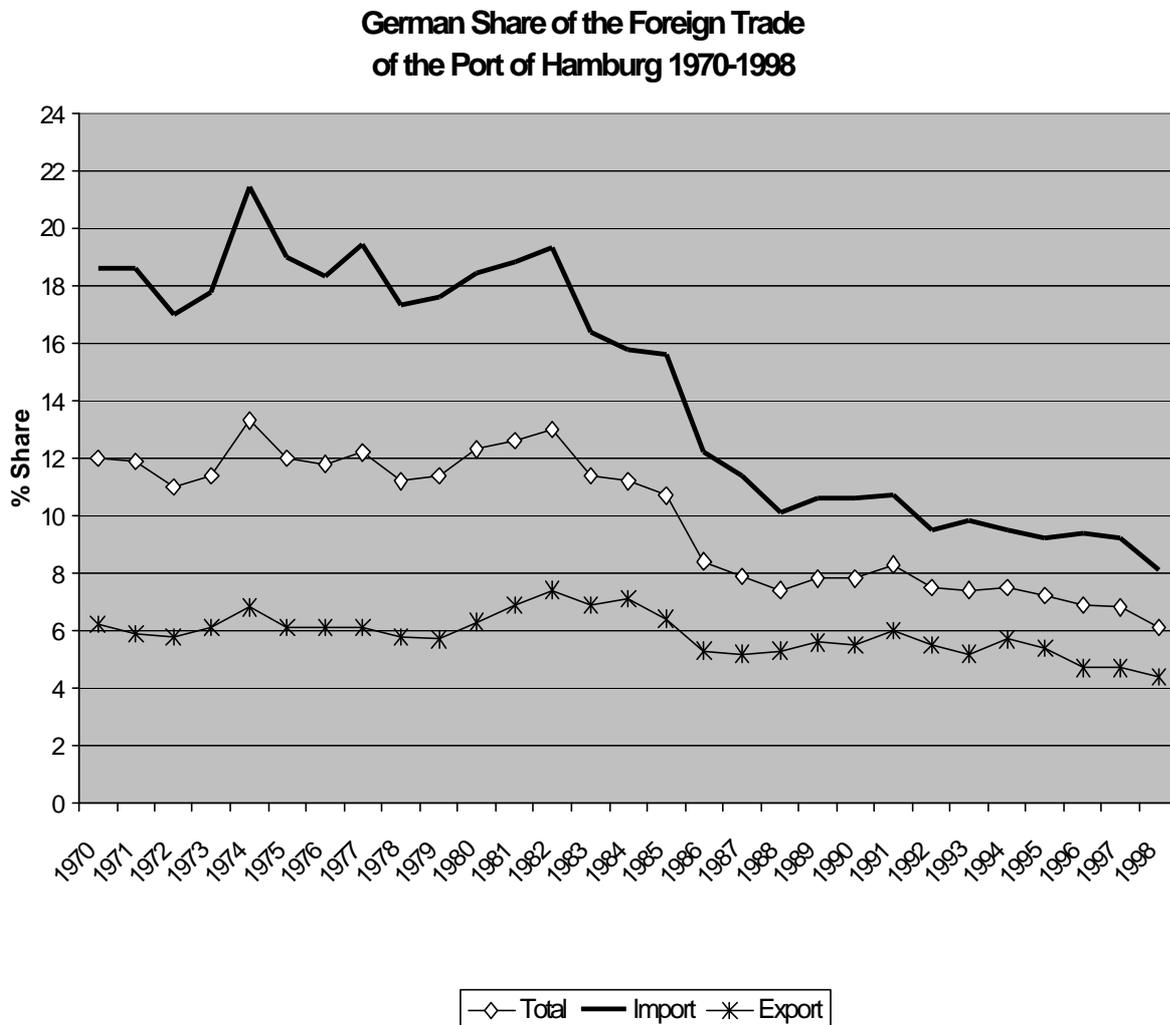


With respect to the total foreign trade of the Federal Republic of Germany, the Hamburg foreign trade shows a negative trend in the long period. The positive correlation between the share of the total foreign trade and the share of the imports remains. The Figure 7.5 shows in particular the ratio of the total foreign trade of Hamburg with respect to the total foreign

trade of Germany, of the Hamburg imports with respect to the German imports, and of the Hamburg exports with respect to the German exports.

The trend is towards a convergence of the shares of trade since the 80s, although the ratio of the Hamburg imports on the total imports of the Federal Republic of Germany has a dominant role with respect to the export share for the local business enterprises of Hamburg.

Figure 7.5 – The share of the foreign trade of Hamburg on the German foreign trade 1970-1998.



The Figure 7.6 and the Figure 7.7 show the geographical split of the Hamburg foreign trade since the year 1970 until the year 1998 [Statistisches Landesamt, 1999]. The European continent as a whole is the first commercial partner, both for the imports and exports of Hamburg, which the local business generates. The import and export of the European Union are distinguished as a share of the general trade of the whole Europe. The countries of the European Union had a share of 51%, equivalent to 55.565 million marks, with respect to the total Hamburg foreign trade, equal to 108.972 million marks, in the year 1998. The countries of the East Asia had a share of 13% (14.194 million marks), the USA of 9,3% (10.191 million marks), and the Central and Eastern European countries had a share of 7,6% (8.266 million marks).

Figure 7.6 – The geographical split of the imports of the enterprises of Hamburg 1970-1998.

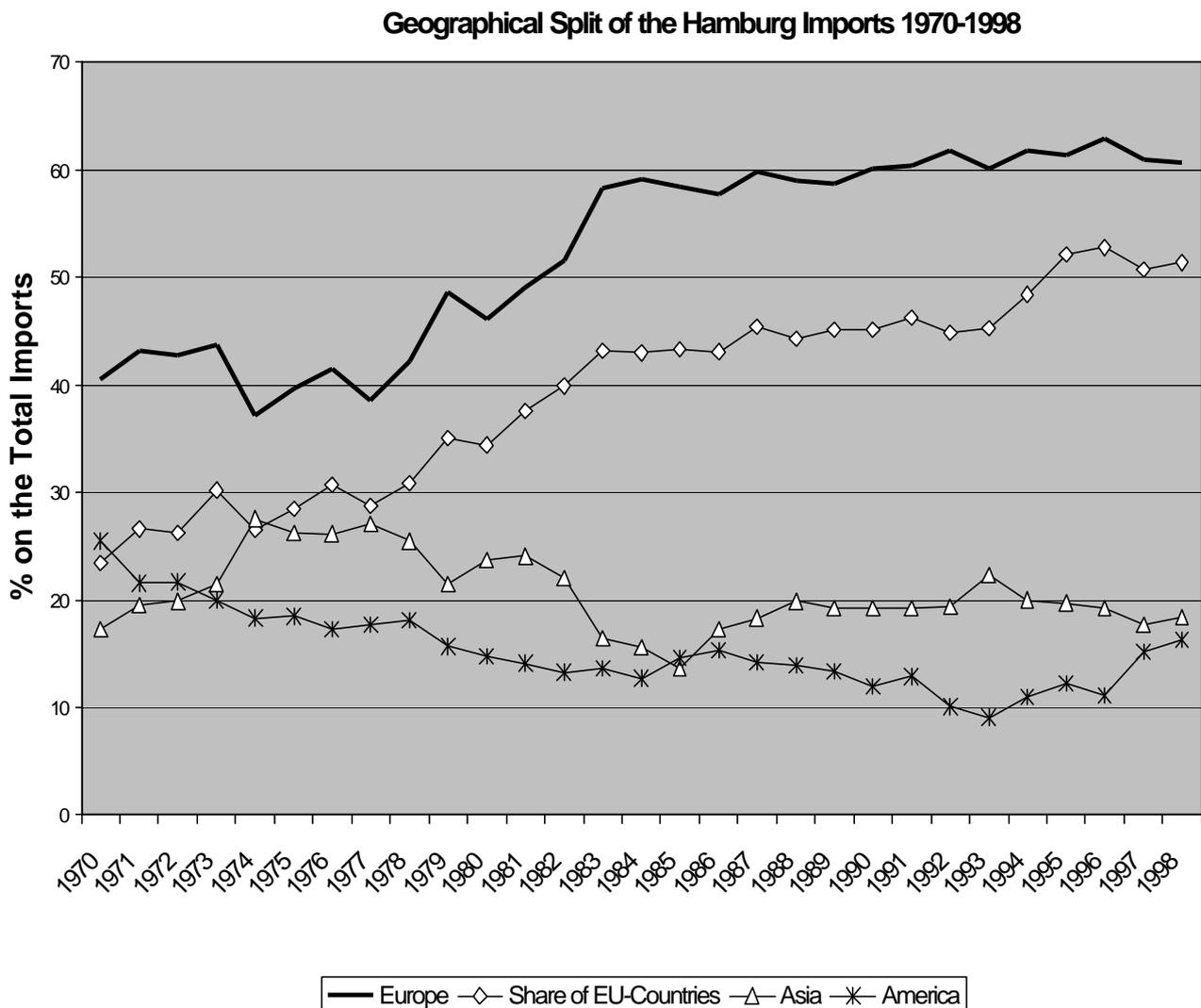
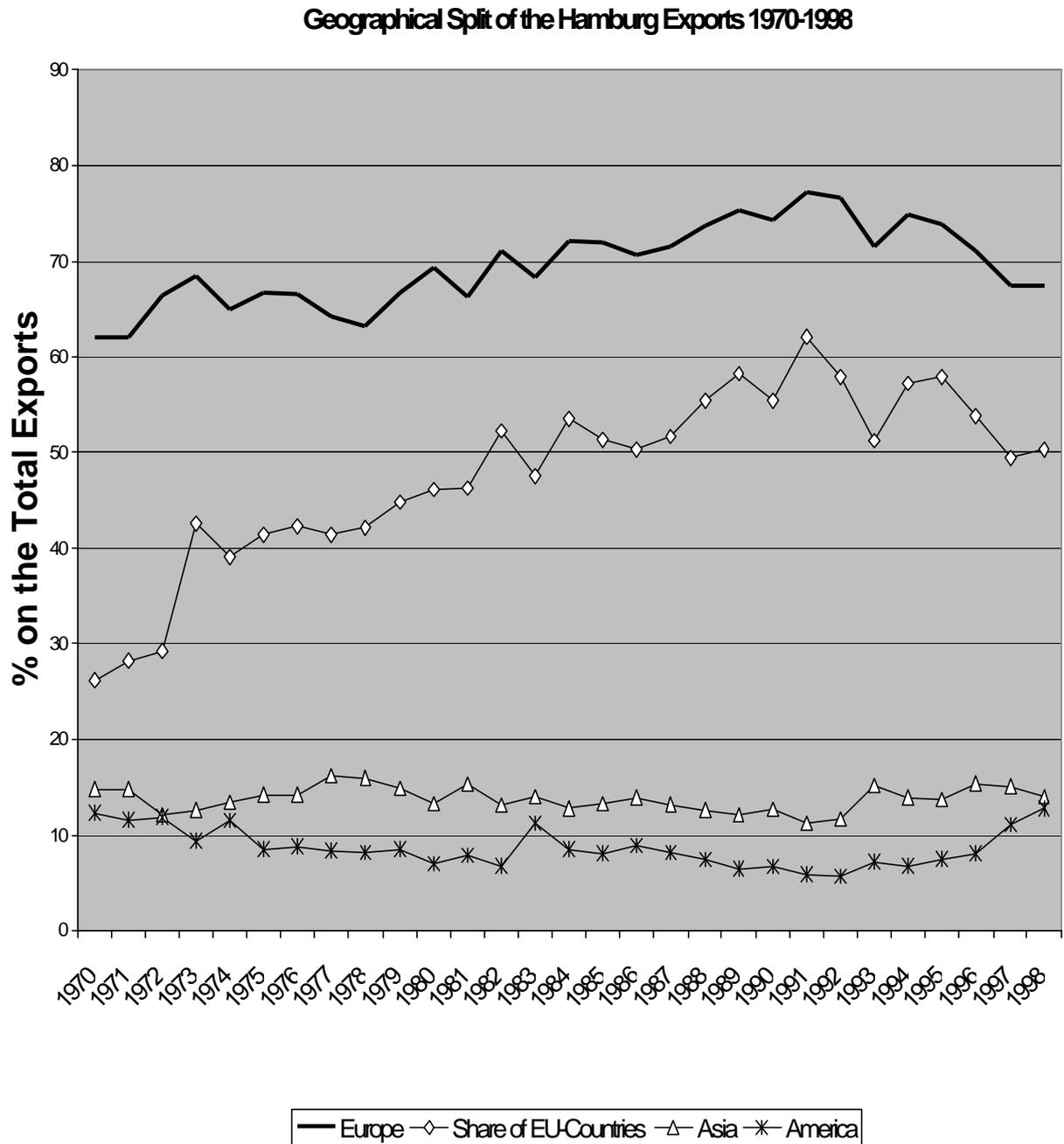


Figure 7.7 – The geographical split of the exports of the Hamburg enterprises 1970-1998.



The value of the imports of the EU was equal to 34.125 million marks in the year 1998, while the import share was equal to 51,4%. The most important import partners for the year 1998 for the local Hamburg enterprises outside the European Union were the following: the American continent with a value of the imports equal to 10.807 million marks and an import share of 16,3%, Asia with a value of the imports equal to 12.197 million marks and an import share of 18,4%, of which the East Asia with a value of the imports of 9.663 million marks and an import share of 14,6% (Figure 7.6).

The total value of the Hamburg imports was equivalent to 66.359 million marks in the year 1998, that corresponds to a rate of 8,1% with respect to the German imports. A positive trend as well as a positive correlation between the import quote on the European continent and the import share of the EU-countries is plain.

The Figure 7.7 plots the geographical split of the exports of the enterprises settled in the seaport city-region Hamburg since the year 1970 to the year 1998.

The value of the Hamburg export was equal to 42.613 million marks in the year 1998, i.e. a rate of 4,4% with respect to the German exports. During the year 1998, the total cargo value delivered towards the countries of the European Union was equal to 21.440 million marks (i.e. an export share of 50,3%), while towards the Central and Eastern European countries was equal to 4.648 million marks (i.e. an export share of 10,9%).

The total value of the cargo delivered towards the USA was equal to 3.363 million marks in the year 1998 (i.e. an export share of 7,9%). It shows a ratio of growth equal to +105,3% during the last two years<sup>32</sup>.

#### ***7.4.2 The Geographic Hinterland of the Local Enterprises of Hamburg in terms of Added Value***

The improvement in the transport networks that link the seaport city-region Hamburg towards its economic hinterland are one of the instrument of economic policy the government of Hamburg used in order to promote

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<sup>32</sup> A ratio of growth equal to +37,5% for the period 1997/96, and equal to +49,26% during the period 1998/97.

the economic growth of the city-region, as well as to achieve the social goal of the welfare of its citizens.

The good quality of the transport infrastructure is absolutely necessary when the gateway function of the seaport is stressed, in particular under the just-in-time constraints, the requirements of the inter-modal transport system, as well as the growing use of the containers.

At the same time, the reduction in the transport costs accomplished cheaper delivering of the bulk cargo, such as raw materials, towards the deeper inland destinations. At such locations, the more favourable economic conditions, such as the cheaper cost of the land, promoted the reallocation, as well as the spatial clustering of the big industrial activities.

The impact on the seaport city-region may be seen in terms of the logistics restructuring process, which stimulates the development of new economic functions inside the seaport city-region itself.

In order to achieve both the economic growth and the social welfare at the local level, the local authorities chose new instruments of economic policy. They offer a set of value added logistics services in order to integrate the seaport site into the transport logistics chain. The seaport location has not to be only a container flood gate, but has to be transformed in a logistics service centre.

The analysis of the exports of the special trade of Hamburg seems to be the most appropriate indicator in order to evaluate the effectiveness of the policy instruments during the functional restructuring process.

According to the methodology of the Statistisches Landesamt of the Free and Hanseatic City of Hamburg, the exports of the Land of Hamburg are defined in terms of special trade. The special trade takes into account only the goods that have been manufactured or end-processed inside the Land of Hamburg, and consequently changed their typology or economic destination. The special trade, therefore, is a useful indicator of the added value generated inside the Land of Hamburg, although it is not exclusively referred to the seaport related activities.

The special trade of Hamburg grew up to 32.993 million marks in the year 1999 (+10,9%) versus the previous year (29.750 million marks).

The share of the special trade delivered from the Hanseatic city towards the EU-member countries grew of +10,7% in the year 1999 (24.508 million marks) with respect to the year 1998 (22.134 million marks). The Euroland share grew up to 18.242 million marks, equivalent to a variation of +13,7% with respect to the year 1998 (16.051 million marks).

France was the first import country with 12.487 million marks and a growth of +12,6% in the year 1999 versus the year 1998, mainly given by the air-craft industry. This share corresponded to circa one third of the total value of the exports of the special trade of Hamburg in the year 1999.

The United Kingdom received goods for a value of 1.946 million marks (+14,6%), while Belgium and Luxembourg for 1.081 million marks with a growth of +169,6% in the year 1999 versus the previous year. About the BSR, Finland had a growth of +248%, from 198 million marks in the year 1998 to 689 million marks in the year 1999.

Sweden and Norway bought goods from Hamburg respectively for a value of 321 million marks (-13,2%) and 118 million marks (-21,3%) during the year 1999, while Denmark for 508 million marks. If the Central and Eastern European countries are considered, then Poland imported goods for a value equal to 524 million marks (-20,5%), the Czech Republic for 292 million marks (+5,8%), while Russia for 316 million marks (-17,9%) in the last year.

Outside Europe, the USA bought goods for a value of the special trade equal to 4.134 million marks with a growth of +59,8% in the year 1999 with respect to the year 1998. Asia as a whole imported goods for 2.594 million marks (-3,9%) in the year 1999, while the geographical area of the ASEAN countries bought goods for 391 million marks (+25,3%), Japan for 566 million marks (+18,7%).

Table 7.2 – The geographic split of the value added generated by the local firms of Hamburg, as special trade, for consumers countries, 1970-2000.

Year	Total special trade	of which towards									
		Europe	of which towards					America	of which towards		
			EU	France	Nether lands	EFTA	Central, Eastern Europe		North America	USA	Central, South America
Millions DM											
1970	3 535	2 502	1 129	394	234	1 039	115	395	234	207	161
1971	3 687	2 640	1 079	313	360	1 031	152	406	206	183	200
1972	3 949	2 846	1 174	361	374	1 185	167	484	237	209	247
1973	5 037	3 730	2 399	578	460	686	293	518	263	242	255
1974	6 967	4 846	2 942	575	685	923	517	855	479	450	376
1975	5 990	4 394	2 698	499	575	798	502	517	320	284	197
1976	6 892	4 972	3 171	800	638	1 082	305	638	325	268	313
1977	7 138	4 799	2 975	797	769	932	461	618	355	319	263
1978	7 203	4 692	3 134	811	772	933	300	654	365	335	289
1979	7 177	4 913	3 203	751	705	998	318	706	340	304	366
1980	8 552	6 146	4 064	920	871	1 238	381	704	370	333	334
1981	9 720	6 222	4 182	1 035	795	1 249	427	920	540	491	380
1982	10 662	6 844	4 408	1 219	784	1 538	443	1 182	619	565	563
1983	12 019	6 870	4 748	1 420	855	1 268	424	2 533	653	600	1 880
1984	12 465	7 486	5 102	1 280	991	1 487	436	1 840	941	874	899
1985	12 105	7 632	5 222	1 206	1 027	1 644	468	1 474	971	898	503
1986	10 932	7 302	4 913	1 336	837	1 728	411	1 362	895	802	467
1987	10 450	7 342	4 763	1 224	735	1 502	462	1 245	830	780	415
1988	10 835	7 632	5 426	1 647	818	1 629	350	1 222	940	865	282
1989	11 979	8 449	5 691	1 856	828	1 968	193	1 176	875	806	301
1990	12 021	8 522	5 817	2 024	879	1 670	324	1 249	822	749	427
1991	12 941	9 183	6 502	2 202	1 029	1 570	761	1 288	803	751	485
1992	12 545	8 990	5 983	2 095	924	1 500	1 194	1 130	757	699	373
1993	11 835	9 692	5 186	2 536	845	1 364	1 047	1 102	782	744	320
1994	13 306	9 108	7 140	2 035	842	1 393	1 089	1 254	845	809	409
1995	16 070	11 883	8 700	3 572	849	950	1 195	1 221	856	813	365
1996	19 436	14 751	11 745	5 971	1 030	784	1 587	1 397	936	828	461
1997	25 034	18 230	14 740	8 059	1 242	992	2 023	3 058	2 662	1 408	395
1998	29 751	22 136	18 772	11 239	1 154	687	1 948	3 881	3 392	2 587	490
1999	32 993	24 508	21 130	12 487	1 078	717	1 606	5 020	4 204	4 134	816
2000	38 994	27 703	24 755	13 646	1 323	-	1 862	6 666	-	5 989	-

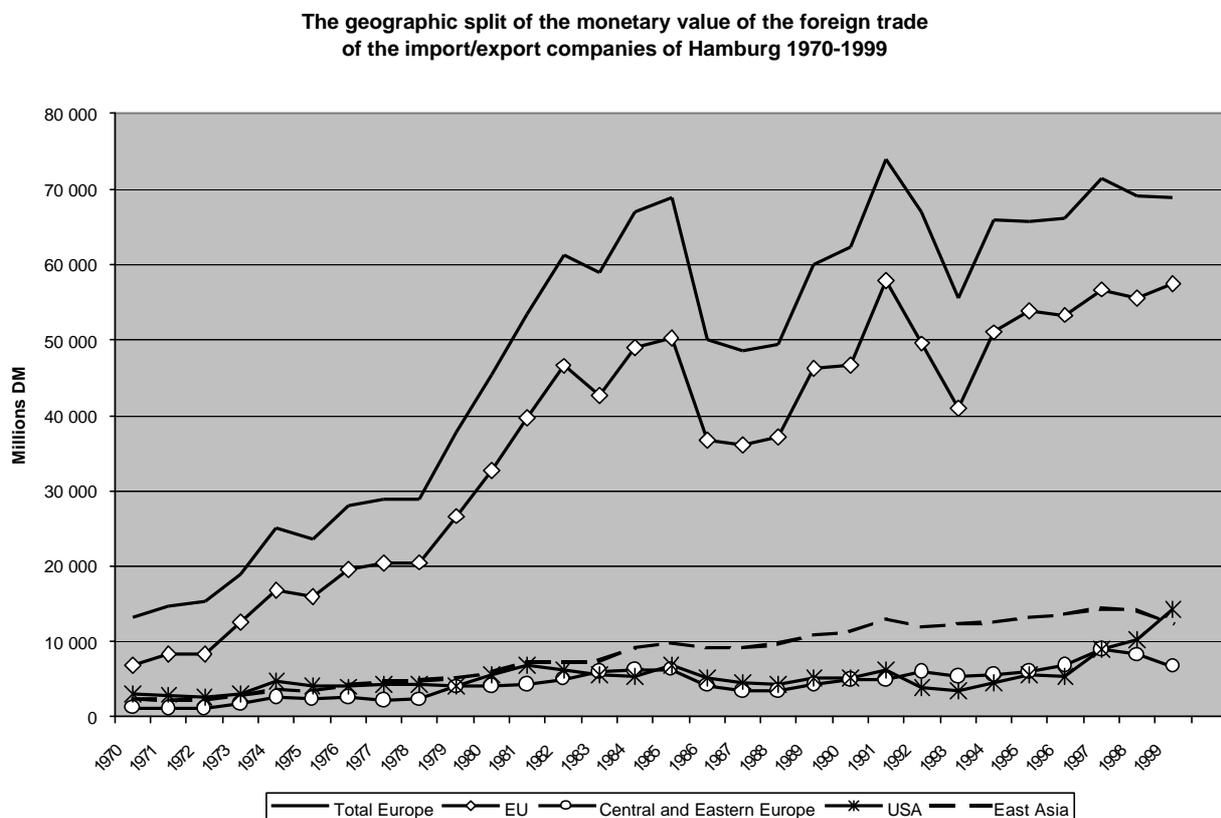
Table 7.2 – Second part: The geographic split of the value added generated by the local firms of Hamburg, as special trade, for consumers countries, 1970-2000.

Year	Total special trade	of which towards							
		Africa	Asia	of which towards					Australia, Oceania
				Near East	Middle East	Far East	of which towards		
Millions DM									
				China	Japan				
1970	3 535	266	340	-	-	-	81	60	32
1971	3 687	297	313	129	41	143	48	45	31
1972	3 949	249	327	123	49	155	15	51	43
1973	5 037	337	411	133	56	222	35	84	41
1974	6 967	610	580	187	103	289	30	108	78
1975	5 990	457	582	286	90	206	15	71	39
1976	6 892	507	711	378	108	225	7	84	65
1977	7 138	591	976	404	250	325	24	120	139
1978	7 203	706	977	380	194	404	70	110	174
1979	7 177	691	770	328	111	330	24	103	98
1980	8 552	737	893	450	108	335	11	105	72
1981	9 720	1 357	1 144	577	157	409	27	143	76
1982	10 662	1 074	1 478	578	282	618	42	171	84
1983	12 019	780	1 756	720	308	728	155	152	80
1984	12 465	1 098	1 958	742	430	786	117	246	83
1985	12 105	854	2 004	615	399	990	290	226	141
1986	10 932	618	1 559	402	286	871	251	249	91
1987	10 450	419	1 365	274	136	855	185	252	80
1988	10 835	444	1 449	359	155	935	124	266	77
1989	11 979	538	1 710	374	130	1 206	130	350	95
1990	12 021	474	1 695	427	162	1 106	77	341	68
1991	12 941	501	1 871	553	136	1 181	120	296	84
1992	12 545	479	1 860	474	140	1 246	156	255	68
1993	11 835	378	2 149	447	195	1 507	341	233	244
1994	13 306	318	2 478	534	227	1 717	656	319	91
1995	16 070	441	2 370	443	118	1 809	571	282	94
1996	19 436	517	2 630	619	94	1 917	693	268	72
1997	25 034	815	2 779	565	111	2 104	426	357	85
1998	29 751	875	2 698	462	124	2 112	496	477	87
1999	32 993	726	2 594	454	142	1 998	304	566	84
2000	38 994	946	3 530	-	-	-	800	565	97

### 7.4.3 The Geographic Split of the Value of the Foreign Trade of the Local Importers/Exporters of Hamburg

The Statistisches Landesamt of Hamburg defines the foreign trade of the import/export companies, which are posted in Hamburg, in terms of general trade. The geographic split of the value of the foreign trade of the importers/exporters of Hamburg is shown in the Figure 7.8.

Figure 7.8 – The geographic split of the monetary value of the foreign trade of the import/export companies of Hamburg 1970-1999.



The companies of import/export of Hamburg handle primary with the countries of the European continent. The total monetary value of the foreign trade in the year 1999 corresponded to 68.771 millions DM, which are split in 38.844 millions DM of imported goods, and to 29.927 millions DM of exported goods.

The member states of the European Union EU are the most important partners for the foreign trade of the local importers/exporters of Hamburg since the 70s.

It has been reached a total monetary value of 57.378 millions DM in the year 1999, of which 33.590 millions DM for the incoming cargo, and 23.788 millions DM for the outgoing cargo.

The countries of the Central and Eastern Europe have been showing a slowly intensification of the relationships with the importers of Hamburg since the beginning of the 80s, and just since the beginning of the 90s with the exporters. The monetary value of the foreign trade in the year 1999 was equal to 6.776 millions DM, of which a value of 3.101 millions DM was referred to the incoming cargo, and 3.675 millions DM to the outgoing cargo.

With reference to the East Asia, the foreign trade of Hamburg was equal to 12.378 millions DM in the year 1999. In the same year, the value of the exports correspond to 4.174 millions DM, while the imports was equal to 8.204 millions DM. There is a positive trend of the foreign trade towards the East Asia in both directions. The trade relationships of the local importers/exporters towards Asia seem to be well consolidated.

A value of the foreign trade of 14.309 millions DM was registered in the year 1999 at Hamburg, of which 9.950 millions DM as incoming cargo, and 4.359 millions DM as outgoing cargo. Since the year 1997, there has been a trend of growth in the foreign trade of the local firms of Hamburg.

The Table 7.3 shows in detail the geographical split of the foreign trade of the importers of Hamburg, according to the monetary value of the incoming goods.

The Table 7.4 shows in detail the geographic split of the foreign trade of the exporters of Hamburg, according to the monetary value of the outgoing cargo.

A further remark can be made with reference to the share of the foreign trade of the local importers/exporters of Hamburg on the total foreign trade of Germany. As two following tables shows, this share has been constantly declining since the beginning of the 70s. The top share of the importers of Hamburg was reached in the year 1974 with a quote of 21,4% on the total imports of Germany, while in the year 1999 it was equal only to 7,5%. The Hamburger exporters had the higher quote on the foreign trade of Germany in the year 1982 (7,4%), while in the year 1999 it felt down to 4,4%.

Table 7.3 – The geographic split of the incoming cargo in terms of monetary value of the foreign trade of the importers of Hamburg 1970-1999.

Year	Total incoming	of which from										Share on the German foreign trade
		Total Europe	EU	EFTA	Central, Western Europe	Total Africa	Total America	USA	Asia	East Asia	Australia, Oceania	
	Millions DM					Millions DM					%	
1970	20 712	8 396	4 844	1 818	820	3 233	5 285	2 721	3 586	1 695	212	18,6
1971	22 553	9 739	5 998	1 958	860	3 335	4 875	2 577	4 389	1 612	214	18,6
1972	22 125	9 470	5 827	1 801	853	3 092	4 804	2 274	4 410	1 772	350	17,0
1973	26 111	11 401	7 879	1 090	1 170	3 402	5 232	2 617	5 607	2 087	469	17,8
1974	39 975	14 849	10 603	1 319	1 565	6 211	7 303	4 116	11 046	2 495	567	21,4
1975	36 137	14 358	10 285	1 291	1 604	5 004	6 700	3 754	9 519	2 660	555	19,0
1976	41 855	17 379	12 853	1 318	1 836	5 670	7 261	3 596	10 952	3 305	593	18,3
1977	46 647	17 939	13 439	1 643	1 541	7 229	8 239	3 796	12 652	3 719	588	19,4
1978	43 246	18 229	13 371	1 752	1 703	5 684	7 815	3 782	11 015	3 736	504	17,3
1979	52 467	25 502	18 404	2 271	3 325	6 892	8 231	3 611	11 285	3 934	556	17,6
1980	64 555	29 763	22 201	3 253	2 911	9 256	9 576	5 044	15 268	4 820	691	18,4
1981	71 262	34 993	26 769	3 676	2 872	8 437	10 014	5 950	17 193	5 726	624	18,8
1982	74 443	38 408	29 718	3 636	3 591	8 972	9 872	5 307	16 462	5 657	729	19,3
1983	65 197	38 040	28 168	4 007	4 407	6 802	8 853	4 656	10 774	5 739	728	16,4
1984	70 151	41 492	30 166	4 268	4 826	8 040	8 895	4 003	10 939	7 101	785	15,8
1985	74 227	43 428	32 154	4 353	4 586	9 004	10 873	5 242	10 100	7 255	821	15,6
1986	51 776	29 950	22 304	3 913	3 100	4 366	7 899	3 827	8 943	6 892	616	12,2
1987	47 638	28 478	21 647	3 713	2 488	3 090	6 774	3 443	8 731	6 835	563	11,4
1988	45 352	26 745	20 098	3 820	2 200	2 744	6 303	3 001	9 030	7 268	528	10,1
1989	55 174	32 406	24 955	3 872	2 936	3 986	7 407	3 767	10 628	7 846	747	10,6
1990	59 507	35 752	26 868	5 034	3 134	4 677	7 137	3 846	11 421	8 163	515	10,6
1991	70 265	42 415	32 555	5 608	3 362	4 775	9 065	4 990	13 495	10 060	514	10,7
1992	61 528	38 066	27 606	6 065	3 672	4 761	6 243	2 768	11 944	8 991	512	9,5
1993	54 147	32 563	24 529	4 428	2 911	4 070	4 953	2 185	12 096	8 805	464	9,8
1994	58 663	36 319	28 386	4 184	2 974	3 683	6 439	2 998	11 708	8 690	513	9,5
1995	59 199	36 322	30 827	1 694	3 012	3 397	7 231	3 817	11 635	9 112	614	9,2
1996	63 550	40 007	33 550	2 273	3 373	3 679	7 033	3 714	12 178	9 406	653	9,4
1997	70 530	42 962	35 787	2 031	4 204	3 802	10 686	6 709	12 473	9 556	606	9,2
1998	66 359	40 248	34 125	1 410	3 618	2 477	10 807	6 828	12 197	9 663	628	8,1
1999	64 957	38 844	33 590	1 214	3 101	2 344	13 104	9 950	10 352	8 204	302	7,5

Table 7.4 – The geographic split of the outgoing cargo in terms of monetary value of the foreign trade of the exporters of Hamburg 1970-1999.

Year	Total outgoing	of which towards										Share on the German foreign trade
		Total Europe	EU	EFTA	Central, Western Europe	Total Africa	Total America	USA	Asia	East Asia	Australia, Oceania	
	Millions DM					Millions DM					%	
1970	7 780	4 828	2 040	1 969	428	704	958	351	1 154	800	79	6,2
1971	8 133	5 049	2 294	1 997	284	798	944	367	1 200	685	72	5,9
1972	8 735	5 803	2 550	2 436	363	701	1 043	407	1 059	570	69	5,8
1973	11 019	7 552	4 696	1 669	589	911	1 034	368	1 391	813	80	6,1
1974	15 867	10 311	6 204	2 210	1 046	1 402	1 824	664	2 123	1 204	135	6,8
1975	13 776	9 206	5 709	1 878	848	1 312	1 170	433	1 956	800	79	6,1
1976	16 003	10 662	6 764	2 376	737	1 500	1 402	446	2 268	903	108	6,1
1977	16 947	10 896	7 019	2 316	778	1 630	1 430	527	2 752	1 044	196	6,1
1978	16 933	10 701	7 134	2 268	657	1 846	1 393	558	2 708	1 129	229	5,8
1979	18 356	12 263	8 220	2 525	726	1 595	1 552	548	2 737	1 269	144	5,7
1980	22 556	15 661	10 409	3 221	1 261	2 136	1 578	539	2 996	1 079	129	6,3
1981	27 798	18 419	12 858	3 141	1 533	2 708	2 200	850	4 247	1 488	151	6,9
1982	32 124	22 826	16 802	3 629	1 471	2 660	2 186	909	4 211	1 640	175	7,4
1983	30 395	20 772	14 444	3 646	1 642	1 732	3 405	955	4 245	1 660	169	6,9
1984	35 144	25 385	18 814	4 145	1 383	1 984	2 975	1 391	4 496	2 130	193	7,1
1985	35 325	25 444	18 124	4 390	1 717	1 973	2 860	1 572	4 697	2 482	216	6,4
1986	28 500	20 147	14 339	4 157	1 133	1 513	2 530	1 325	3 966	2 332	184	5,3
1987	27 994	20 040	14 483	3 564	987	1 195	2 295	1 227	3 707	2 342	178	5,2
1988	30 644	22 611	16 983	3 925	1 223	1 156	2 253	1 336	3 848	2 449	196	5,3
1989	36 466	27 468	21 232	4 233	1 447	1 260	2 355	1 394	4 400	3 000	198	5,6
1990	35 764	26 606	19 796	4 242	1 886	1 184	2 384	1 296	4 531	3 120	165	5,5
1991	40 778	31 541	25 307	4 109	1 553	1 245	2 400	1 248	4 565	2 940	167	6,0
1992	37 765	28 931	21 864	3 966	2 447	1 232	2 164	1 145	4 424	2 936	136	5,5
1993	32 011	22 897	16 382	3 368	2 470	855	2 299	1 254	4 859	3 479	307	5,2
1994	39 507	29 602	22 612	3 643	2 631	723	2 705	1 506	5 509	3 856	153	5,7
1995	39 635	29 278	22 964	1 996	2 992	969	2 971	1 848	5 414	4 119	154	5,4
1996	36 739	26 122	19 769	1 841	3 556	952	2 962	1 638	5 643	4 300	128	4,7
1997	42 217	28 494	20 858	2 018	4 830	1 319	4 701	2 253	6 360	4 845	148	4,7
1998	42 613	28 711	21 440	1 506	4 648	1 378	5 459	3 363	5 987	4 531	128	4,4
1999	43 851	29 927	23 788	1 643	3 675	1 372	5 752	4 359	5 750	4 174	118	4,4

#### ***7.4.4 The Geographic Split of the Monetary Value of the Incoming Cargo for Countries of Production***

The Statistisches Landesamt of Hamburg defines in terms of general trade, the monetary value of the incoming cargoes of Hamburg, for country of production. It was equal to 64.504 millions DM in the year 1999. Since the year 1970, this value has shown a positive trend. As it is shown in the two parts of the Table 7.5, the three most relevant areas of production are: 1) the European Union, with France at the first place; 2) the U.S.A.; and 3) the Far East, where China is taking the dominant share.

The states of the Central and Eastern Europe have been showing a variable trend of slow growth and slow decrease since the middle of the 70s. They are Poland, the Czech Republic, Slovakia (till 1992: Czechoslovakia), Hungary, Rumania, Bulgaria, Albania, and the countries of the former Soviet Union. In the year 1976, the value was of 1.288 millions DM; in the year 1985 of 2.389 millions DM; in the next year it fell to 1.658 millions DM; and afterwards it grew up constantly again, till to reach the value of 2.312 millions DM in the year 1996. In the year 1997, the value of the general cargo sprang up to 3.122 milliards DM, while in the year 1999 it was equal to 3.394 milliards DM.

Within the EU countries, France is particularly relevant as producer for Hamburg because of the aircraft industry. There was a pick period between the years 1991-1994 (13.910 millions DM was the highest value), as well as between 1997-1999 (13.090 millions DM in the last year).

The Netherlands show a variable trend during the last three decades. In the year 1999, this country of production sent to Hamburg freights for a total value equal to 2.436 millions DM.

In the year 1999, Hamburg received goods from the American continent for a total value of 14.240 millions DM, of which a value of 9.777 millions DM is referred to North America, while 4.463 millions DM to the Central and South America. The U.S.A. by own have the biggest share, which correspond to 9.510 millions DM in the same year.

Asia as a whole produced goods for 16.137 millions DM that entered to Hamburg in the year 1999. Within this continent, the Far East has a trend of growth since the beginning of the 70s (1.482 millions DM in the year 1970). In the year 1999, the value of the incoming cargo from the Far East was equal

to 13.900 millions DM. Since the year 1985, China has been showing a positive growth as country of production: 1.166 millions DM in that year, 2.881 millions DM in the year 1991, 3.409 millions DM in the year 1996; and 4.645 millions DM in the 1999. Therefore, China has the prevalent quote with reference to the Far East.

Table 7.5 – The geographic split of the monetary value of the incoming cargo of Hamburg for countries of production 1970-1999.

Year	Total general trade	of which from									
		Europe	of which from					America	of which from		
			EU	France	Nether lands	EFTA	Central, Eastern Europe		North America	USA	Central, South America
Millions DM											
1970	12 627	4 746	2 171	397	940	772	496	4 026	2 291	2 114	1 735
1971	13 203	5 306	2 558	463	1 195	886	541	3 779	2 219	2 091	1 560
1972	12 944	5 087	2 444	539	1 018	723	539	3 499	1 813	1 643	1 686
1973	15 244	5 975	3 399	511	1 002	824	877	3 778	1 947	1 732	1 831
1974	21 297	7 328	4 708	584	1 348	1 077	1 018	5 952	3 653	3 392	2 299
1975	20 501	7 161	4 697	759	1 225	1 081	974	6 052	3 709	3 489	2 343
1976	24 481	8 485	5 613	1 482	1 109	1 093	1 288	6 938	4 031	3 706	2 907
1977	26 109	9 623	6 548	1 834	1 139	1 382	1 101	6 900	3 545	3 248	3 355
1978	25 470	10 048	6 676	1 578	1 263	1 484	1 299	6 837	3 550	3 253	3 287
1979	31 090	13 607	9 108	2 431	1 637	1 629	2 144	7 595	4 203	3 748	3 392
1980	37 833	16 055	11 479	3 725	1 774	1 847	1 946	9 244	5 504	4 997	3 740
1981	41 174	18 793	14 318	5 522	1 958	2 036	1 645	9 554	6 055	5 644	3 499
1982	44 985	22 971	18 411	9 004	2 296	2 341	1 627	8 726	5 264	4 765	3 462
1983	41 210	22 654	17 636	7 265	2 286	2 233	2 128	7 377	4 094	3 743	3 283
1984	43 753	24 226	18 778	7 597	2 678	2 368	2 206	7 319	3 437	3 094	3 882
1985	47 382	25 005	18 804	7 146	2 415	2 968	2 389	9 677	4 914	4 670	4 763
1986	37 347	17 929	13 324	4 239	1 969	2 435	1 658	7 253	3 961	3 774	3 293
1987	35 453	17 566	13 014	4 815	1 725	2 619	1 367	5 993	3 432	3 207	2 561
1988	37 803	19 537	15 217	7 147	1 643	2 481	1 285	6 108	3 330	3 096	2 778
1989	43 051	22 982	18 210	8 493	2 215	2 725	1 466	6 534	3 602	3 411	2 932
1990	46 090	25 152	19 713	9 007	2 250	3 235	1 543	6 718	3 640	3 435	3 078
1991	58 661	31 934	25 493	13 910	2 344	3 700	1 917	8 523	4 496	4 169	4 027
1992	52 240	29 025	22 667	11 727	2 313	3 487	2 156	7 230	3 752	3 518	3 478
1993	47 203	24 365	18 133	10 058	1 697	3 331	2 168	6 672	3 573	3 393	3 099
1994	48 919	24 353	19 899	9 017	1 804	3 291	2 178	7 923	4 195	3 910	3 728
1995	44 919	21 100	16 497	6 778	1 407	1 511	2 278	7 686	4 097	3 796	3 589
1996	45 305	22 062	17 044	6 911	1 785	1 820	2 312	7 452	4 346	4 131	3 106
1997	55 363	27 191	21 164	9 000	2 150	1 809	3 122	10 172	6 225	5 966	3 947
1998	58 333	29 956	24 168	12 701	2 047	1 559	3 075	9 857	5 972	5 628	3 885
1999	64 504	31 153	25 237	13 090	2 436	1 396	3 394	14 240	9 777	9 510	4 463

Table 7.5 – Second Part: The geographic split of the monetary value of the incoming cargo of Hamburg for countries of production 1970-1999.

Year	Total general trade	of which							Australia, Oceania
		Africa	Asia	of which from			of which from		
				Near East	Middle East	Far East	China	Japan	
Millions DM									
1970	12 627	1 406	2 310	699	129	1 482	129	608	137
1971	13 203	1 268	2 699	855	141	1 703	136	740	150
1972	12 944	1 145	2 946	762	142	2 042	151	931	267
1973	15 244	1 397	3 645	1 010	187	2 448	199	1 048	449
1974	21 297	2 200	5 295	1 891	228	3 176	267	1 279	522
1975	20 501	1 610	5 177	1 951	226	3 000	224	1 236	501
1976	24 481	2 147	6 379	2 046	338	3 995	322	1 587	531
1977	26 109	2 232	6 844	1 859	461	4 524	317	1 970	510
1978	25 470	1 497	6 587	1 661	376	4 550	332	1 962	502
1979	31 090	1 826	7 515	1 957	481	5 077	513	1 885	547
1980	37 833	2 476	9 379	2 770	610	5 999	634	2 388	679
1981	41 174	2 075	10 077	2 798	604	6 675	722	2 958	675
1982	44 985	2 316	10 217	3 069	556	6 592	685	3 033	755
1983	41 210	1 672	8 806	1 381	556	6 870	755	3 135	711
1984	43 753	1 910	9 569	1 052	628	7 889	895	3 591	729
1985	47 382	2 351	9 645	791	614	8 240	1 166	3 736	704
1986	37 347	2 090	9 394	758	560	8 076	1 036	3 561	682
1987	35 453	1 498	9 807	767	667	8 372	1 266	3 481	590
1988	37 803	2 163	9 423	563	680	8 180	1 178	3 548	583
1989	43 051	2 278	10 398	577	811	9 010	1 542	3 901	859
1990	46 090	2 060	11 627	631	833	10 163	1 919	4 070	528
1991	58 661	2 357	15 368	805	1 126	13 438	2 881	5 074	479
1992	52 240	1 937	13 526	750	1 054	11 722	2 601	4 370	519
1993	47 203	1 702	13 917	788	1 261	11 868	3 089	3 874	546
1994	48 919	1 902	13 943	839	1 323	11 781	3 258	3 762	571
1995	44 919	1 706	13 690	719	1 213	11 758	3 369	3 835	735
1996	45 305	1 816	13 247	763	1 233	11 251	3 409	3 203	727
1997	55 363	2 014	15 272	878	1 452	12 943	4 098	3 530	711
1998	58 333	2 098	15 717	762	1 498	13 456	4 190	3 809	700
1999	64 504	2 233	16 137	840	1 397	13 900	4 645	3 644	730



## 8 The Maritime Functions of the Seaport of Hamburg

### 8.1 *The Impact of the Containerisation on the Cargo Structure*

Hamburg is the Northern main port of the Northern Range. In order to develop a research in a scientific way, it is necessary to make use of the most appropriate indicators to measure and compare homogeneous data. Two classical indicators are available in order to measure the dimension of a seaport site: 1) the volume of the cargo, that is given by the tonnage of the goods transhipped; and 2) the value of the goods, estimated by the monetary value of the cargoes handled (for example, in terms of the national currency).

Due to the growing importance of the containerised cargo, the rate of containerisation is become the most common indicator of the prosperity of a seaport site, as well as of the impact of the two complementary concepts of containerisation and inter-modal transportation. This measurement may be calculated both in terms of gross and net rate of containerisation.

The gross containerisation rate is defined by the HHVW Hafen Hamburg Verkaufsförderung und Werbung e.V. as the percentage rate of the general cargo. It is the ratio of the gross weight of the containers<sup>33</sup> transhipped at the seaport site divided by the gross weight volume of the general cargo, commonly expressed in million tons and calculated over the same period of time, usually a solar year.

The Statistisches Landesamt of the Free and Hanseatic City of Hamburg instead makes use of the net rate of containerisation. This is defined as the net weight of the containers/trailers (1000 tons) divided by the net weight of the general cargo. The net weight of the general cargo is calculated subtracting by the total volume of the break-bulk cargo (1000 tons) the weight of the containers/trailers, calculated over a solar year.

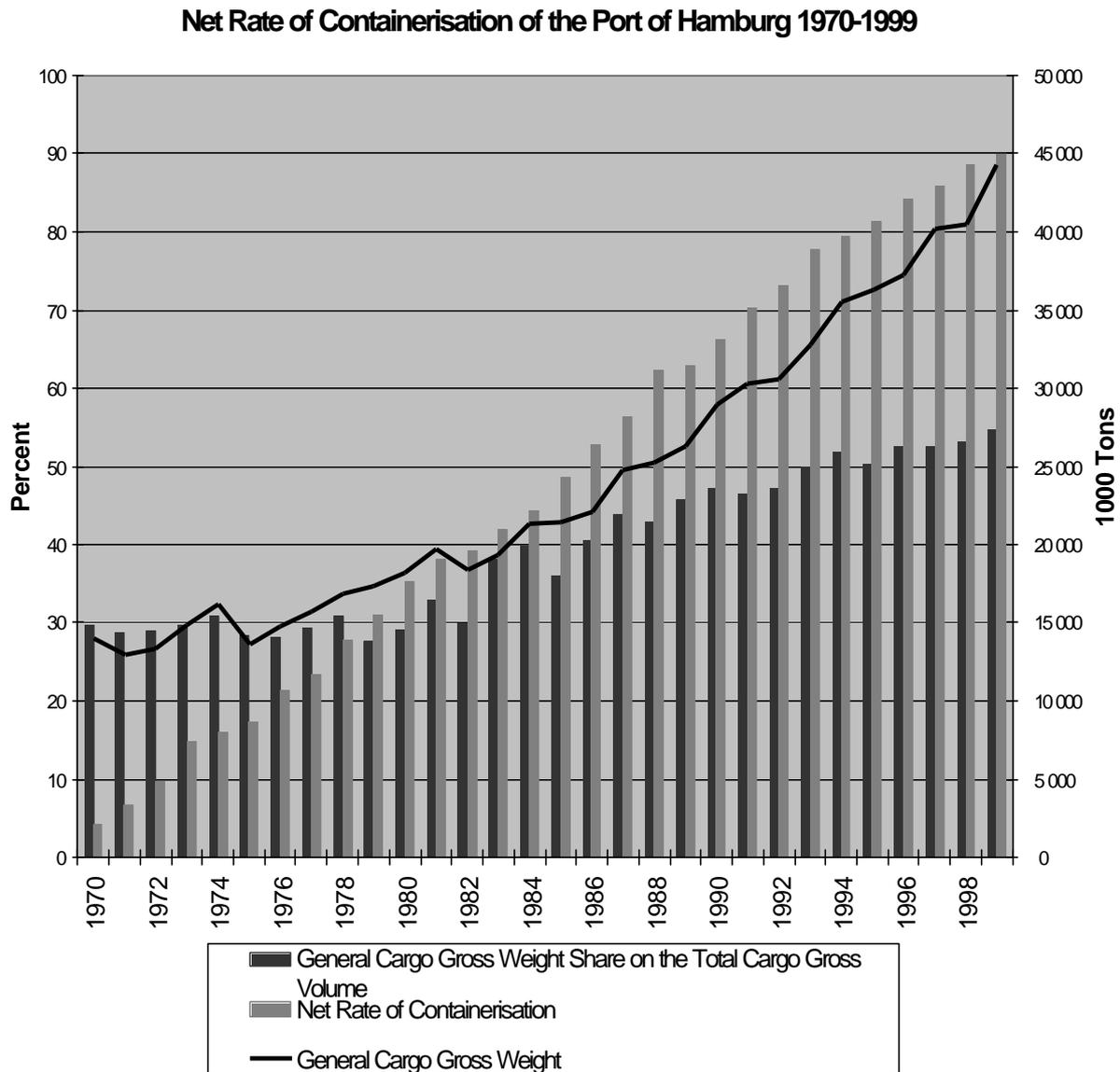
The seaport Hamburg handled during the year 1999 a total volume of cargo equivalent to 81.003 thousand tons. A growth of +6,8% with respect to the previous year (75.821 thousand tons) may be underlined. Since the last

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<sup>33</sup> It is given by the weight both of the cargo and the container.

decade, a positive trend both in the total tonnage handled through the seaport Hamburg and in the containerised cargo can be noted. The containerised cargo transhipped through the seaport of Hamburg in the year 1999 was equivalent to 40.011 thousand tons, with a growth of +10,8% in respect to the previous year (36.105 thousand tons).

Figure 8.1 – The net rate of containerisation of the port of Hamburg 1970-1999.



According to the definition of the HHVW, in the year 1999, the gross rate of containerisation of the seaport of Hamburg reached the share of 91,5%, equivalent to a growth of +1,3% with respect to the previous year (90,3% in the

year 1998). Following the Statistisches Landesamt definition, the net rate of containerisation of the seaport of Hamburg was equal to 89,9% in the year 1999 with a growth of +1,6% if compared to the 88,5% of the year 1998.

The Figure 8.1 shows the trend of the net rate of containerisation for the period 1970-1999, according to the statistical data of the Statistisches Landesamt. The total volume of break-bulk cargo are expressed in terms of gross ton value.

The analysis of the structure of the cargo handled through the seaport of Hamburg stresses the growing relevance of the general cargo with respect to the volume of the bulk cargo. Until the year 1993, there was a prevalence in the volume of the bulk cargo (33,547 thousand tons in the year 1993) with respect to the volume of the general cargo (32.303 thousand tons in the year 1993), that was handled at Hamburg.

The year 1994 may be considered the turning-point because of the larger volume in the transshipment of the break-bulk cargo (35.019 thousand tons) with respect to the bulk cargo (33.304 thousand tons). This new asset of the cargo structure of the seaport Hamburg has been kept until now. The trend is towards the growth on the containerisation rate during the next years. In the year 1999, a total volume of 44.279 thousand tons of general cargo was handled, and a total volume of 37.255 thousand tons of bulk cargo was transhipped.

With respect to the bulk cargo, the break-bulk cargo have the intrinsic potential to generate value added by the logistics activity. Therefore, it is clear that the larger the volume of general cargo handled, the higher the potential benefits to the economy of the maritime region.

This consideration highlights in particular the logistics function of adding value to the goods, that can be exploited at the seaport site. Furthermore, the role of the seaport region is enlarged to a urban centre of international level, which has a set of multiple functions to accomplish. The seaport regions are in competition not only with the others seaport regions, that are at the same functional level, for the logistics and distributions functions. They are also in competition with those inland locations, that exploits similar economic functions, within a broader inter-regional framework.

## **8.2 The Gateway Function for the German Foreign Trade**

It is useful to take into account the geographical split of the German foreign trade through the city-region of Hamburg from/towards the other Federal Länder in order to define its hinterland at a national level and depending on the volume of cargo (tonnage) sent and delivered through the Hanseatic seaport.

Following the methodology used by the Statistisches Landesamt of the Free and Hanseatic City of Hamburg, the foreign trade traffic of Hamburg is defined as the freight traffic between the Federal Republic of Germany and other foreign countries that takes place through the customs of the city of Hamburg.

Since the year 1974, the foreign trade traffic has been defined in terms of general trade<sup>34</sup>. The general trade is split into imports, that show the volume of cargo received from a foreign country and delivered towards a region of destination inside the Federal Republic of Germany; and exports, that show the volume of cargo sent towards a foreign country and originated from a German region. The volume of cargo includes both the free cargo traffic and the volume of freights directed to/received from a storage facility.

In the year 1998, the total volume of cargo of the German foreign trade was equal to 54.020,4 thousand tons, that was handled at the seaport of Hamburg. It corresponds to a share of 7,2% of the total foreign trade of the Federal Republic of Germany. With respect to the previous year, it was registered a growth of +15,9% (46.604,8 thousand tons, i.e. a share of 6,6% of the total German foreign trade in the year 1997). In the year 1999, the volume of the German foreign trade through the Hanseatic seaport drop down to 46.502,5 thousand tons, that was equal to a share of 6,5% on the German foreign trade. The fall has to be referred in particular to the volume of the exports, from 38.160 thousand tons in the 1998 (i.e. a share of 7,7%) to 31.624 thousand tons in the 1999 (i.e. a share of 6,7%).

Since the year 1970, the trend in absolute value has been positive. This trend is expressed by the tonnage of German foreign trade, which used the seaport of Hamburg to leave/entry the Federal Republic of Germany. If the percentage ratio is considered, then during the period 1970-1999, the range varied between the minimum of 6,5% in the year 1999, and the maximum of 8,5% in the years 1979 (48.784,7 thousand tons) and 1982 (42.359,4 thousand tons).

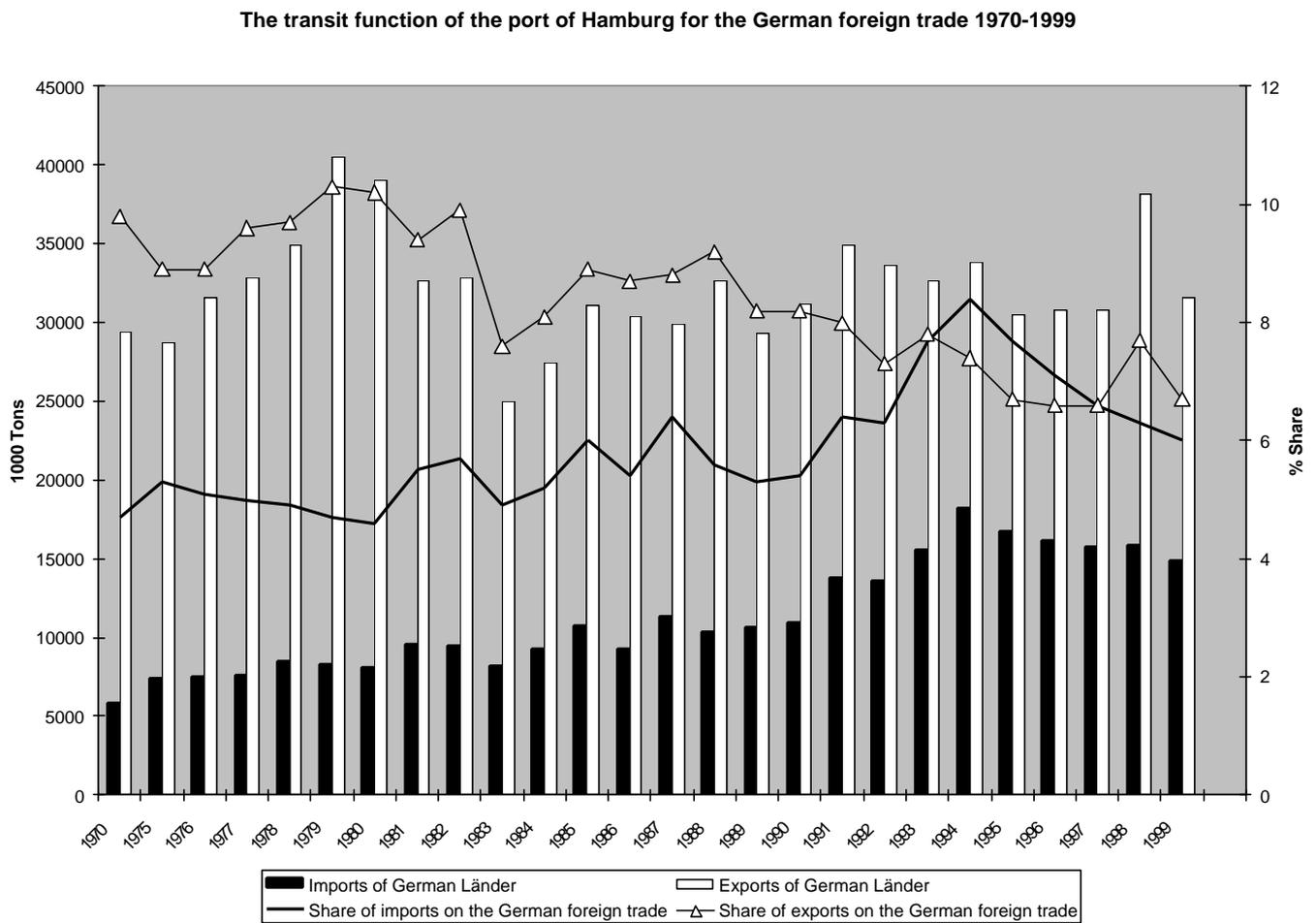
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<sup>34</sup> Before that year, the foreign trade traffic was referred to in terms of special trade.

The Figure 8.2 shows the gateway function of the port of Hamburg for the foreign trade of Germany during the period 1970-1999.

The total volume of the German foreign trade has been analysed, according to the cargo received/delivered from/to the German Länder through the seaport of Hamburg.

Figure 8.2 – The gateway function of the port of Hamburg for the foreign trade of the German Länder 1970-1999.



### **8.2.1 The German Länder of Origin of the Exports through the Port of Hamburg**

The Table 8.1, first and second part, shows the statistical data of the German Länder, which make use of the seaport of Hamburg as gateway for their exports. The data are expressed as volume of the exports, since the year 1970.

Obviously the first German region that exports through the seaport of Hamburg is the Land of **Hamburg** itself, with 17.397,7 thousand tons in the year 1998. This was a share of 45,6% on the export of the German foreign trade in the year 1998, with a slop down of -6,6% with respect to the previous year. In the year 1999, the Land of Hamburg exported goods through the port for 17.327,4 thousand tons.

**Low Saxony** is at the second place with a spectacular growth of +110,1% of the exports through Hamburg in the year 1998 with respect to the previous one (14.174,3 thousand tons in the year 1998 with respect to 6746,1 thousand tons in the year 1997). The share is equal to 37,1%. In the year 1999 the volume of freights exported through the port felt down to the value of 7.182,9 thousand tons, that is in line with the other years.

**Nordrhein-Westfalen** had a share of 4,2% of the export of the foreign trade of the seaport of Hamburg during the year 1998 (1.618 thousand tons) and a growth of +67,7% with respect to the previous year. In the year 1999, the volume grew up to 1.826 thousand tons. This Federal Land seems to be more interested to the port of Hamburg as gateway for its exports since the year 1991.

**Schleswig-Holstein** delivered through the seaport of Hamburg a volume of export of the foreign trade equivalent to 708,5 thousand tons in the year 1998. It corresponds to a share of 1,9% of the export of the foreign trade, and to an increase of +40,1% if compared to the year 1997. In the year 1999, the volume of the export of this Land through the port of Hamburg grew up to 1.372 thousand tons, that is the highest value since the year 1970.

**Brandenburg** sent a total volume of 1.215,6 thousand tons through the port, in the year 1998. This is a share of 3,2% of the exports of the foreign trade of the seaport of Hamburg. It corresponds to an increase of +33,3% with respect to the previous year. In the year 1999, the exports of this Land through Hamburg

was equal to 1.123 thousand tons. The trend seems to be positive since the year 1995.

The Land of **Bremen** had a export share of 2,6% in the year 1998, which is equal to a volume of 996,9 thousand tons, but with a decrease of -6,4% with respect to the previous year. In the year 1999, the volume of the exports of Bremen through the port of Hamburg fell to 803 thousand tons. Anyway, the volume of the cargo export has been more or less constant around these values during the last ten years.

**Baden-Württemberg** had a share of 1,4% of the exports of the German foreign trade of the seaport of Hamburg. There was a growth of +15,2% with respect to the year 1997. In the year 1999, this German Land exports freights through the Hanseatic port for a volume of 592,2 thousand tons. Also for this Land, there is a growing trend, although slow, to use Hamburg as port of export.

**Bayer** made use of the Hanseatic seaport to send 559,6 thousand tons of cargo as its exports in the year 1998. This was a share of 1,5% of the exports of the foreign trade, and corresponded to an increase of +5,3% with respect to the year 1997. In the year 1999, Bayer used the port of Hamburg as gateway for its exports for a volume of 551 thousand tons. The trend is constantly positive since the 70s.

**Hessen** seems to have a positive trend during the last thirty years, although if in the year 1999 the exports of this Land through Hamburg fell down to 287,4 thousand tons with respect to the 1998 (345,3 thousand tons).

**Rheinland-Pfalz** has a positive growth in the volume of the exports through the Hanseatic port. In the year 1999, it was exported cargo for 149,7 thousand tons, that was a light drop with respect to the 158,3 thousand tons of the previous year.

**Berlin** shows a relevant drop into the volume of goods exported through Hamburg since the year 1995. In that year, the German capital exported freights for 88,6 thousand tons, while in the previous year the volume was equal to 213,8 thousand tons. The variability between the years 1970-1994 was not so relevant, and the exports were fixed on higher volumes of goods. Despite that the data of the Statistisches Landesamt of Hamburg refer to West Berlin till the year 1990, there is a fall of the volume of exports from 360,9 thousand tons in the 1991, to 190,9 thousand tons in the following year.

**Saxony-Anhalt** had a share of 0,1% on the total export of the foreign trade of the seaport of Hamburg in the year 1998. Despite the low relevance on the total volume, there is a positive trend since the year 1991 of this Land to use the port of Hamburg for its exports. If the volume of freights is compared to the year 1997, Saxony-Anhalt grew up to +13%. In the year 1999, the volume of the cargo exported through the Hanseatic seaport was of 68,4 thousand tons. The volume of the exports grew with respect to the previous year.

**Mecklenburg-Vorpommern** shows a certain variability in the use of the port of Hamburg as gateway for its exports since the year 1991. In the year 1999, this New Land exported through the seaport a volume of cargo equal to 59,7 thousand tons, that was the lowest volume since the 1991.

**Saxony** had a share of 0,2% on the total export of the foreign trade of the seaport of Hamburg in the year 1998. there is a positive trend of this New Land to export through the port of Hamburg, since the year 1991, despite the low relevance on the total volume. If the volume of freights is compared to the year 1997, Saxony grew up to +18,7%. In the year 1999, the volume of the cargo exported through the Hanseatic seaport was of 59,6 thousand tons. The volume of the exports declined with respect to the previous year.

**Thuringia** had a share of 0,1% on the total export of the foreign trade of the seaport of Hamburg in the year 1998. Since the year 1991, and despite the low relevance on the total volume, there is a positive trend of Thuringia to use Hamburg as exports port. If the volume of freights is compared to the year 1997, Thuringia grew up to +13,4%. In the year 1999, the volume of the cargo exported through the Hanseatic seaport was of 38 thousand tons. The volume of the exports slowly declined with respect to the previous year.

**Saarland** is the Federal Land of Germany that makes less use of the seaport of Hamburg for its exports. The volume of goods exported was equal to 27,4 thousand tons in the year 1999. Since the 70s, there was very low volumes of goods exported, with only two picks in the 1978 (164,6 thousand tons) and in the 1984 (130,8 thousand tons).

Table 8.1 – The German Länder of origin of the exports through the port of Hamburg, with respect to the volume of the incoming cargo, 1970-1999.

Year	Total incoming		of which from						
	Total volume	Share on the German foreign trade	Baden-Württemberg	Bayer	Berlin	Brandenburg	Bremen	Hamburg	Hessen
	1000 Tons	%	1000 Tons						
1970	29 420,0	9,8	188,2	351,3	352,7	.	56,2	26 432,6	191,2
1975	28 744,8	8,9	136,9	372,3	207,5	.	58,8	26 446,8	148,5
1976	31 559,5	8,9	140,3	369,2	245,7	.	59,2	29 023,4	149,5
1977	32 868,9	9,6	148,6	293,1	207,5	.	67,9	27 371,0	156,3
1978	34 930,3	9,7	206,4	273,1	127,7	.	69,5	28 650,7	152,0
1979	40 456,3	10,3	187,2	275,3	142,6	.	78,8	33 540,0	161,9
1980	39 013,4	10,2	194,6	320,7	161,2	.	74,4	32 531,5	177,8
1981	32 654,9	9,4	191,1	286,8	294,6	.	93,7	26 905,0	174,6
1982	32 865,5	9,9	186,6	328,3	407,2	.	106,5	29 936,7	190,1
1983	24 960,8	7,6	245,5	286,5	319,0	.	157,7	20 397,5	195,8
1984	27 492,6	8,1	179,2	337,0	200,2	.	147,9	20 255,3	168,4
1985	31 058,7	8,9	203,5	357,6	355,6	.	160,1	22 844,4	165,6
1986	30 397,1	8,7	234,5	344,1	311,5	.	185,0	22 500,7	201,2
1987	29 888,7	8,8	249,1	372,2	394,1	.	202,1	22 135,2	235,7
1988	32 642,3	9,2	257,2	623,4	292,5	.	772,9	22 793,7	316,4
1989	29 324,2	8,2	243,3	360,4	256,9	.	873,7	18 854,9	426,9
1990	31 131,0	8,2	265,5	493,8	293,2	.	619,3	20 788,5	386,8
1991	34 884,2	8,0	310,4	484,5	360,9	281,6	860,5	23 797,7	505,0
1992	33 666,9	7,3	321,5	439,9	190,9	25,2	1 109,2	22 328,8	429,5
1993	32 680,9	7,8	380,5	438,3	133,7	52,5	985,7	20 180,9	386,7
1994	33 821,5	7,4	379,4	546,5	213,8	40,9	979,1	21 803,4	354,1
1995	30 458,2	6,7	398,0	530,6	88,6	694,1	709,8	18 652,0	322,9
1996	30 794,0	6,6	473,3	557,4	99,0	645,5	598,7	18 945,1	381,0
1997	30 824,8	6,6	461,2	531,5	85,8	912,0	1 065,3	18 618,8	354,0
1998	38 160,8	7,7	531,1	559,6	80,6	1 215,6	996,9	17 397,7	345,3
1999	31 624,2	6,7	592,2	551,2	73,7	1 123,9	803,6	17 327,4	287,4

Table 8.1 – Second part: The German Länder of origin of the exports through the port of Hamburg, with respect to the volume of the incoming cargo, 1970-1999.

Year	of which from								
	Mecklenburg-Vorpommern	Low Saxony	Nordrhein-Westfalen	Rheinland-Pfalz	Saarland	Saxony	Saxony-Anhalt	Schleswig-Holstein	Thuringia
	1000 Tons								
1970	.	707,5	427,5	44,5	9,3	.	.	616,0	.
1975	.	361,5	409,6	33,5	7,7	.	.	550,1	.
1976	.	398,9	485,6	30,4	9,1	.	.	646,6	.
1977	.	3 155,0	664,8	27,6	87,4	.	.	689,1	.
1978	.	3 973,9	529,2	61,1	164,6	.	.	721,2	.
1979	.	4 543,2	714,1	43,8	8,1	.	.	759,2	.
1980	.	4 123,8	543,8	53,5	6,7	.	.	822,3	.
1981	.	3 562,5	505,6	68,7	20,0	.	.	549,5	.
1982	.	564,8	538,0	61,7	11,2	.	.	525,7	.
1983	.	2 115,2	499,1	80,8	4,6	.	.	647,1	.
1984	.	5 051,3	529,3	69,1	130,8	.	.	389,0	.
1985	.	5 883,8	550,8	71,8	26,2	.	.	410,5	.
1986	.	5 385,0	573,8	109,1	13,8	.	.	474,1	.
1987	.	4 887,3	609,7	106,7	19,0	.	.	629,8	.
1988	.	5 899,1	847,1	167,3	37,8	.	.	573,1	.
1989	.	6 470,5	925,4	133,3	24,1	.	.	670,7	.
1990	.	6 200,4	964,1	130,3	25,2	.	.	617,8	.
1991	91,3	6 057,5	1 039,1	153,7	28,4	30,6	111,3	677,2	7,7
1992	246,8	6 465,3	958,1	121,6	16,4	38,0	215,1	664,2	16,9
1993	67,9	7 151,8	1 890,1	145,6	17,6	31,5	33,4	692,8	19,1
1994	119,7	6 896,0	1 461,4	148,0	29,7	33,4	52,8	661,8	29,3
1995	77,3	6 511,1	1 323,4	171,9	28,9	98,1	31,3	646,2	24,5
1996	122,9	6 375,1	1 422,1	168,9	21,3	.	41,4	734,0	23,3
1997	103,3	6 746,1	964,8	170,2	60,3	67,4	44,7	505,7	34,4
1998	87,9	14 174,3	1 618,0	158,3	29,3	80,0	50,5	708,5	39,0
1999	59,7	7 182,9	1 826,6	149,7	27,4	59,6	68,4	1 372,1	38,0

### **8.2.2 The German Länder of Destination of the Imports through the Port of Hamburg**

The Table 8.2, first and second parts, shows the statistical data of the German Länder, which make use of the seaport of Hamburg as gateway for their imports. The data are expressed as volume of the imports, since the year 1970.

About the Länder of destination of the German foreign trade of the seaport of Hamburg, the region of **Hamburg** itself is at the first place with a total volume of 4.667,2 thousand tons of cargo received in the year 1998. This was a share of 29,4% of the total imports on the German foreign trade received through the Hanseatic seaport in that year, and corresponded to a growth of +18,9% with respect to the 1997. In the year 1999, the Land of Hamburg imported a smaller quantity of goods for 3.362,2 thousand tons.

**Schleswig-Holstein** covered a share of 4% of the Hamburg imports in the year 1998 (633,1 thousand tons). This was a negative variation of -21,8% if compared to the previous year. This Land spectacularly grew the use of the Hanseatic seaport for its imports in the year 1999. It imported a pick volume of goods equal to 2.083,3 thousand tons.

**Saxony-Anhalt** received a volume of cargo equal to 2.388,6 thousand tons during the year 1998. It was a share of 15,1% on the total imports of the port of Hamburg, and corresponded to a growth of +31,1% with respect to the previous year (1.821,3 thousand tons). Since the year 1989, the trend has been absolutely positive, hence Saxony-Anhalt used more and more the Hanseatic port for its imports. This Land received a volume of cargo equal to 413,2 thousand tons in the year 1989; in the next year, the volume grew up to 817 thousand tons, and in the year 1994 there was a jump to 1.578,7 thousand tons of freights imported through Hamburg. In the year 1999, it has not been possible to reach the volume of the previous year, but the 1.999,3 thousand tons of goods imported through the Hanseatic seaport confirm anyway the positive trend of this Land.

**Low Saxony** imported 1.517,6 thousand tons in the year 1998, that was a share of 9,6% of the imports. Therefore, its share decreased of -22,7% with respect to the previous year. In the year 1999, this German Land used Hamburg as imports port for a volume of goods equal to 1.621,8 thousand tons.

It is a growth with respect to the previous year, but it was more or less the same value of cargo imported in the 1985.

The Land of **Nordrhein-Westfalen** is placed at the third place, with a volume of the imports received through the seaport of Hamburg of 1.906,6 thousand tons. This corresponded to a share of 12% of the total exports during the year 1998, but there was a slop down of -19,2% with respect to the previous year 1997 (2.359,4 thousand tons). In the year 1999, This Land made use of the port of Hamburg as gateway for 1.541.9 thousand tons of its imports. It signed a negative tendency during the last three years, back to the volume of the 1991.

**Hessen** imported 1.326,1 thousand tons during the year 1998, although there was a decrease of -9,6% with respect to the year 1997. The share of the imports on the foreign trade of Hamburg corresponded to 8,4% in the year 1998. In the year 1999, Hessen imported goods through the Hanseatic port for a volume of 945,1 thousand tons. Since the 1985, it has not been registered a level under the thousand tons in the volume of the imports.

**Bayer** received goods from the seaport of Hamburg for a volume of 896,8 thousand tons during the year 1998. It corresponded to a share of 5,7% of the imports of Hamburg, and to a decrease of -1,9% with respect to the year 1997. In the year 1999, Bayer imported a volume of cargo equal to 730,2 thousand tons, that fits the values of the imports since the 1993.

**Baden-Württemberg** imported 544,8 thousand tons through the Hanseatic seaport, that was a share of 3,4% in the year 1998. There was a decrease of -7,6% with respect to the previous year. In the year 1999, this land used the port of Hamburg as gateway for its imports for a volume of cargo equal to 460,9 thousand tons. This shows a negative trend back to the lower volumes of the year 1992 and the previous.

**Thuringia** had a share of 2% of the foreign trade of the imports of the seaport of Hamburg in the year 1998, which was a volume of 319,4 thousand tons imported. There was a decrease of -11,3% with respect to the previous year. In the year 1999, this land imported a volume of freights equal to 290,4 thousand tons. This corresponded to the second lower volume of goods imported since the 1991 (the lower volume was in 1995 with 239,5 thousand tons imported).

**Berlin** had just a share of 0,8% of the imports through the seaport of Hamburg in the year 1998. It corresponded to a volume of 126,9 thousand tons, and to an increase of +53,8% with respect to the previous year (82,5 thousand tons in the

1997). In the year 1991, there was the peak of the imports through Hamburg towards the German capital. A volume of 746,7 thousand tons of cargo was imported in the 1991, but this Land had a low volume of imports from 1987 to 1997. In fact, it has to be noted that the data of the Statistisches Landesamt of Hamburg was referred to West Berlin till the year 1990. The imports fell down to 81,6 thousand tons in the year 1992. In the year 1999, the Land of Berlin used the seaport of Hamburg in order to import a volume of 262,3 thousand tons of goods. This was a growth with respect to the 1998.

**Rheinland-Pfalz** had a variable trend, but almost positive, since the 70s. The top of the volume of the imports of this Land through Hamburg was reached in the years 1993-1994, with around 470 thousand tons of goods. Afterwards, it seems that there is a decline in the imports through the Hanseatic port. In the year 1999, the volume of goods imported by this Land was of 205,8 thousand tons.

**Brandenburg** received in the year 1998 a volume of 271,8 thousand tons of cargo through the seaport of Hamburg, with a growth of +29,4% with respect to the previous year. Since the year 1989, the trend of the volume of the imports through the seaport of Hamburg has been quite variable. The share of the total imports of Hamburg towards this Land was 1,7% in the year 1998. In the year 1999, the fall to 196 thousand tons of goods imported confirmed again the variability of this Land to make use of Hamburg as gateway for its imports.

**Bremen** reinforced the use of the port of Hamburg for its imports since the year 1990. There was a pick of 343,8 thousand tons in the year 1994, no reached anymore. The year 1999 saw a volume of 170,4 thousand tons imported through Hamburg, that confirms the trend of the last decade.

**Saxony** showed a positive trend in the years between 1994-1997, when the imports grew up from 92,6 thousand tons in the year 1991; to 118,4 in the 1994; and finally to the pick of 171,6 thousand tons in the 1997. In the year 1998, Saxony imported 153,5 thousand tons through the Hanseatic seaport. It was a decrease of -10,5% in the volume of cargo imported through the seaport of Hamburg in the year 1998, if compared to the previous year. The share of the foreign trade of the imports of Hamburg corresponded to 1% in the year 1998. In the year 1999, Saxony imported a lower volume of goods through Hamburg, that was equal to 137,3 thousand tons. It was around the value of the 1996.

Despite of the growth of +43,3% of the volume of cargo imported through the seaport of Hamburg in the year 1998 with respect to the previous year (105,4 thousand tons in the year 1997, the lowest volume of cargo since the German Unification), **Mecklemburg-Vorpommern** shows a negative trend since the year 1989 (381,5 thousand tons in the year 1989, 151 thousand tons in the year 1998). The share of the imports on the foreign trade of the seaport of Hamburg corresponded to 1% in the year 1998. In the year 1999, the imports of this Land through Hamburg felt down to 133,2 thousand tons, that was the same volume of the 1996.

Table 8.2 – The German Länder of destination of the imports through the port of Hamburg, with respect to the volume of the outgoing cargo, 1970-1999.

Year	Total outgoing		of which towards						
	Total volume	Share on the German foreign trade	Baden-Württemberg	Bayer	Berlin	Brandenburg	Bremen	Hamburg	Hessen
	1000 Tons	%	1000 Tons						
1970	5 817,4	4,7	239,5	275,5	68,7	.	18,5	2 445,2	293,9
1975	7 428,6	5,3	286,6	277,5	89,0	.	23,7	2 625,1	534,5
1976	7 485,6	5,1	287,8	293,9	106,4	.	15,3	2 564,0	449,7
1977	7 582,3	5,0	237,2	303,1	104,1	.	68,5	2 440,1	546,0
1978	8 457,7	4,9	281,7	334,9	115,2	.	33,4	2 663,3	896,6
1979	8 328,4	4,7	301,4	302,1	113,3	.	9,6	2 492,0	900,0
1980	8 069,7	4,6	294,1	297,1	108,7	.	68,0	2 340,7	925,7
1981	9 583,7	5,5	309,1	386,4	161,1	.	112,9	2 485,1	899,1
1982	9 493,9	5,7	305,5	377,9	113,5	.	82,7	2 703,0	827,5
1983	8 192,8	4,9	250,3	415,8	98,2	.	36,6	2 199,5	843,5
1984	9 260,8	5,2	282,4	416,6	104,0	.	45,0	2 535,3	1 219,7
1985	10 710,7	6,0	336,8	461,8	133,0	.	64,3	2 940,7	1 121,5
1986	9 250,5	5,4	309,1	477,5	106,3	.	41,7	2 819,6	1 143,8
1987	11 393,7	6,4	302,0	442,2	78,7	.	72,0	3 119,9	1 237,2
1988	10 389,0	5,6	363,3	446,8	62,9	.	89,7	3 023,5	1 302,9
1989	10 695,6	5,3	352,1	496,1	74,0	.	78,6	2 865,1	1 304,9
1990	10 912,3	5,4	353,3	530,3	84,7	.	98,4	3 324,3	1 557,0
1991	13 753,4	6,4	350,6	487,7	746,7	257,9	119,6	4 201,2	1 505,0
1992	13 659,0	6,3	384,8	544,2	81,6	126,5	172,4	4 593,6	1 415,7
1993	15 556,4	7,7	562,5	837,3	59,1	139,7	193,9	4 588,0	1 353,4
1994	18 263,1	8,4	614,4	781,5	57,8	203,1	343,8	5 704,5	1 554,3
1995	16 706,1	7,7	546,7	751,7	56,4	176,6	243,0	5 547,7	1 393,2
1996	16 190,0	7,1	556,5	786,0	87,4	202,0	232,5	5 196,4	1 346,5
1997	15 780,0	6,6	589,3	913,8	82,5	210,1	178,7	3 926,0	1 467,1
1998	15 859,6	6,3	544,8	896,8	126,9	271,8	138,0	4 667,2	1 326,1
1999	14 878,3	6,0	460,9	730,2	262,3	196,0	170,4	3 364,2	945,1

Table 8.2 – Second part: The German Länder of destination of the imports through the port of Hamburg, with respect to the volume of the outgoing cargo, 1970-1999.

Year	of which towards								
	Mecklenburg-Vorpommern	Low Saxony	Nordrhein-Westfalen	Rheinland-Pfalz	Saarland	Saxony	Saxony-Anhalt	Schleswig-Holstein	Thuringia
	1000 Tons								
1970	.	976,0	922,5	79,5	76,3	.	.	421,9	.
1975	.	1 412,0	1 060,0	86,0	87,7	.	.	269,7	.
1976	.	1 392,9	1 079,1	92,4	87,0	.	.	263,2	.
1977	.	1 669,3	1 036,8	96,2	102,6	.	.	307,1	.
1978	.	1 592,2	1 283,0	108,0	82,0	.	.	356,8	.
1979	.	1 581,0	1 312,3	132,1	76,6	.	.	331,5	.
1980	.	1 585,0	1 094,2	115,3	80,7	.	.	274,5	.
1981	.	1 790,7	1 127,6	151,2	61,1	.	.	537,7	.
1982	.	1 345,4	1 144,5	145,2	69,3	.	.	270,3	.
1983	.	1 184,8	1 153,1	179,9	104,5	.	.	305,1	.
1984	.	1 539,8	1 357,2	185,3	118,8	.	.	352,6	.
1985	.	1 628,6	1 431,9	201,7	127,8	.	.	263,9	.
1986	.	1 680,9	1 242,5	174,1	55,5	.	.	435,1	.
1987	.	2 107,2	1 079,8	152,9	133,4	.	.	546,2	.
1988	.	1 836,1	1 317,6	204,8	166,9	.	.	460,7	.
1989	.	1 940,4	1 477,4	219,4	53,3	.	.	557,0	.
1990	.	1 888,6	1 402,1	194,7	43,7	.	.	370,5	.
1991	381,5	1 892,5	1 507,6	177,9	67,2	92,6	413,2	388,3	458,3
1992	385,4	1 899,3	1 423,6	240,6	44,3	60,1	817,0	505,3	479,2
1993	233,4	2 172,5	2 291,0	487,3	102,5	69,1	592,0	476,3	853,0
1994	257,2	2 402,7	2 567,7	466,2	50,7	118,3	1 578,7	532,0	537,6
1995	243,3	2 081,2	2 007,1	319,6	46,6	139,4	1 594,7	611,4	239,5
1996	133,4	1 522,9	2 424,3	351,5	74,4	142,5	1 576,1	751,3	324,5
1997	105,4	1 964,0	2 359,4	318,8	115,9	171,6	1 821,3	809,4	360,1
1998	151,0	1 517,6	1 906,6	253,3	68,0	153,5	2 388,6	633,1	319,4
1999	133,2	1 621,8	1 541,9	205,8	108,4	137,3	1 999,3	2 086,3	290,4

### 8.2.3 The Geographic Split of the German Foreign Trade with respect to the Value of the Cargo

According to the methodology in use by the Statistische Landesamt of Hamburg, the German foreign trade in transit through the Hanseatic City is expressed in terms of general trade in monetary value. The general trade defines the incoming cargoes as the incoming goods that are originated from the free traffic and from the warehouses. The general trade defines the outgoing cargoes as the direct outgoing, and as the outgoing from the warehouses. The geographic split of the incoming and outgoing general trade is expressed in monetary value in the Table 8.3 and in the Table 8.4.

The share of the German foreign trade in transit through the seaport of Hamburg is declining since 1970, from 11,8% to 8,3% in 1999. The share on the incoming cargo decreased from 12,3% in 1970 to 9,1% in 1999. The share of the outgoing cargo decreased from 11,4 in 1970 to 7,6% in 1999.

Table 8.3 – The geographic split of the German foreign trade, according to the monetary value of the incoming cargo through the port of Hamburg 1970-1999.

Year	Total incoming	of which from										Share on the German foreign trade
		Total Europe	EU	EFTA	Central, Western Europe	Total Africa	Total America	USA	Asia	East Asia	Australia, Oceania	
	Millions DM					Millions DM					%	
1970	14 224	2 924	565	1 423	490	1 830	5 179	2 757	3 767	2 592	225	12,3
1971	14 572	3 495	841	1 479	504	1 546	4 985	2 721	4 259	2 753	281	11,7
1972	15 015	3 364	800	1 288	514	1 408	5 047	2 571	4 709	3 211	485	11,2
1973	17 629	3 901	1 438	703	817	1 685	5 742	2 971	5 710	3 719	591	11,5
1974	22 311	4 397	1 692	835	903	2 477	7 213	4 060	7 582	5 026	643	12,3
1975	21 437	3 935	1 573	769	806	1 951	7 142	3 995	7 758	5 146	651	11,3
1976	26 915	5 263	2 519	720	1 111	2 520	8 347	4 353	2 838	7 161	674	11,8
1977	29 677	6 501	3 417	914	1 220	2 802	8 571	3 870	11 053	8 032	750	12,3
1978	28 691	6 617	3 041	1 012	1 630	1 960	8 481	3 941	10 904	8 214	729	11,5
1979	34 623	9 635	4 896	1 204	2 521	2 352	9 456	4 579	12 406	9 258	774	11,6
1980	42 207	10 968	6 855	1 362	1 663	3 115	11 370	5 996	15 865	11 691	889	12,0
1981	47 461	13 511	9 398	1 592	1 445	2 734	11 709	6 683	18 598	14 253	909	12,5
1982	50 371	17 081	12 769	1 794	1 426	2 966	10 752	5 740	18 494	13 826	1 079	13,1
1983	44 232	14 450	10 381	1 458	1 590	2 507	9 299	4 585	16 878	15 052	1 099	11,1
1984	49 723	16 158	10 998	1 895	2 023	3 122	9 708	4 233	19 351	17 568	1 384	11,2
1985	54 537	16 827	11 365	2 387	1 906	3 824	12 495	6 120	20 167	18 397	1 223	11,5
1986	45 932	11 239	7 421	2 202	1 304	3 396	9 739	4 842	20 449	18 888	1 108	10,8
1987	46 017	11 523	7 342	2 652	1 183	2 371	8 128	4 290	23 013	21 249	981	11,0
1988	49 503	12 489	8 832	2 409	1 000	2 965	8 007	4 046	24 930	23 047	1 111	11,0
1989	55 509	14 142	10 211	2 673	990	2 545	8 905	4 497	28 154	26 073	1 762	10,7
1990	57 768	15 953	11 412	3 009	1 237	2 288	8 628	4 410	29 627	27 386	1 270	10,3
1991	74 164	22 271	17 056	3 264	1 559	2 369	10 543	5 346	37 857	34 818	1 123	11,3
1992	66 573	19 346	14 644	3 098	1 289	1 954	9 267	4 939	34 755	31 814	1 249	10,3
1993	55 759	8 404	4 249	2 618	1 188	1 598	8 983	4 781	35 696	32 271	1 075	10,1
1994	57 497	8 328	4 221	2 426	1 138	1 883	10 505	5 316	35 555	31 800	1 225	9,3
1995	54 091	7 091	4 523	920	1 108	1 991	10 168	5 078	33 600	29 825	1 240	8,4
1996	56 534	8 782	5 826	1 193	1 142	2 042	10 513	5 713	33 928	29 983	1 268	8,3
1997	68 153	12 991	9 082	1 394	1 746	2 182	12 911	6 624	38 660	34 158	1 408	8,9
1998	75 889	17 807	14 215	1 232	1 474	2 111	13 664	6 951	40 968	36 330	1 333	9,2
1999	78 444	18 445	14 795	1 007	1 788	1 829	16 951	9 598	40 042	35 719	1 172	9,1

The gateway function of the port of Hamburg for the German foreign trade is relevant for the incoming and outgoing cargo from/to the East Asia and the U.S.A., as well as for the countries of the European Union, although if the trend of the share of the German foreign trade is declining since the beginning of the 70s.

The analysis of the data shows a constant trend with respect to the countries of the Central and East Europe since the year 1970. It seems that the German foreign trade did not improved the use of the port of Hamburg after the Fall of the Berlin Wall, as it might be supposed to happen.

On the contrary, it is stressed the role of Hamburg as main port for the overseas trade towards and from America and Asia, as well as the variable values of the German foreign trade through Hamburg with the EU. This value declined between the years 1993-1996, and since 1997 it shows a positive trend.

From a long term perspective, the value of the incoming cargo from Asia, and in particular from East Asia, are growing since 1970, while the outgoing cargo of the German foreign trade through the port of Hamburg are showing a negative trend since the last three years. The total German foreign trade to/from Asia in monetary values declined in 1999 (69.258 millions DM as a whole in 1999, 75.841 millions DM in 1998), and for East Asia (56.868 millions DM in 1999, 62.988 millions DM in 1998).

The value of the incoming and outgoing cargo from the American continent, and in particular from the United States, shows a positive trend during the past three decades. The total German foreign trade to/from U.S.A. was equal to 23.285 millions DM in the year 1999, with respect to 39.548 millions DM of America as a whole.

The EFTA countries, on the contrary, are losing of importance for the German foreign trade through Hamburg since 1995, both in terms of incoming and outgoing movements. The total German foreign trade incoming/outgoing through the seaport of Hamburg was equal to 1.765 millions DM in the year 1999, while in the year 1970 their value was of 3.226 millions DM.

Table 8.4 – The geographic split of the German foreign trade, according to the monetary value of the outgoing cargo through the port of Hamburg 1970-1999.

Year	Total outgoing	of which towards										Share on the German foreign trade
		Total Europe	EU	EFTA	Central, Western Europe	Total Africa	Total America	USA	Asia	East Asia	Australia, Oceania	
Millions DM						Millions DM						%
1970	14 745	3 860	414	1 803	502	2 397	4 375	1 804	3 426	2 218	630	11,4
1971	15 313	3 883	455	1 760	464	2 604	4 519	1 791	3 507	1 891	730	10,9
1972	15 397	4 231	495	1 936	576	2 546	4 577	1 787	3 324	1 779	659	10,0
1973	17 428	5 335	2 142	1 075	929	2 980	4 244	1 605	3 999	2 292	818	9,4
1974	25 690	7 164	2 450	1 451	1 672	4 319	6 196	2 416	6 054	3 436	1 400	11,0
1975	22 804	6 713	2 085	1 106	2 176	4 254	4 899	1 664	5 860	3 019	1 026	10,1
1976	25 857	7 591	2 874	1 389	2 121	5 018	5 538	1 935	6 480	3 344	1 172	9,9
1977	25 747	6 321	2 517	1 396	1 318	5 120	5 867	2 293	7 035	2 947	1 362	9,2
1978	26 545	5 754	2 422	1 236	1 219	5 704	6 095	2 692	7 612	3 405	1 324	9,2
1979	27 734	6 902	3 373	1 190	1 438	4 932	6 129	2 473	8 451	4 764	1 255	8,6
1980	30 090	7 955	3 561	1 454	1 859	5 982	6 812	2 517	8 052	4 046	1 236	8,4
1981	38 221	10 773	6 533	1 607	1 840	7 658	7 639	2 791	10 509	5 072	1 569	9,4
1982	43 299	15 417	10 454	1 748	2 362	7 360	6 856	2 852	11 777	5 342	1 826	9,9
1983	40 659	11 805	7 550	1 295	2 086	5 774	8 788	4 323	12 746	7 238	1 483	9,2
1984	45 115	15 074	10 470	1 529	2 334	6 230	7 289	3 217	14 288	8 299	2 160	9,1
1985	48 892	14 071	9 391	1 489	2 218	5 913	8 585	4 463	17 481	10 979	2 781	8,9
1986	42 899	9 788	6 265	1 782	1 246	4 818	8 644	4 354	16 951	11 794	2 587	8,0
1987	39 220	9 773	6 321	1 506	955	3 888	7 747	3 883	15 102	11 054	2 190	7,3
1988	46 246	11 989	8 892	1 313	1 146	5 096	9 198	4 932	17 595	13 073	2 329	8,0
1989	52 581	15 921	12 338	1 628	1 319	5 380	8 914	4 885	19 414	14 761	2 949	8,0
1990	53 509	14 718	11 342	1 434	1 296	5 398	8 923	4 953	22 067	17 182	2 395	8,2
1991	60 241	19 390	16 293	1 414	815	5 417	8 652	4 200	24 718	18 450	2 058	8,9
1992	59 072	16 665	13 868	1 262	791	4 959	8 914	4 374	26 142	19 356	2 382	8,7
1993	59 721	7 320	4 377	1 006	935	5 005	13 344	7 443	31 638	24 179	2 400	9,7
1994	64 133	6 989	4 150	1 307	716	4 457	14 154	7 752	35 866	27 273	2 658	9,2
1995	67 248	7 519	4 157	953	907	4 970	15 300	8 412	36 592	28 461	2 860	9,1
1996	69 855	7 442	4 699	763	742	4 984	16 180	8 636	38 536	30 586	2 669	8,9
1997	82 362	12 583	9 190	1 011	1 369	5 743	20 344	10 256	40 414	31 940	3 228	9,2
1998	87 150	19 189	15 897	855	1 155	5 607	24 021	13 011	34 873	26 658	3 402	9,1
1999	75 112	15 153	12 420	758	999	5 479	22 597	13 687	29 216	21 149	2 629	7,6

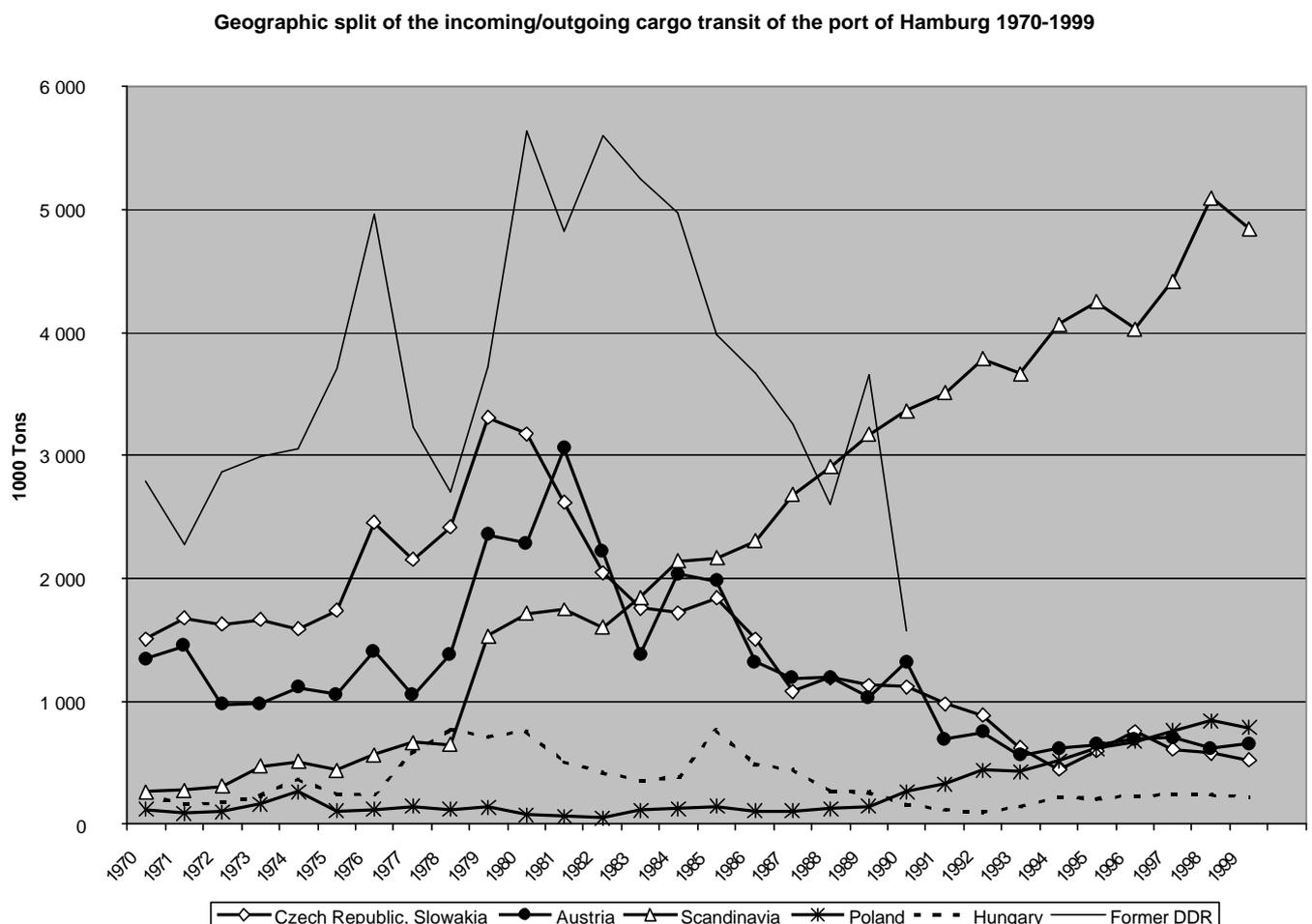
### 8.3 The Transit Function of the Seaport of Hamburg

The traditional geographic function of a seaport site is to be the interface node between the maritime space and the territorial space. The gateway function of a seaport city-region is aimed to enable the mobility of people and goods between the two territorial spaces, i.e. its geographical hinterland and foreland. The following part analyses the transit freight traffic of the seaport Hamburg.

### 8.3.1 The Maritime Transit of Cargo through the Port of Hamburg

According to the methodology used by the Statistisches Landesamt of the Free and Hanseatic City of Hamburg, the transit cargo traffic is defined as all the maritime incoming/outgoing freights that are originated/delivered from/towards a foreign country (Figure 8.3).

Figure 8.3 – The geographic split of the total transit (incoming/outgoing goods) through the port of Hamburg 1970-1999.



The Figure 8.3 shows the geographical split of the transit freight traffic of the seaport Hamburg since the year 1970. The transit function of the seaport Hamburg became more and more significant for the Scandinavian countries and for Poland during the last decade. The positive trend of both regions is exploited on two different scales. The Scandinavian Countries reached a transit volume of cargo equal to 5.095 thousand tons in the year 1998 (in the year 1990: 3.366

thousand tons), while the Polish freight transit traffic in the year 1998 was of 842 thousand tons (in the year 1990: 263 thousand tons).

Czech Republic, Slovakia and Austria, geographically located in the Central Europe, progressively reduced the use of Hamburg as transit port for their commercial traffic. In the year 1998, the freight transit volume was equivalent to 581 thousand tons for the Czech Republic and Slovakia, and to 614 thousand tons for Austria. The peak transit volume was reached in the year 1979 by the Czechoslovakian Republic with 3.310 thousand tons, and in the year 1981 by Austria with 3.060 thousand tons.

Figure 8.4 – The geographic split, for selected countries of origin, of the incoming cargo in maritime transit through the port of Hamburg 1970-1999.

Geographic split of the incoming freight transit of the port of Hamburg 1970-1999

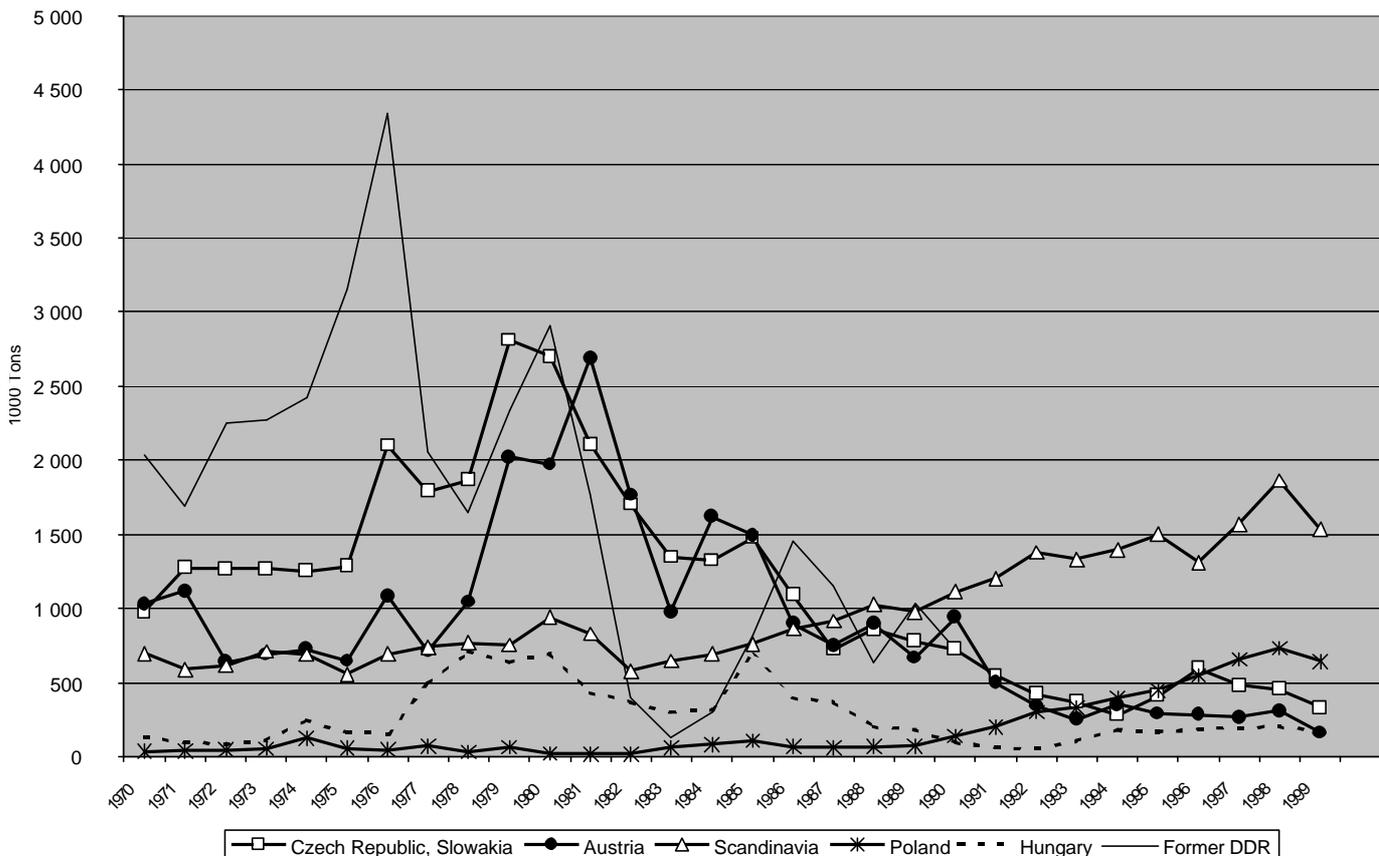
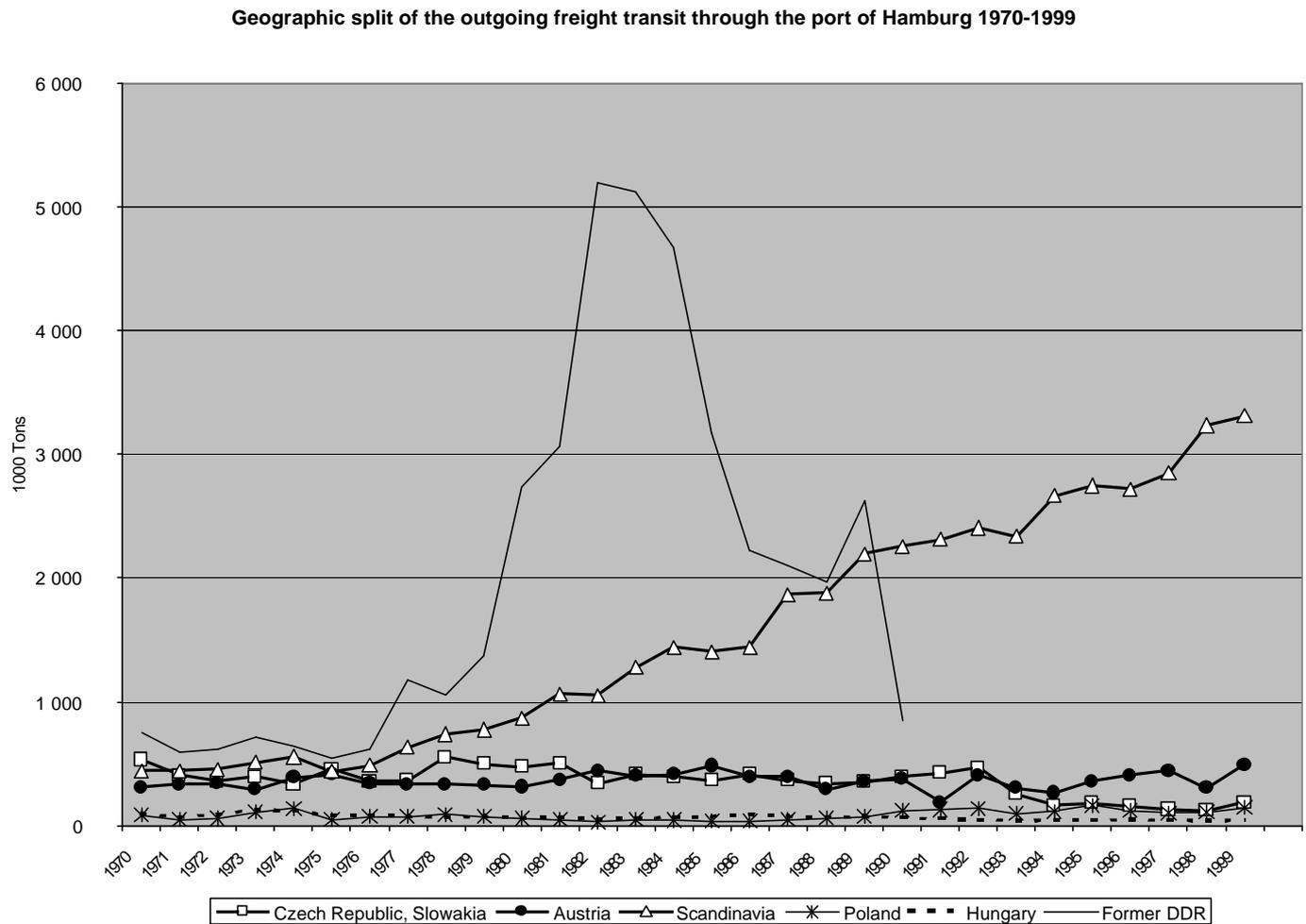


Figure 8.5 – The geographic split, for selected countries of destination, of the outgoing cargo in maritime transit through the port of Hamburg 1970-1999.



### 8.3.2 The Transit of Cargo by Road and by Inland Waterways through the Port of Hamburg

According to the methodology of the Statistisches Landesamt of Hamburg, the transit of goods through the seaport of Hamburg is also defined in terms of incoming/outgoing cargoes in transit by road and by inland waterways.

The analysis of the statistic data shows that these two transport modalities are particularly relevant for the shipments directed towards Denmark (666.000 tons sent in the year 1999, with a growth of +27,8% with respect to 1998), Sweden (336.000 tons sent in the year 1999, with a growth of +72,7% with respect to

1998), Czech Republic (173.700 tons send in the year 1999, with a growth of +59,8% with respect to 1998), Austria (494.900 tons send in the year 1999, with a growth of +62,2% with respect to 1998), Hungary (44.000 tons send in the year 1999, with a growth of +16,1% with respect to 1998), France (10.200 tons send in the year 1999, with a growth of +17,2% with respect to 1998).

The deliveries towards Spain grow up to 3.600 tons (+11,8% with respect to 1998), although the geographic distance between Hamburg and this country. In fact, on the long distance the shift from the road to the rail transport modality should be promoted. In the case of Spain, the shipment by sea through Hamburg lost of -20,9% in 1999 with respect to 1998.

The transit of cargo towards Russia through the port of Hamburg increased of +202,2% in the year 1999 with respect to the previous year (229.700 tons send in 1999), while the transit by road and waterways decreased of -14,9% in the same year (16.500 tons send in 1999). The low quality of the transport infrastructures from the West Europe towards Russia explains the prevalence of the use of the maritime transport modality in these area.

The Czech Republic and Slovakia (50.100 tons received in Hamburg with a growth of +7,7% in the year 1999 with respect to 1998) shows an increase in the incoming/outgoing freight transit by road and waterways. In particular, the growth in the outgoing transit towards the Czech Republic may be explained by the new Elbe Container Line ECL.

Poland shows a decrease both in the incoming/outgoing cargo transit through Hamburg by road and waterways (-14,8% in the year 1999 with respect to 1998 with refer to the 463.400 tons of incoming goods in 1999; -24,1% % in the year 1999 with respect to 1998 with refer to the 29.900 tons of outgoing goods in 1999), although the geographical proximity of Germany and Poland.

Once again, the insufficiency in the transport network on the land side plays the decisive role on the choice of the most efficient transport mode. In this case, the maritime transit through Hamburg towards Poland grew of 66,6% in 1999 (117.100 tons delivered from the German seaport).

## **Section 5**

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### **The Seaports of the Northern Europe**



## 9 The Seaports of the European Northern Range

### 9.1 *The Main Seaports of the Northern Range*

The idiom “European Northern Range” is commonly used in the maritime transportation sector in order to identify the seaports on the Atlantic Ocean along the coastal line that embraces the maritime sites of Antwerp, Rotterdam, Bremen-Bremerhaven and Hamburg (Map 4).

The ports of the European Northern Range are sharply differentiated by the Mediterranean seaport sites, in particular by the Italian ports, because of the different approach to the seaport management of the competent public authorities. In fact, until just few years ago, the Southern European seaports were managed as a public service that the State had to provide [Degrassi, 1997/98]. On the contrary, the management of the seaports of the European Northern Range follows the quite different approach of seaport-as-entrepreneur.

In the Northern Europe, the natural geographical advantages offered both by a thick inland waterway network, and by the large navigable rivers across the whole continent, as well as by the big industrial clusters settled in the European core areas such as the Ruhr region, all played a positive role in favour of the development of an efficient inter-modal transport network. Undoubtedly, the set of factors just mentioned enabled the flourishing as well as the prosperity of the seaport sites along the Northern Range, while the others European maritime sites were relegated to a secondary role (Map 3).

Therefore, stimulated by the entrepreneur approach of the seaport management, the Northern European maritime ports gained the trust of the ocean carriers and attracted the stopping calls of the inter-continental shipping lines. This strategic location choice of the shipping companies may be referred not only to the stopping calls within the maritime routes between Northern America and Europe, where the geographical location of the Northern Range main ports with respect to the Mediterranean maritime sites is incontrovertible, but also to the maritime routes between Europe and Asia, where the Mediterranean seaport sites should be geographically favourite.

With reference to the Far East commercial routes, the Mediterranean maritime ports offer a temporal advantage equal to 5/6 days of navigation with respect to the main ports of the Northern Range. Notwithstanding, the choice of the shipping companies in favour of the seaports of the Northern Range is supported by two factors: 1) the inadequacy in the maritime infrastructures at the Mediterranean ports; and 2) the lack in the efficiency of the transport network that links the Mediterranean ports to the hinterland [Informare, 1998].

The major attractiveness of the Northern Range seaports may be explained by a flourishing industrial hinterland linked through an efficient transport network, a superior marketing capability, as well as a better integration of the seaports within the whole transport chain (i.e. door-to-door services, reduced waiting time, as well as a better quality of the service).

### **9.1.1 *The Management at the Seaports***

The port operators of the Northern Range commonly have a high degree of professional preparation. Furthermore, the public agents usually have a correct approach to the maritime sector, that is also remarked by the advanced level of intervention in the non-traditional sectors of the economy of the seaport, with respect to the classical seaport functions.

The non-traditional activities of the maritime economy can be summarized as follows:

1. The planning of the seaport developments is made on a medium-long term basis. For example, Hamburg, Rotterdam and Antwerp have already planned the spatial expansion of the seaport till the year 2010.
2. The typical aggressive way of promotion of the seaport services, by the use of the most advanced techniques of marketing and public relations on a world wide scale. The Port of Hamburg Marketing and Public Relations - Hafen Hamburg Verkaufsförderung und Werbung HHVW has settled more than 14 foreign representative offices on 3 continents. All together, the Northern Range seaports have settled more than 55 commercial representative offices in Europe and in the rest of the world.
3. The activity of professional training are frequently implemented, with the goal to improve the quality of the technical preparation of the human resources of the seaport community at the seaport site.

4. The development of ad hoc software packages, in order to promote the Electronic Data Interchange EDI. This is thought to be a milestone, in order to exploit the higher efficiency of the inter-modal system through the door-to-door transportation [Kuby et al., 1992]. The internal flexibility of the flexible or post-fordist accumulation may be achieved. At Hamburg, this task is exploited by DAKOSY AG, a software company that specifically works for developing and promote the electronic data interchange between seaports and their hinterland with the goal to achieve a paperless-port.
5. The availability of the most up-to-date seaport infrastructures in order to offer the most modern technologies to the ocean carriers.
6. Furthermore, there is a high degree of collaboration between the seaport private operators, the municipality and the port authority, the so called corporate identity.

Some trends of strategic development may be pointed out when the expansion plans of the Northern Range seaport are observed, as follows:

first, the sharp pressure on the development, enlargement and improvement of the container branch; second, the search for a general improvement of the relationship between the city-region and its port, in particular by the revitalization of the waterfront; third, the selection of the economic activities that could generate added value, as the industrial clusters, the logistics activities, etc.; finally, the goal of developing the links towards the seaport hinterland.

Due to the huge infra-structural investments made in all the Northern European seaports during the past decades, the supply of the maritime port services at the Northern Range seaport sites, expressed by their potential to handle goods, is expected to rise more than proportionally with respect to the short term needs of the shipping companies, hence with respect to the demand of maritime services.

The oceanic carriers are using larger and larger freight vessels. The seaports are supposed to adapt their equipment in advance. It follows that it could be predicted an excess in the supply of maritime services, with respect to the demand of them in the short-medium term. Therefore, the reduction in the economic margins, that the seaport operators might exploit, will be expressed in a sharper and more aggressive policy of marketing on the international level.

## 9.2 The Spatial Agglomeration and the Network Interaction

The maritime seaport of the Northern Range handle the overseas European freight traffic on the Atlantic Ocean. They are traditionally specialized in the bulk cargo handling, although there was a stagnation trend during the last 15 years. In spite of this trend, the barycentre of the cargo handling at Rotterdam is given by the import of raw petroleum products. Moreover, the overseas container line services on the Atlantic Ocean make necessarily their stopping calls at the Northern Range main ports [von Rohr, 1996].

The Northern and Baltic European regions are linked to these main ports by feeder services. Hence, the extension of the hinterlands of the Northern Range main ports often overlap with respect to the final destination towards both the EU states and the Central- and Eastern Europe. In comparison to the bulk cargo, the handling of the general cargo, which includes also the container as well as the conventional cargo, is more and more concentrated just on few main seaport sites per continent.

Table 9.1 – The world fleet of the container vessels.

Description	Status 1 <sup>st</sup> /2/1994	Variation 1986-1994
Number of vessels	1387	+ 42%
Loading capacity dwt <sup>1</sup>	34	+ 76%
Loading capacity 1000 TEUs <sup>2</sup>	2.2	+ 103%

<sup>1</sup> dwt = dead weight tonnage.

The dwt indicates the maximum cargo weight a vessel may carry without surpassing the freeboard line. The cargo include both the stocks and the fuel [Ente Autonomo del Porto di Trieste, no year].

<sup>2</sup> TEU = Twenty-foot Equivalent Unit.

A TEU indicates the length of a standard container according to the International Standard Organization ISO parameters. The 20 feet container is taken as the standard unity [Borruso, 1971] [Ente Autonomo del Porto di Trieste, no year].

The reasons that lead towards this deep and intensive specialization of the main ports, in particular during the last 15 years, may be searched into the growing division of labour at the international level of the economy, the rising liberalization of the trade on a world scale, the special development of the commercial relationships between Europe and East-South East Asia, as well as the slow but appreciable opening of the Eastern and Central European countries to the market economy.

It is forecasted a considerable increase of the container traffic at world level, that could be lead to a double volume of the containers handled during the next 10 or 15 years. This positive growing trend is matched by the dynamic enlargement of the world container vessels fleet. The Table 9.1 shows the consistency of the world container fleet since the year 1994, as well as its variation since the year 1986 and till the year 1994 [von Rohr, 1996]. Only the container ships with the Gross Register Ton GRT exceeding 300 are taken in account.

Within the Northern Range area, the maritime ocean activities are clustered at few seaport sites, or only at one or two main ports. It is important to point out that no main port is able to threaten the others, due to the following factors:

1. A huge financial availability is necessary in order to afford the long term investments plans for building infrastructure at the seaport sites [Borruso, 1971]. The public agent has to support these expenditures. In Hamburg, the financial availability may be referred both to the deepening works of the river Elbe, and to the expansion of the port area at Altenwerder [Nuhn, Oßenbrügge et al., 1983].
2. The free land areas where each maritime site could expand its operative capacity are limited from a quantitative point of view [Wirtschaftsbehörde, 1997]. This limit focus on the impossibility to expand the seaport area endlessly. For example, the main port of Rotterdam is expanding now by following a networking conception. The first European seaport is building the new port sites far away from its geographical core, because there are no more free areas available. The Hamburg Senat stresses the need to handle often more than 2000 container a day per each area of depot, during the loading/discharge operations of the big container ships [Wirtschaftsbehörde, 1997]. Moving from this consideration, it emerges the need of availability of wider and wider handling area at the quay. Therefore, the most relevant problem of the main ports is the scarcity in the supply of free space.

3. From the scarcity in the supply of free space, it follows the growing resistance performed at every seaport site to make use of large portions of free land. For example, Rotterdam lost a quote of its container traffic in favour of the seaports of Hamburg and Antwerp during the last 5-8 years, although if it is unquestioned the advantage of Rotterdam in terms of dimension.

In any case, the seaport policy within the Northern Range main ports gives the absolute priority to the investments for the seaport spatial expansions, as well as for the new infrastructures and superstructures. This means the expansion of the seaport area, the increase in the transshipment cargo operations, as well as the restructuring of the old port areas in order to gain new land in reserve.

With reference to the main ports of the Northern Range in particular, two pairs of main ports can be defined, according to the different spatial extension of the hinterland. The first pair is formed by the two main ports of Hamburg and Bremen-Bremerhaven. From the geographical point of view, they are quite close to the Central, Eastern, and Northern Europe (Map 2 and Map 4).

The second pair is given by the two main ports of Rotterdam and Antwerp, geographically oriented towards the Central-Western Europe (Map 3), and embracing the whole Rhine region. In spite of this geographical split of their hinterland, there is in fact a quite broad superimposition of the hinterlands of these main ports. Anyway, the most relevant shift in the share of the commercial traffic occurs between the two main port pairs of Hamburg-Bremen and Rotterdam-Antwerp, while the total sum of the market share with refer to the Northern Range as a whole remains constant.

The negotiations between the port authorities and the line shipping companies; the feeder services; the public and private rail companies, especially for the Eastern European countries; as well as the international forwarders and logistics companies could be accepted as a set of wide indicators of the division of labour between the Northern Range main ports within the framework of the growing volume of freight traffic.

The interests involved are quite various. The shipping companies wish to minimise the number of main ports for their stopping calls. This action is called traffic consolidation from a wide number of seaports to a reduced number of dominant seaport sites [Kuby et al., 1992]. The rail activities also tend to be clustered just on few seaports, with the aim to achieve the optimum in the hinterland connections. Furthermore, the logistics companies look for a central

location as the basis for their logistics activities directed to their international clients, as well as a departure site in order to enlarge their commercial relationships. A relevant role is played by the technological changing in the loading/discharge operations, as well as the increasing availability of space within the neglected old port areas. At these locations, the logistics service companies may find an interesting supply of space to turn into their activities.

### ***9.2.1 The Market Position and the Spatial Scale of Competition between the Seaports of the Northern Range***

The main container ports of the European Northern Range are marked by a sharply competition due to the overlapping of their hinterlands [Degrassi, 1997/98], while the competition among the German seaports is negligible [Deecke et al., 1996]. The principal characteristics of the competition among the Northern Range seaports cover two aspects.

The first is a quantitative pattern, that is the remarkably growth in the volume of the container flow within the international scope during the last years. It is forecasted a double in the volume of the container flow during the next 10-15 years.

This expectation justifies the high level of the investments in the port infrastructures already planned [Kuby et al., 1992], but at the same time the seaports have to face the spatial problem of the limitation in the availability of free areas for the expansion. Hence, no main port within the Northern Range is supposed to be in the dominant position within this competition framework.

The second is a qualitative pattern. This refers to the seaport technological and organizational development forecasts. Four factors of influence can be mentioned, as follows:

1. The use of container vessels with a bigger and bigger loading capacity. Since the Middle of the 80s, the container ships of the III<sup>rd</sup> generations became operative.

They have a 3000 slots capacity for 20 TEUs containers, where the number of slots means the number of standard containers of 20 TEUs each a vessel can be loaded with. These container ships are mainly operative along the North America-East Asia routes, as well as the Europe-East Asia routes.

The bigger container vessels have a loading capacity of 6000 TEUs. They are called post-panamax or post-panamax because their dimensions exceed the limits of the Panama Canal (that is 32,5 meters bright, while these vessels are more than 40 meters bright).

A further remark regards the age of the container fleet at the world level, which is over 20 years old. This means that during the next years, the fleet will be replaced mainly by the III<sup>rd</sup> and IV<sup>th</sup> generation container ships with a load capacity equal respectively to 3000 and 4500 TEUs, and a maximum draft equal to 13,5 meters.

Following these considerations, the seaports have to adapt their equipment to the new standard ships of the next future. Hence, the accessibility to the seaport site has a necessary requirement to achieve [Mayer, 1973], although the ecological impact on the maritime locations can be quite relevant as well as underestimated.

Furthermore, it seems to be not desirable the building of the 8000 TEUs container ships because it would be necessary to remove the existing maritime port equipment, to enlarge considerably the stock capacities, as well as to restructure the whole transportation chain.

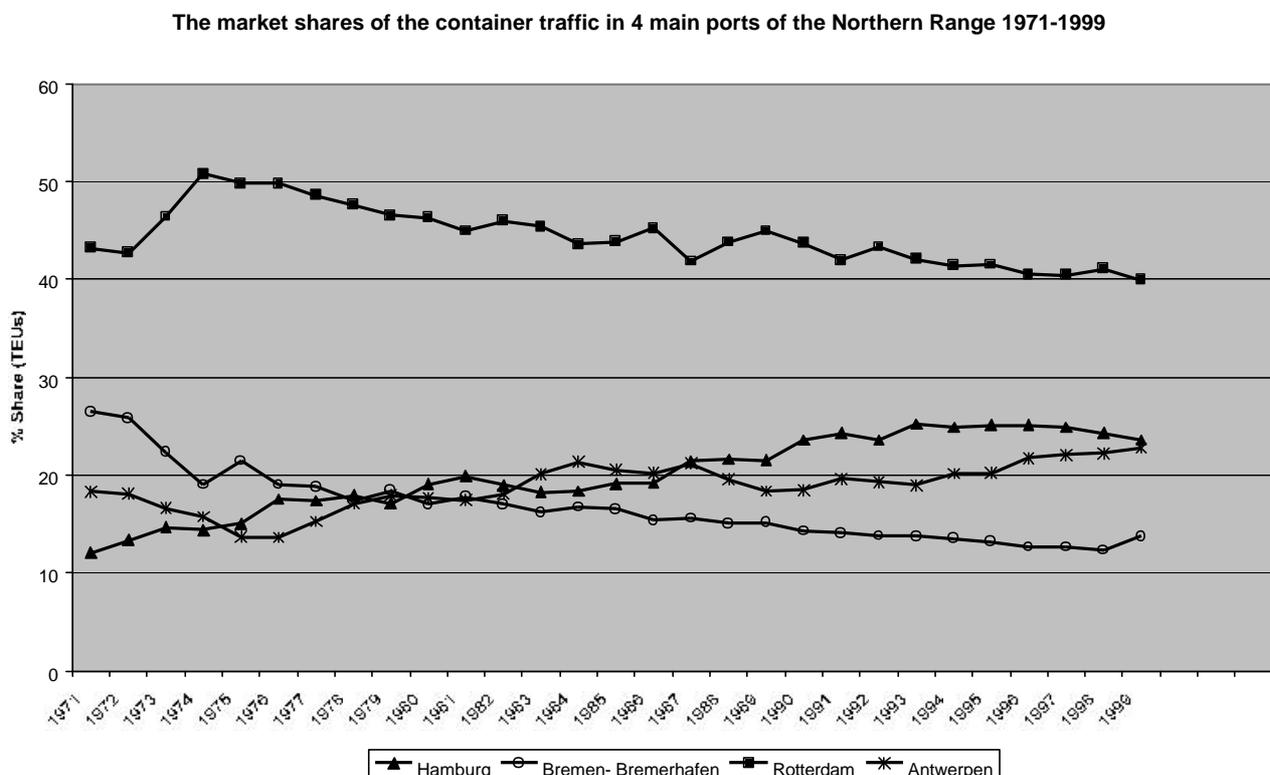
2. The shortening of the stopping time at the seaport. In order to achieve this goal, a continuous rationalization of the container handling operations is required to accelerate the terminal activities.
3. The decrease in the number of the ports of call. This means that the cargo volume handled at a single seaport should be necessary higher. It follows that it should be possible to maximise the productivity of the vessel by exploiting its larger load capacity. A shipping company usually makes at least two stopping calls per continent.
4. The replacement of the direct liner services with feeder services. This happens between the Northern Range seaports and the Baltic seaports, for example.

All the developments mentioned above, induce the increasing competitiveness among the maritime ports. The bigger container ships as well as the feeder services needs wide infra-structural investments.

On the other side, the restructuring process involves also the supply side. The reorganization of the ship-owners in the form of supply consortia, which are strategic concentrations of maritime suppliers, is due to the intensification of the costs competition [Mayer, 1973]. This may be explained firstly by the relatively short time the shipping companies have when they choose the main port of call along their maritime route, and secondly by the negotiations on the tariffs and handling conditions.

As mentioned above, two double poles of maritime agglomeration are identified within the seaports of the European Northern Range: a) Rotterdam-Antwerp, and b) Hamburg-Bremen-Bremerhaven. A political and administrative competition between the two German seaports might be distinguished by a functional competition on a macro-scale among the two pairs of main ports a) and b). The following four Figures 9.1, 9.2, 9.3 and 9.4 show the market positions of the four main ports of the European Northern Range since the 1971.

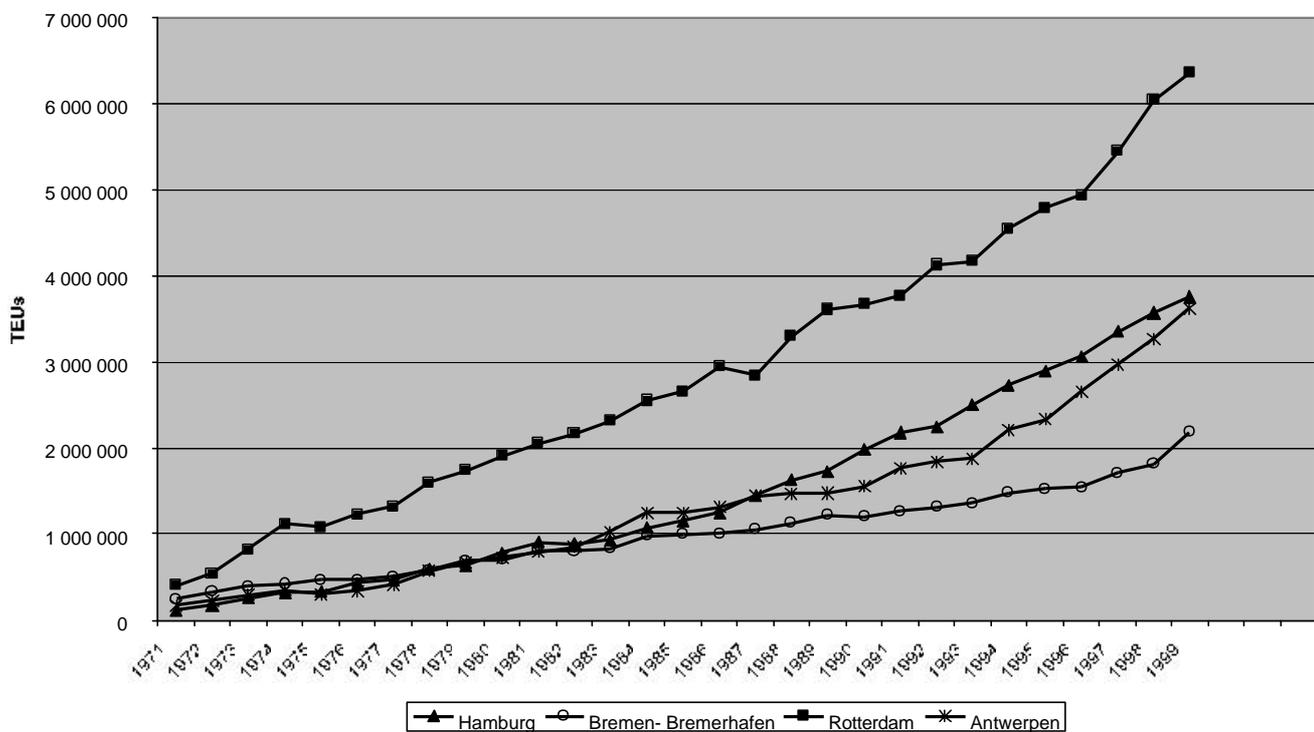
Figure 9.1 – The market shares of the container traffic in 4 main ports of the European Northern Range 1971-1999.



From a functional point of view, the two German main ports are involved in an international maritime competition. A complementary set of functions should be promoted at each seaport site in order to lead to a better integration of the transportation chain, as well as of the road and rail links between the two seaports.

Figure 9.2 – The traffic of container (TEUs) in 4 main ports of the European Northern Range 1971-1999.

Container traffic in 4 main ports of the Northern Range 1971-1999

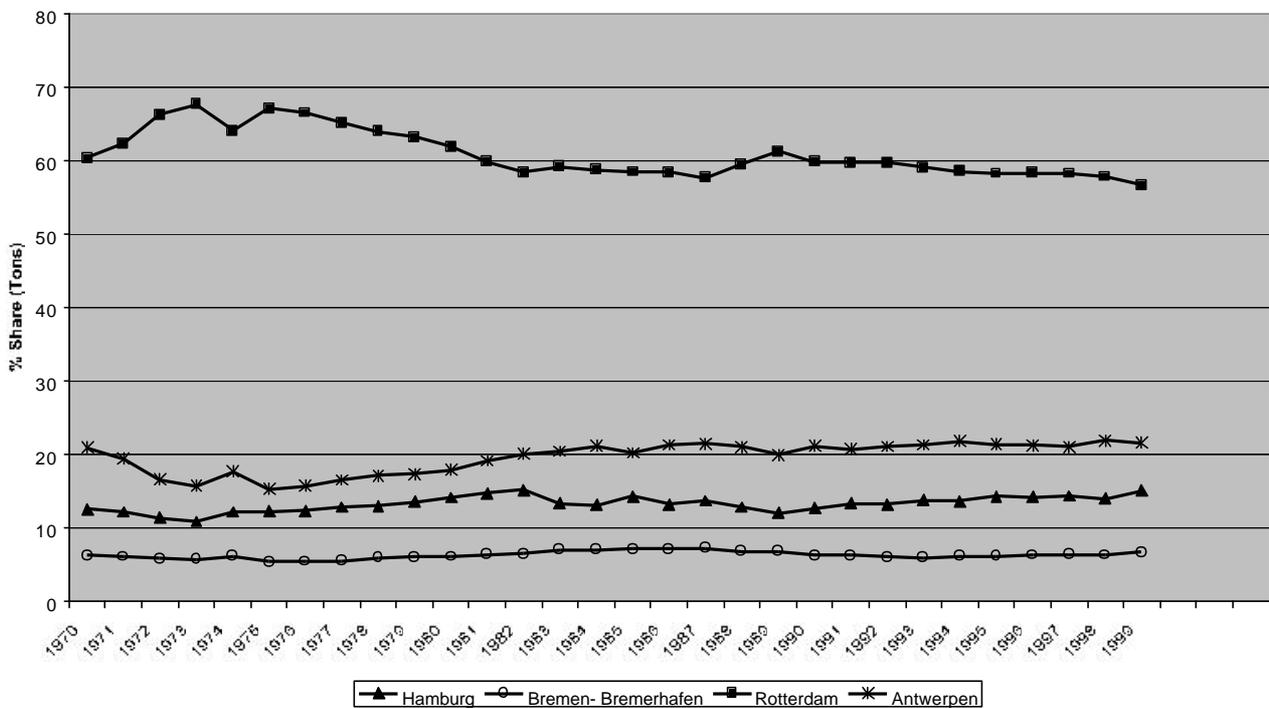


In fact, the transport links from the seaport site towards the hinterland have to perform an increasing efficiency in order to attract the shipping companies, and moreover the specialist total logistics provider. The Betuwe Linie [von Rohr, 1996], [Charlier, 1996], [van Ierland, 2000] between the main port of Rotterdam and the Ruhr region is a clear example of an attractive inland transport link, as well as, at the same time, of unfair competition.

The shipping companies do not stop exclusively at one main port per continent when they perform the Round-The-World Service [Kuby et al., 1992], but they touch at least two main ports per continent. In fact, the maritime efficiency should be maximized, if the vessels could stop only at one main port per continent, because of the minimization of the costs of the terminal at the wharf.

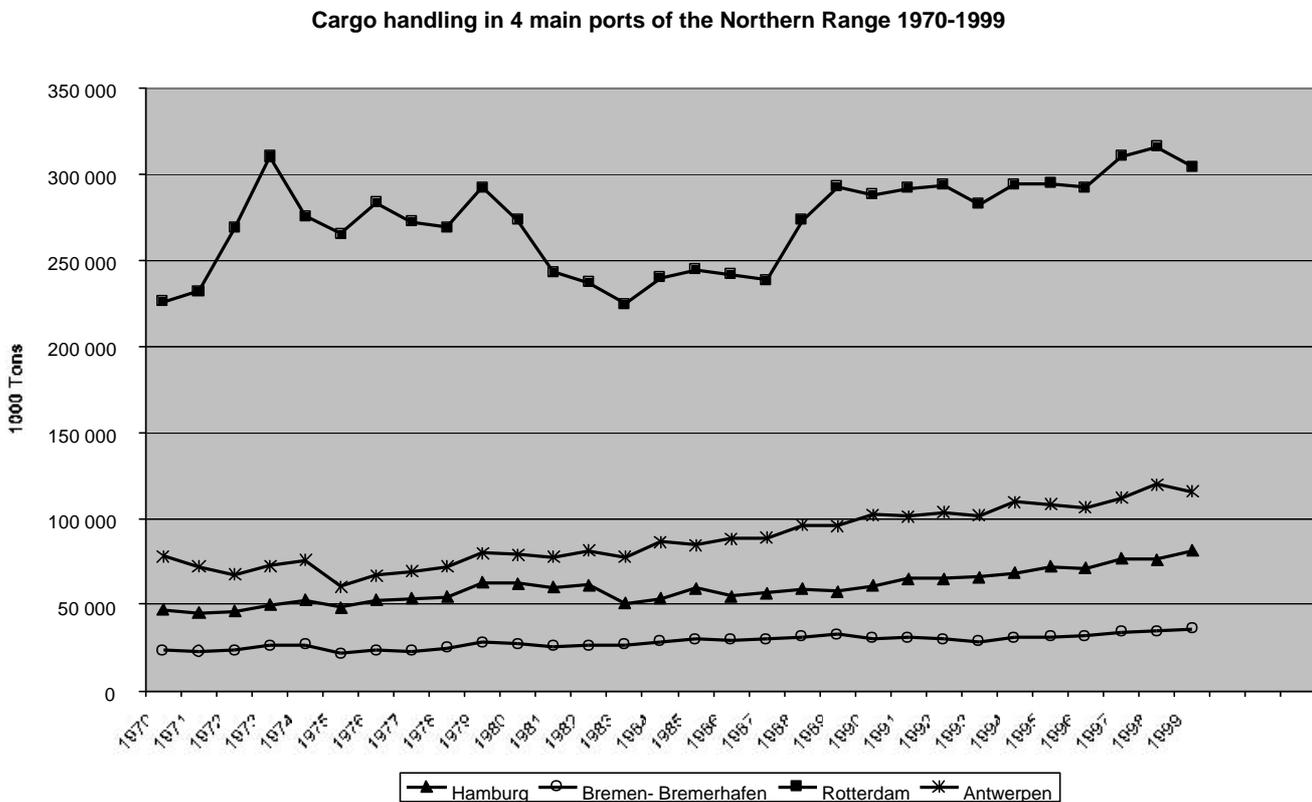
Figure 9.3 – The market shares of the maritime cargo handling in 4 main ports of the European Northern Range 1970-1999.

The market shares of the maritime cargo handling in 4 main ports of the Northern Range 1970-1999



There are different reasons in order to explain the multiple stopping calls per continent. The main one may be the high level of congestion on the land side, which would be imposed to the infra-structural links<sup>35</sup> at the main port that would be chosen as one-stop call. The transport infrastructures would be probably unable to sustain the enormous volume of freight traffic generated to connect the seaport site to the final destinations of the hinterland.

Figure 9.4 – The cargo handling (tons) in 4 main ports of the European Northern Range 1970-1999.



<sup>35</sup> They are the railways, roads, inland waterways, rivers, etc.

## 10 The Seaports of the Northern Germany

### 10.1 *The Restructuring Process of the German Seaports*

The diffusion of the global economy induced a reorganization of the economic activities. Under this influence, the German seaport sites (Map 2) are facing a restructuring phase in order to grant their international competitiveness [Deecke et al., 1996].

The economic innovations in the technological and information branches promoted the enlargement in the volume of the international trade, in terms of the flows of goods and passengers at a world level. Furthermore, the German seaport sites on the Baltic Sea (Map 2) had to face the increasing volume of traffic directed towards the BSR. The economic and spatial impact that derived was due: 1) to the economic changes within the Baltic Sea Region BSR (Map 5 and Map 6) after the fall of the Iron Curtain; as well as 2) to the ongoing process of political-economic restructuring in the former Socialist states (Map 3).

Moreover, the restructuring process in the technological and economic organization of the inter-continental transport of container is shown by the two main ports of Hamburg and Bremen-Bremerhaven. In fact, a fundamental issue for each maritime port site is to keep the step with the technological innovations of the maritime sector, in order to be attractive to the ocean carriers.

Therefore, the restructuring process of the German seaport sites follows two different paths [Deecke et al., 1996]. First, the provision to the maritime settlement of the more efficient seaport infrastructures according to the changing needs of the transport sector. Second, the development and reinforcement of the network of relationships between the seaport and its hinterland.

Undoubtedly the German seaports of the Northern Range have few obstacles to overcome, not last the financial lack of the public budget. The Land of Hamburg tries to cover in advance the financial expenditures related to the seaport activities, due to the priority given to the seaport economy [Wirtschaftsbehörde, 1997]. Obviously the port policy is also influenced by the EU policy and in particular by the decisions of the European Commission.

The German maritime port sites (Map 2) can be split into three main groups [Deecke et al., 1996], as follows:

1. Hamburg and Bremen-Bremerhaven as intercontinental main ports.
2. The Baltic Sea ports, as communication seaport sites between the BSR and the Scandinavian countries.
3. The seaports on the North Sea, as regional and specialized maritime ports.

Hamburg, Bremen-Bremerhaven, as well as the North Adriatic Italian seaport of Trieste, are classified as rail ports. At all these three maritime port sites, an intensive inter-modal activity between vessels and railways takes place, besides the traditional transshipment from the ships to the trucks [Degrassi, 1997/98]. On the contrary, Rotterdam and Antwerp are characterized as inland waterway ports, due to the dominant use of the navigation on the river Rhine.

Table 10.1 – Classification of the German seaports on the North Sea.

Seaport site	Classification
Hamburg	Main port, universal seaport, container seaport
Bremen-Bremerhaven	Main port, universal seaport, container seaport
Wilhelmshaven	Bulk cargo seaport
Emden	Bulk cargo seaport
Brake	Bulk cargo seaport
Nordenham	Bulk cargo seaport
Cuxhaven	Roll on/Roll off seaport terminal
Brunsbüttel	Bulk cargo seaport, regional seaport

Source: Deecke et al., 1996.

The main seaport of Hamburg is traditionally a rail port because of the direct impact on the structure and extension of its hinterland due to the geo-political-economic changes and consequences after the end of the Second World War. The use of the Elbe river as natural transport way from the seaport Hamburg towards its natural hinterland was hindered.

The freight transport by rail covers a dominant position in the Hanseatic city-region with respect to the two concurrent alternative transport modalities such as the inland waterways and the road transport mode.

The Table 10.1 shows the characteristics of the most important German seaports on the North Sea [Deecke et al., 1996]. Hamburg and Bremen-Bremerhaven may be distinguished because they are both classified as two main seaports.

With respect to the traffic flow of the containers through the seaports of the Northern Range, the following observations may be pointed out.

The line shipping companies choose only one main port per each pair Rotterdam-Antwerp and Hamburg-Bremen-Bremerhaven, when they decide their stopping calls on the European continent. According to the principle of port equalization, the two German seaports Hamburg and Bremen-Bremerhaven apply the same rail and road tariffs on the container transport towards the hinterland.

The German Railways is going to establish a Y-rail-link between the two seaports of Hamburg and Bremen-Bremerhaven, and the rail node at Hanover in order to improve the track productivity for the freight transport. Full container loaded trains FCL from Hamburg and Bremen-Bremerhaven should meet at the nodal rail point Hanover. They should be there properly composed and send towards the final inland destination towards the Southern-, Central- and Eastern Europe. The same for the opposite route, which involves the decomposition of the trains at Hanover. The rail operator could be Transfracht [Informare, 1998]. Furthermore, the betterment in the efficiency of the rail links between the two seaport cities of Hamburg and Bremen-Bremerhaven should be achieved.

The collection of containers for the composition of less-than-container-load LCL is also promoted. In this case, the composition of the cargo train may be various, because it is composed not only by containers. The use of the LCL enables the reduction of the costs of transport. The full-container-load FCL trains are already operative. This trains are composed exclusively by containers

and the loading/discharge operations take place at predisposed transshipment sites [Schäfer, 1988].

Table 10.2 – Classification of the German seaports on the Baltic Sea.

Seaport site	Classification
Kiel	Universal seaport, ferry terminal
Lübeck	Universal seaport, ferry terminal, transit seaport
Puttgarden	Ferry terminal
Wismar	Bulk cargo seaport
Rostock	Bulk cargo seaport, ferry terminal
Strassuld	Regional seaport, rail ferry terminal
Warnemünde	Ferry terminal
Saßnitz	Rail ferry terminal
Mukran	Rail ferry terminal

Source: Deecke et al., 1996.

The two seaports of Lübeck and Kiel play the role of transit ports as well as feeder ports for the main German seaports on the North Sea. This is true in particular for the port of Hamburg with refer to the container traffic towards Scandinavia. In fact, the larger container ships can not transit through the Kiel Canal in order to transfer the containers towards the Baltic area. Therefore, the containers are transferred by land (usually by road) from Hamburg to Kiel or Lübeck, and then by feeder services towards the final destinations. The dimensions of the Kiel Canal are the following: 40 m bright, 9,50 m depth [Nuhn, 1994].

The HHLA Group of the port of Hamburg is planning to build a new container terminal on the Trave River, nearby Lübeck. The permission to build the terminal has been formally granted and the construction of the quay wall for this facility has been began. This inter-modal link between the two seaports of Hamburg and Lübeck may be defined as a mini-land bridge by rail. Through the building of this new facility, the HHLA Group is going to enforce its market

position on two seas simultaneously. For the seaport of Hamburg itself, the new rail mini-land bridge represents the next step to turn into a seaport network.

Puttgarden is undergoing a huge modernization program in order to reinforce its role as an important ferry terminal for the transit of passengers for tourism. In fact, the Vogelfluglinie is the most direct and quick way in order to reach Copenhagen from Hamburg, despite the new land links through the Großen Belt and the Öresund.

Travemünde, nearby Lübeck, may be considered as the German gateway towards Finland and St. Petersburg by rail-ferry links. Since the year 1998, it is operative a link between the Swedish port of Trelleborg and Travemünde. The forecasts of traffic for cargoes and passengers are positive for the next ten years. The Königslinie (a joint venture between the DFO Deutsche Fährgesellschaft Ostsee GmbH and the SJ Hansa Ferry) estimates a growth of the freight traffic from the actual 3 million tons to 7 million tons in the year 2010.

The launch of the port site of Warnemünde as ferry terminal has not been a success, due to the fact that only the low tariffs on the traffic has been promoted.

## ***10.2 The Impact of the Political and Economic Restructuring in the Eastern and Central Europe***

Due to its geographical location on the river Elbe, flowing into the North Sea, the universal seaport Hamburg is at the same time the most Northern main port of the Northern Range (Hamburg-Rotterdam-Antwerp Range), as well as the most Western hub port for the Baltic Sea Region BSR (Map 2 and Map 6).

After the end of the Second World War, substantial political, social, as well as economic changes occurred on the European continent. The BSR was strongly influenced by the new geopolitical division of Europe into two blocks. The new two political and economic spheres of influence were differentiated both by the different ideological inspiration, and by the different application of the post-Keynesian economic principles (Map 3).

On one side, the Western European countries were regulated mainly by the imperfect competition principles of the free market economy, therefore by different levels of private and governmental intervention in the economic sectors of production. The principles of the Keynesian welfare state, such as the

principle of full employment and the principle of social justice, were applied both at a macro-level and at a regional level. The doctrine of diminishing the interregional disparities pursued the goal to reduce the social, political and economical inequalities among regions, described as gaps in case of relevant deep qualitative and quantitative disparities<sup>36</sup>.

On the other side, the East and Central Europe applied the socialist economic principles, which marked for about fifty years the entire Central-Eastern European society through the so called “real socialism”.

Due to the historical changes occurred after the collapse of the Soviet economy and the consequent Berlin Wall Fall in 1989, the former socialist countries opened their economic systems to the Western free market economy. A new phase of economic transition began. Foreign investments and development programs were promoted for achieving the goals of social stability and economic development in the Central and Eastern European regions.

The fall of the Iron Curtain had a relevant impact also on the economic system of the Western Europe. A first positive effect was the growth in the international trade of goods transhipped through the Northern Range seaports, and exported towards the former DDR, Poland, Czechoslovakia, etc. The volume of containers, fresh fruit, as well as of essential goods sensibly rose during the first years of the 90s. The hinterland of the main ports of the Northern Range was enlarged towards the Central- and Eastern Europe. Therefore, the seaport Hamburg got back again its natural hinterland, and performed again the natural maritime functions of main port and transit port for this geographical area.

The European Union was and is obviously interested to achieve the social and economic integration of the former socialist countries into the Western society and economy. After the opening of these economies to the Western market, the flow of goods in transit from/to the Czech Republic, Slovakia, Hungary, and Poland did not pass anymore through the maritime sites on the Baltic Sea. A shift towards the Northern Range main ports took place, in particular in favour of the two main ports of Hamburg and Rotterdam.

The geographical periphery of the BSR with respect to the Northern Range maritime core had a strong impact on the accessibility to the former socialists seaports during the past fifty years. In fact, the Western shipping companies

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<sup>36</sup> An example is the gap between the Northern- and Central Italy and the Mezzogiorno.

choose to stop on the European continent only at the Northern Range main ports rather than to continue their route toward the BSR. This strategic decision may be explained because of the better geographical position, as well as the higher efficiency of the equipment and organization of the seaports of the Northern Range in order to receive the new "giants of the ocean" container ships and tankers.

This choice became more relevant especially after the two revolutionary innovations occurred during the Sixties in the Western transportation sector: the diffusion of the two complementary concepts of containerisation and inter-modal transportation.

Due to the international division of labour, as well as to the improvements in the telecommunications and information technology branches, the application of these two technological revolutions strengthened the two other new complementary concepts of globalisation and market regionalism in the Western countries.

Because of the political-ideological division of Europe, a failure in the networking interchange between the Western and Eastern countries and regions occurred. This lack of external networking is indicated by the different intensity in the diffusion of the two important transport innovations above mentioned. The Northern European seaports perform a high degree of networking, as the technological homogeneity and efficiency of the seaport system along the Northern Range from Antwerp, Rotterdam, Bremen-Bremerhaven to Hamburg immediately show.

The disparities in the quality and quantity of the infra-structural transport network stress the lack of networking the seaports on the Baltic Sea of the former socialist states suffer. After the Berlin Wall Fall in the year 1989, the governments of the post-socialist countries pursued the following main goals on three levels of decision: the state, the companies and the citizens [Faßmann, 1994].

The state gave the general dispositions and rules in order to promote the transition towards the market economy. Different political and economic instruments were used, such as privatisation; restrictions of the former socialist duties of the State; reduction of the state subsidies; liberalization of the market prices; control of the inflation; new organization of the fiscal policy; etc. In particular, the post-socialist economies had the difficult task to afford the transition from the real socialism to the real capitalism.

The real capitalism passed through a restructuring process during the last quarter of the 20<sup>th</sup> century. The Western economies turned from the fordism to the post-fordism, as well as from the Keynesian welfare state to the Schumpeterian workfare state approach. The main goals of the Schumpeterian workfare state are to promote a competitive and innovative entrepreneurship in the framework of the competition and competitiveness paradigms.

Therefore, the post-socialist economies are actually living an absolutely new transformation process, which presents a particular economic and social impact. The transition process might not lead the former socialist countries to the economic and social standards of the West. An independent restructuring path of development could be a most appropriate solution.

The companies gained autonomy and independence as they never had before. At the same time, the management had to shift from the socialist paradigm to the new competitive approach to the market economy. The impact on the way of thinking as well as on the way of life induced a more difficult mental restructuring process that has not to be under-evaluated.

The citizens had to play new roles both in the political and social sphere as consumers, labour force and electors. The behaviour of the population was hardly marked by the different socialist approach both to the economy and to the national policy during the past regime. Because of this particular situation, a conflict took place during the last decade of the 20<sup>th</sup> century: the economic needs of the former socialist countries in a current transition phase crashed into their political feasibility.

An other effect on the Western European economies, in particular with reference to the industries of the Northern German, may be forecasted on the long term. Little by little the economic distance between Western Europe and Eastern Europe should decrease, and the economic competition between Western and Eastern industries should grow acute, due to the export of products from the former socialist countries towards the Western market.

At the same time, it could be forecasted the enlargement of the market share of the international trade of the Western industries towards the Central- and Eastern Europe. The market expansion may be referred in particular to the high technological products which can not be produced at the same level of quality in the former socialist countries, because of the huge investments both in financial capital and human training the hi-tech production needs. On the other side, the industries of the Eastern European countries should be able to export towards

the West basic products such as energy, fuel, manufactures, etc. in order to compensate the lack in the production the Western countries use to suffer.

This idea is based on the well known fundamental economic theory of the comparative advantages formulated by David Ricardo, which gives the justification for the international trade. Unfortunately during the last decade few Eastern and Central European countries performed a quite opposite experience. Few transition economies imported exactly the labour intensive commodities from the Western countries which theoretically might be produced in loco at a cheaper cost of production and sold at a lower price with respect to the market price of selling the imported product<sup>37</sup>. Products such as foods and textile may be also imported illegally into a country. This is an unfair competition on the imports, which obviously may have a negative impact on the economic development of an economy in transition.

As reported by Storper, the economic specificity of a region can be split in two dimension: knowledge as the basis of technology, and the human relations essential to the economic co-ordination [Storper, 1997]. A pregnant influence of local rules, conventions and social behaviour appears clear, if different territorial regions are compared in order to try to explain the economic differentiation of the regional development.

Therefore, after the fall of the Berlin Wall in the year 1989 and the dramatic changes of the European political geography, the Baltic Sea Region affirmed its economical and commercial role with respect to the European Union. In particular, the gateway function of the seaport Hamburg towards the Eastern and Central Europe was revitalized.

### **10.2.1 An Instrument of Networking between Seaports: VASAB 2010**

The metropolitan seaport city-region Hamburg may be defined as an international maritime cluster, which performs relevant central place functions among the "pearls" of the urban network formed by the "ring of competitive European cities" [VASAB 2010, 1994], [VASAB 2010, 1996], [INTERREG II C, 1997]. Following the functional

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<sup>37</sup> This happened to Ukraine, that imported Dutch butter at a cheaper price than the local production.

classification of VASAB, the ring embraces the European cities of Hamburg, Berlin, Copenhagen, Stockholm and St. Petersburg (Map 5 and Map 6).

In order to achieve the VASAB "Vision around the Baltic Sea Region for the year 2010" pursuing the VASAB values of development, environmental sustainability, freedom and solidarity, the seaport city-region Hamburg holds the important role of promoting the marketing actions useful to make the step from the abstract VASAB mainframe to a concrete comprehensive spatial planning in the Baltic Sea Region, based on the VASAB principles of subsidiary, participation and transparency.

The metropolitan city-region Hamburg is one of the European "pearls" embedded into the competitive system of European cities mentioned above, as well as involved into the network of the Baltic cities by many efficient qualitative transport and telecommunication linkages. VASAB defines these links as "strings", and states their use in order to promote an environmental friendly mobility of people and goods, as well as to provide an effective spatial integration among the "patches".

VASAB defines as patches the "areas supporting dynamism and quality of life" inside the Baltic Sea Region: this natural driving function of the pearl Hamburg brings out its effects on the metropolitan city-region, as well as on the whole Northern German area. At the same time, it should work as an engine for the economic and social integration and development of BSR itself.

The New European Space NES concept takes care of the New Belt of Innovation in Europe called the "Red Carrot". This is a geographical region board from Oslo, Stockholm, Kaliningrad, Warsaw, Budapest, Zagreb, Ljubljana, Trieste, Venice, Florence, Munich, Nürnberg, Hamburg and Copenhagen. The Red Carrot is a third conception of European space, that was emerged next to the "Blue Banana" and "Croissant". This belt should become a spatial concentration of innovative activities, in order to promote the connection between the BSR and the Mediterranean basin, as well as to stimulate the cultural, economic and social integration between Western and Central Europe.

The spatial impact of VASAB on the geography of the NES refers in particular to two common actions to accomplish strings between pearls: the identification of suitable locations for the building of the inter-modal transport centres; and the improvement of the seaport hinterland infrastructures.

## **Section 6**

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### **Hamburg as Distribution and Logistics Node**



# 11 The Inter-modal Networks of the Seaport of Hamburg

## 11.1 *The Modal Agglomeration at the Seaport Hamburg*

The regional impact of the transport activity in the metropolitan city-region Hamburg has been analysed. It has been evaluated the impact on the urban quality of life and the sustainability of the transport activity, with respect to the future trend of growth of the trade activities related to the seaport of Hamburg.

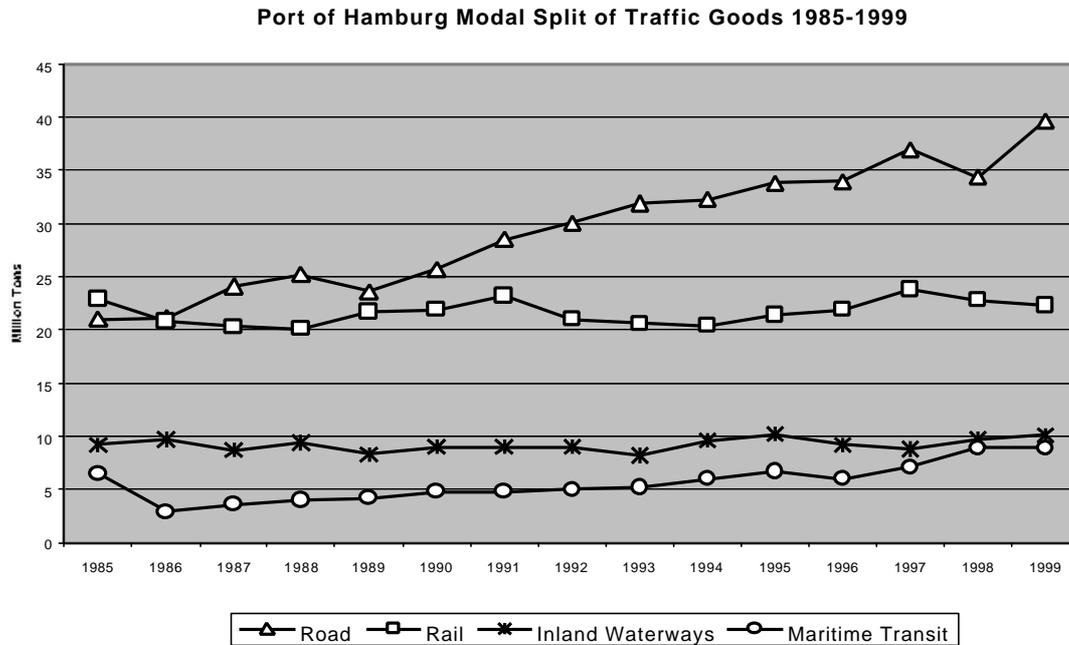
The transport modalities used for the freight movements from/to the seaport city-region Hamburg are the following: the maritime transit, the inland waterways transport, the railway transport, and the roadway transport. In the next chapters are exposed the main characteristics of these "mobility networks" [VASAB 2010, 1994], [VASAB 2010, 1996], as well as their future developments with respect to the instruments of transport policy.

The seaport site and its hinterland has to be seen through a holistic point of view with respect to the various transport modalities. The economic accessibility from the seaport location towards the hinterland plays the main role. Obviously the quality/price of the service of land transport is a key element of the transport chain. Others crucial factors are: the quality and quantity of the transport infrastructures, such as roads, rails, inland waterways; organization, price and quality of the transport service offered by the land carriers.

The economies of time are the most important factor in the transport chain. The quality of the service can be referred to the terms of the transport contract, to the punctuality of the delivery, to the security of the cargo; as well as to the high frequency of the transport service supplied [Degrassi, 1997/98].

The Figure 11.1 shows the modal split between the freight transport carriers at the seaport of Hamburg, between the year 1986 and the year 1999. The percentage variation of the total tons transported during the year 1999 with respect to the year 1998 reflects an increase in the road transport tons of +15,4% and a decrease of the rail of -2,2%. The inland waterways increased of +4,1% the volume of tons transported due to the new Elbe Container Line operative since March 1999.

Figure 11.1 – The modal split for the freight transport at Hamburg 1985-1999.



During the year 1999, the seaport of Hamburg handled a total amount of 81 million tons of goods. It follows that the 49% was transported by road, the 27,5% by rail, the 12,5% by inland waterways, and the 11% by maritime transit.

The relevance of the city logistics concept, or distribution centres of goods, underlines the spatial impact, at the urban scale, of the restructuring process of the activities that are related to the seaport in the city-region of Hamburg.

The following indicators has been used to analyse the regional impact of each transport modality:

1. *Maritime transit.*

It takes into account the maritime transit of the cargo flows from/to the seaport Hamburg along the reach of the river Elbe towards the North Sea.

2. *Rail transport.*

It has been analysed the network structure at the functional level and at the technical level. The functional level considers the privatisation and restructuring process of the German Railways; while the technical level considers the quality of the rail links inside the seaport city-region, and with respect to the international rail network.

3. *Inland waterways transport.*

It has been analysed the network structure of this mobility network, and the recent improvements by the use of the information technology. With reference to the river Elbe, an appropriate evaluation has to be given about the economic needs, with respect to its use as natural way of transport and its navigability. Furthermore, a balanced compromise had to be found between the ecological aim to preserve the natural state of the river and, at the same time, to promote the use of such transport modality, because it is supposed to be environmental friendly.

4. *Road transport.*

The network structure of the highways; the quality of these strings in terms of traffic volume for motor vehicles and its sustainability, both at a urban, regional and inter-regional level. The city logistics concept has also been taken into account.



## 12 The Maritime Transport Network

### 12.1 *The Maritime Accessibility to the Seaport of Hamburg*

From a macroeconomic point of view, the maritime transport modality enables to exploit the economies of scale due to the increasing cargo capacity of the freight ships, both tankers and container ships. Therefore, the transport costs are lower if compared to the land transport modality. In general, the average cost in the transportation sector is given by the total cost divided by the total output, where the total cost is defined by the sum of the total fixed cost and the total variable cost, while the total output is defined in terms of TEU/km or ton/km.

In order to maximise the economies of scale, the vessels have to reduce their stopping time at the hub ports for the terminal operations, because the longer the stopping time the higher the working costs per day (i.e. the variable cost), as well as to maximise the number of days of navigation. A limitation that the maritime transport modality suffers is the speed of the vessels. Due to this limit, the land transportation is more efficient on the short distances.

The gateway of the seaport of Hamburg towards the North Sea is the reach of the Elbe river called Unter Elbe – Lower Elbe. It is about 110 km long, and its navigability depends on the tide fluctuations. The tide is defined as the time necessary to pass from a high tide condition to a low one, equivalent to 12 hours 30 minutes. With reference to the river Elbe, the low tide is longer than the high tide, and it is 7 hours 30 minutes long. At Hamburg, the tide range is of 3,56 meters (1994-1998 average) [HHVW, 1999].

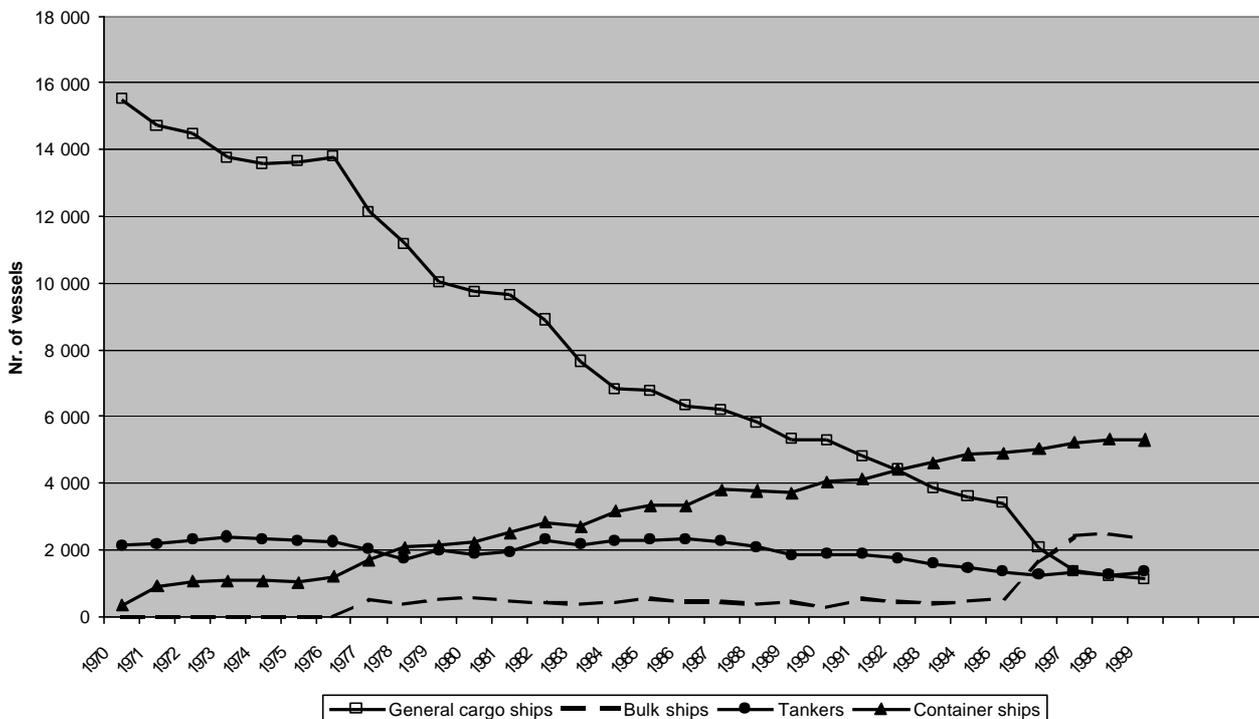
If the tide fluctuations are not taken in account, ships till 12,80 meters fresh water draught may reach or leave the seaport of Hamburg independently on the tide variations; while vessels with a deepest draught of 15,10 meters fresh water have to depend on the high tide. The outgoing vessels may use of a 13,80 meters fresh water draught availability during the high tide to leave the seaport of Hamburg. At the present moment, the Lower Elbe is 15,30 meters deep, but for a full independence of its navigability on the tide fluctuations, it would be necessary a 16 meters depth, although around Stade the Elbe would have a depth of just 14 meters.

The BVWP 1992 forecasted a total expenditure of more than 1 milliard Marks to realise this project. It has to be noted that the deepening of the river Elbe may have some possible negative consequences on several protected areas along this reach of the river due to the higher level of the water. An evaluation of the environmental impact of the Elbe deepening should be given, and alternative networking solutions could be help to satisfy both the economic and the environmental requirements of the Hanseatic seaport city-region.

The Figure 12.1 shows the data of the Statistisches Landesamt of Hamburg on the maritime traffic of the Hanseatic seaport since the year 1970. The analysis of the number of freight vessels according to the typology of the ships indicate the growing number of container ships that reached the port of Hamburg during the last decades. On the contrary, the vessels for the transport of general cargo loose in importance. The number of tankers slowly declined (the liquid cargo may also be transported in containers), while the number of bulk ships grew since the year 1995.

Figure 12.1 – The maritime traffic of the port of Hamburg according to the typology of the vessels 1970-1999.

Maritime traffic of the port of Hamburg according to the typology of the vessels 1970-1999



The inter-modal transport modality and the use of the containers are the two revolutionary innovations in the transport sector. According to the methodology in use by the Statistisches Landesamt of the Free and Hanseatic City of Hamburg, the maritime cargo traffic is split into incoming or receipt cargo, and outgoing or delivery cargo.

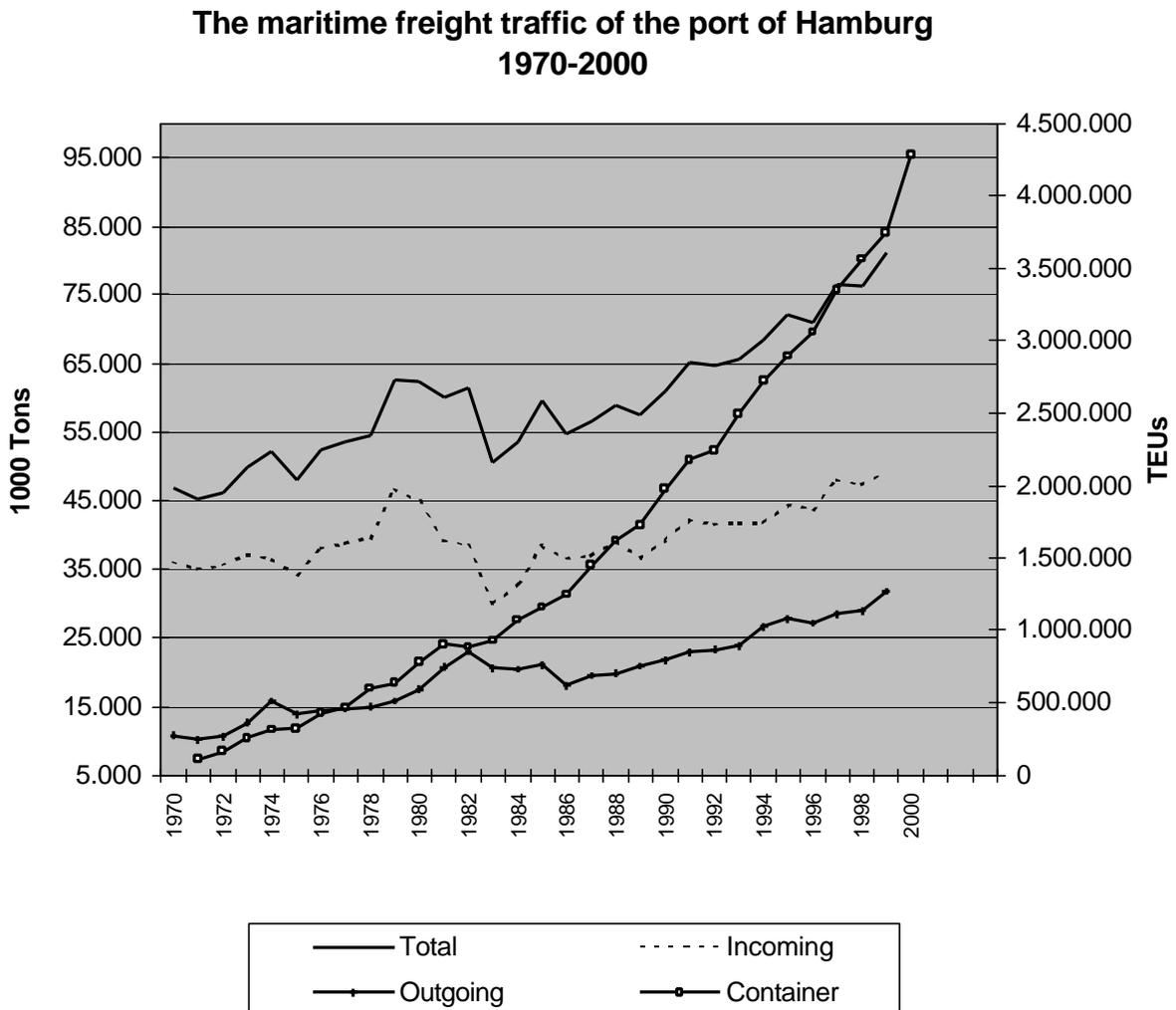
The maritime incoming cargo is defined as the volume of cargo received at the seaport of Hamburg by the maritime transport modality from a geographical location of origin and without any intervening transshipment activity between its loading port and the seaport of Hamburg.

The maritime outgoing cargo is defined as the volume of cargo delivered from the seaport of Hamburg by the maritime transport modality, towards a geographical location of destination, and without any intervening activity of transshipment between the seaport of Hamburg and the port where it takes place the discharge of the goods.

The volume of cargo are given both by the gross tonnage of the commodities, that are split in bulk cargo, general cargo and containerised cargo; and by the number of containers handled, that are distinguished between 20 and 40 feet containers. Since 1996, the volume of containers is expressed also in terms of total number of TEUs (Figure 12.2).

The Figure 12.3 shows the maritime traffic of the seaport of Hamburg since the year 1980 for incoming merchant vessels. Although the trend in the number of freight vessels is constant, the cargo space capacity increased since 1994. This means that a larger quantity of goods has been transhipped through the seaport of Hamburg. This observation is confirmed by the positive growth trend in the cargo volume handled at this maritime port site (Figure 12.2).

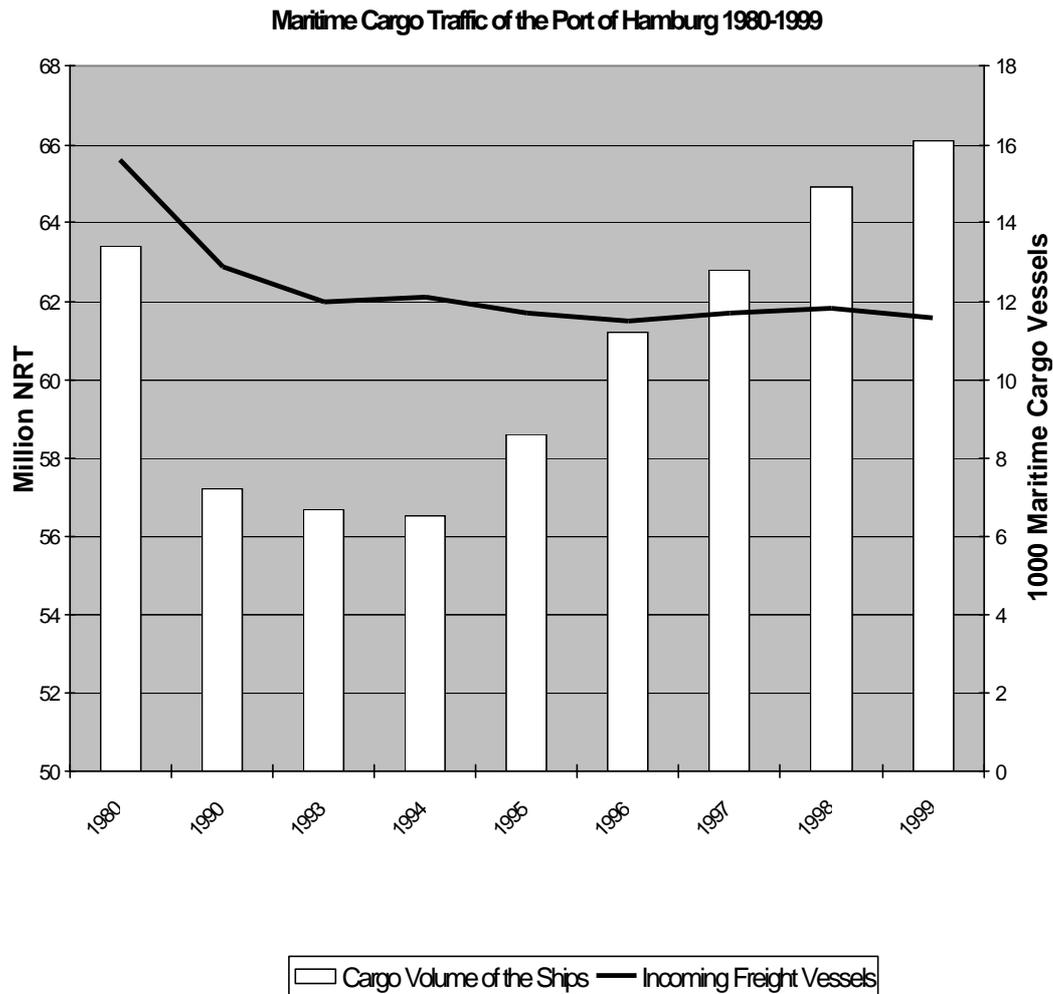
Figure 12.2 – The maritime freight traffic of the seaport of Hamburg 1970-2000.



Since the Sixties, the number of ships sharply declined, while the Net Register Tons NRT absolutely grew (Figure 12.3). An explanation may be found with reference to the increasing dimension of the ships. During the first half of the 80s, the number of tankers approaching the seaport Hamburg decreased, therefore also the NRT during those years slope down.

Two main reasons can be given to explain the drop in the quantity of goods handled: firstly, the pipeline between Hamburg and Wilhelmshaven became operative; secondly, the impact of the two petrol crises on the fuel imports<sup>38</sup>.

Figure 12.3 – The maritime traffic of cargo vessels at Hamburg 1980-1999.



<sup>38</sup> The first petrol crises occurred between the years 1973/'74, while the second petrol shock between the years 1978/'81.

## **12.2 The Maritime Traffic of the Port of Hamburg for Cargo Typology**

The Table 12.1 and the Table 12.2 shows the data of the Statistisches Landesamt of Hamburg on the maritime traffic of the Hanseatic seaport for cargo typology. The volume of the cargo is split into incoming and outgoing maritime traffic, for the period 1970-1999.

The total volume of the incoming goods was equal to 49.232 thousand tons in the year 1999, while the total volume of the outgoing cargo was equal to 31.805 thousand tons in the same year. With respect to the year 1970, there was a growth of +36,49% of the volume of the total incoming cargo in the year 1999. The total deliveries grew of +192,06% in the year 1999 with respect to the 1970.

There has been showing a positive trend in the maritime traffic of the general cargo of the seaport of Hamburg since the 70s. In the year 1999, the port of Hamburg received general cargo for 22.193 thousand tons (7.635 thousand tons in the 1970), while it delivered break bulk cargo for 22.086 thousand tons (6.339 thousand tons in the 1970).

The bulk cargo has not been showing a trend to growth during the last three decades. The incoming cargo of the maritime traffic in the year 1999 was equal to 27.039 thousand tons (28.434 thousand tons in the year 1970), while the outgoing bulk cargo was 9.719 thousand tons (4.551 thousand tons in 1970).

With reference to the general cargo, the most important typology for the incoming cargo is the category of the fresh fruits, in particular the import of bananas. With reference to the bulks, there are the metallic minerals, the mineral products and the crude mineral oil to have the most relevant role for the incoming bulk cargo.

When the deliveries of the break bulk cargo are considered, then there are the chemical products to have the most important share. Electro-technical products and machines are the second typology of general cargo with reference to the outgoing freights of the port of Hamburg. Fertilisers and mineral oil products are the most relevant categories of bulks that are sent from the Hanseatic port.

Table 12.1 – The maritime incoming traffic, for cargo typology, of the port of Hamburg 1970-1999.

Year	Incoming		of which												
			General cargo			Bulk cargo									
	1000 Tons	% Var.	1000 Tons	% Var.	Fresh fruits	1000 Tons	% Var.	Cereals	Oil for cooking	Oil fruits	Coal, Coke	Crude mineral oil	Mineral oil products	Metallic minerals	
								1 000 Tons							
1970	36 069		7 635		793		28 434		2 013	1 224	1 599	3 018	12 166	5 292	1 441
1971	35 090	-2,7	7 097	-7,0	787		27 993	-1,6	2 356	1 252	1 775	2 081	11 137	6 079	1 581
1972	35 581	1,4	7 482	5,4	782		28 099	0,4	3 105	1 299	1 778	1 989	11 117	5 593	1 401
1973	37 154	4,4	7 803	4,3	836		29 351	4,5	3 109	1 677	1 896	1 865	11 882	5 111	1 939
1974	36 527	-1,7	7 598	-2,6	778		28 929	-1,4	2 756	1 921	2 277	1 615	11 592	4 584	2 255
1975	34 240	-6,3	6 588	-13,3	725		27 652	-4,4	3 451	2 102	2 118	1 690	10 224	4 128	1 979
1976	38 120	11,3	7 349	11,6	707		30 771	11,3	5 543	2 162	2 106	1 219	10 248	4 838	2 342
1977	38 788	1,8	7 339	-0,1	752		31 449	2,2	2 472	2 125	2 284	1 294	10 280	5 460	4 494
1978	39 614	2,1	7 785	6,1	878		31 829	1,2	1 949	2 394	2 337	999	9 747	6 112	5 239
1979	46 758	18,0	8 098	4,0	832		38 661	21,5	2 738	2 538	2 213	2 737	10 309	7 076	7 361
1980	44 911	-4,0	8 497	4,9	734		36 415	-5,8	3 724	2 374	2 431	2 976	9 846	5 312	6 534
1981	39 234	-12,6	8 319	-2,1	694		30 915	-15,1	3 731	2 164	1 934	2 342	8 874	3 951	4 871
1982	38 482	-1,9	7 696	-7,5	651		30 786	-0,4	3 983	1 299	2 324	1 844	8 534	5 010	4 889
1983	29 935	-22,2	8 048	4,6	631		21 889	-28,9	1 991	1 338	2 036	1 362	3 300	5 305	3 706
1984	32 959	10,1	8 726	8,4	668		24 233	10,7	1 606	929	1 511	1 185	3 252	6 328	6 672
1985	38 380	16,4	8 869	1,6	691		29 511	21,8	2 991	975	2 232	1 696	3 680	6 910	8 233
1986	36 584	-4,7	9 769	10,1	690		26 815	-9,1	551	883	2 360	1 941	3 781	8 331	6 691
1987	37 026	1,2	11 195	14,6	748		25 831	-3,7	524	1 087	2 519	1 892	2 947	9 148	4 944
1988	39 114	5,6	11 613	3,7	.		27 501	6,5	701	458	1 951	1 091	6 701	6 877	6 375
1989	36 630	-6,4	12 189	5,0	.		24 441	-11,1	1 063	558	1 373	753	4 219	5 466	7 588
1990	39 340	7,4	13 967	14,6	842		25 373	3,8	520	920	1 606	735	4 160	7 712	7 120
1991	42 243	7,4	14 985	7,3	925		27 258	7,4	399	1 063	1 409	1 205	4 680	9 430	6 391
1992	41 522	-1,7	15 333	2,3	1 031		26 189	-3,9	312	1 029	1 514	900	3 997	9 141	6 412
1993	41 846	0,8	15 899	3,7	929		25 947	-0,9	456	511	1 853	667	4 396	8 596	6 787
1994	41 799	-0,1	17 639	10,9	1 197		24 160	-6,9	340	356	2 013	526	4 629	6 563	6 670
1995	44 404	6,2	18 103	2,6	907		26 301	8,9	302	435	2 341	992	4 820	6 195	8 555
1996	43 782	-1,4	18 538	2,4	946		25 244	-4,0	411	580	2 325	1 048	5 005	6 720	6 725
1997	48 077	9,8	19 674	6,1	906		28 403	12,5	252	409	2 388	1 451	4 511	8 085	8 245
1998	47 298	-1,6	20 537	4,4	713		26 761	-5,8	323	329	2 726	2 449	5 074	5 437	6 419
1999	49 232	4,1	22 193	8,1	892		27 039	1,0	327	291	2 667	2 758	4 868	5 195	6 988

Table 12.2 – The maritime outgoing traffic, and the total traffic, for cargo typology, of the port of Hamburg 1970-1999.

Year	Outgoing		of which										Total Incoming and Outgoing		
			General cargo					Bulk cargo							
			1000 Tons	% Var.	1000 Tons	% Var.	Chemical products	Iron and steel	Electro-technic products, machines	1000 Tons	% Var.	Oil for cooking			Coal, Coke
1 000 Tons													1 000 Tons		
1970	10 890	-	6 339	-	725	1 239	701	4 551	-	480	316	2 314	849	46 959	-
1971	10 213	-6,2	5 898	-7,0	693	1 079	671	4 315	-5,2	340	436	2 700	469	45 303	-3,5
1972	10 673	4,5	5 900	0,0	935	1 198	638	4 773	10,6	392	572	2 439	502	46 254	2,1
1973	12 696	19,0	7 038	19,3	1 260	1 715	691	5 658	18,5	637	487	2 615	695	49 850	7,8
1974	15 822	24,6	8 543	21,4	1 388	2 444	921	7 279	28,6	623	784	2 981	1 394	52 349	5,0
1975	13 941	-11,9	7 052	-17,5	1 245	1 665	964	6 889	-5,4	711	435	2 920	1 050	48 181	-8,0
1976	14 340	2,9	7 424	5,3	1 369	1 449	922	6 916	0,4	702	460	2 793	1 157	52 460	8,9
1977	14 786	3,1	8 367	12,7	1 375	1 732	958	6 418	-7,2	734	242	1 971	1 880	53 574	2,1
1978	14 982	1,3	9 074	8,4	1 338	2 255	961	5 908	-7,9	842	495	1 433	1 786	54 596	1,9
1979	15 892	6,1	9 216	1,6	1 461	2 280	1 093	6 676	13,0	675	303	1 982	1 884	62 651	14,8
1980	17 482	10,0	9 659	4,8	1 426	2 353	1 058	7 823	17,2	727	269	2 880	2 051	62 393	-0,4
1981	20 793	18,9	11 415	18,2	1 688	2 923	1 237	9 378	19,9	908	132	2 792	2 087	60 027	-3,8
1982	23 099	11,1	10 715	-6,1	1 853	2 680	1 187	12 384	32,1	944	34	5 065	1 745	61 581	2,6
1983	20 696	-10,4	11 261	5,1	1 976	3 249	1 036	9 435	-23,8	816	20	3 959	1 493	50 631	-17,8
1984	20 530	-0,8	12 552	11,5	2 057	3 350	1 086	7 978	-15,4	365	20	3 161	1 837	53 489	5,6
1985	21 155	3,0	12 572	0,2	2 131	3 442	1 162	8 583	7,6	660	17	2 514	1 503	59 535	11,3
1986	18 112	-14,4	12 367	-1,6	2 213	2 838	1 136	5 745	-33,1	570	23	1 895	1 325	54 696	-8,1
1987	19 544	7,9	13 565	9,7	2 328	2 765	1 065	5 979	4,1	1 210	40	1 278	1 431	56 570	3,4
1988	19 828	1,5	13 641	0,6	570	-	-	6 187	3,5	546	95	1 910	1 135	58 942	4,2
1989	20 952	5,7	14 096	3,3	671	-	-	6 856	10,8	417	577	2 263	1 217	57 582	-2,3
1990	21 758	3,8	15 022	6,6	2 927	2 068	1 402	6 737	-1,7	746	246	1 889	1 684	61 098	6,1
1991	22 961	5,5	15 290	1,8	3 085	1 818	1 412	7 670	13,8	806	86	1 503	2 318	65 204	6,7
1992	23 359	1,7	15 261	-0,2	3 043	1 530	1 327	8 098	5,6	844	48	907	3 026	64 881	-0,5
1993	23 926	2,4	16 840	10,3	3 470	1 519	1 641	7 086	-12,5	675	24	1 032	2 601	65 772	1,4
1994	26 640	11,3	17 847	6,0	3 526	1 548	1 873	8 793	24,1	640	0	1 315	3 263	68 439	4,1
1995	27 785	4,3	18 227	2,1	3 756	1 547	2 072	9 558	8,7	636	15	1 072	2 681	72 189	5,5
1996	27 138	-2,3	18 706	2,6	3 859	1 613	2 117	8 432	-11,8	717	21	1 026	2 659	70 919	-1,8
1997	28 426	4,7	20 533	9,8	4 128	1 734	2 162	7 893	-6,4	843	1	1 112	2 896	76 503	7,9
1998	28 966	1,9	19 923	-3,0	4 103	1 443	2 075	9 042	14,6	873	1	1 859	2 773	76 263	-0,3
1999	31 805	9,8	22 086	10,9	4 311	1 551	2 261	9 719	7,5	728	2	1 669	2 599	81 036	6,3

### **12.3 The Geographical Split of the Maritime Traffic of the Port of Hamburg**

The Table 12.3 and the Table 13.4 show the geographical split of the volume of the maritime traffic of the seaport of Hamburg, for the period 1970-1999. The data of the Statistisches Landesamt of Hamburg are split into incoming cargo and outgoing cargo. Therefore, it is shown the geographical area of origin and destination of the maritime traffic of Hamburg.

The volume of the incoming and outgoing cargo has been growing since the 70s. The total volume of incoming cargo was 42.232 thousand tons in the year 1999 (36.069 thousand tons in the 1970), while the outgoing cargo was equal to 31.805 thousand tons (10.890 thousand tons in the year 1970).

Europe is the most important geographic area of origin of the maritime traffic of Hamburg. In the year 1999, the volume of the incoming freights was equal to 23.791 thousand tons. The volume of incoming cargo has been quite stable around this value during the last ten years. The role of Germany grew up to 1.715 thousand tons of incoming goods in the year 1999. The foreland of Hamburg is dominated by the deliveries received from the American continent (11.889 thousand tons in the 1999). The Central and South America<sup>39</sup> have the most relevant share of the incoming cargo of Hamburg (9.117 thousand tons in the 1999), while Asia send goods for 9.385 thousand tons in the year 1999.

Asia dominate the foreland of Hamburg for the outgoing cargo of the maritime traffic, with 13.749 thousand tons sent from the port in the 1999. Europe received 11.080 thousand tons of outgoing cargo from Hamburg in the same year. Germany received a larger volume of goods from Hamburg in the 1999 (1.019 thousand tons), as it did not happen since the 1983. America received from Hamburg by sea freight for 4.173 thousand tons in the year 1999, of which 2.802 thousand tons were delivered towards Central and South America<sup>40</sup>. This volume of goods is comparable to the 2.222 thousand tons sent to Africa in the same year.

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<sup>39</sup> It includes the U.S.A. on the Gulf of Mexico.

<sup>40</sup> It includes the U.S.A. on the Gulf of Mexico.

Table 12.3 – The geographic split of the maritime traffic of the port of Hamburg for the incoming cargoes 1970-1999.

Year	Total incoming		of which from													
			Europe				Africa	America				Asia		Australia, Oceania		
	Total		Germany		Total	North America		Central, South Am	Total		Total					
	1000 Tons	% Var.	1000 Tons	% Var.			1000 Tons		% Var.	1000 Tons	% Var.	1000 Tons	% Var.	1000 Tons	% Var.	
1970	36 069	-	14 205	-	375	-	5 814	-	10 106	-	3 931	6 175	5 368	-	554	-
1971	35 090	-2,7	14 121	-0,6	372	-0,8	5 094	-12,4	9 783	-3,2	3 108	6 675	5 329	-0,7	734	32,5
1972	35 581	1,4	16 320	15,6	521	40,1	4 464	-12,4	9 631	-1,6	3 118	6 513	3 840	-27,9	1 325	80,5
1973	37 154	4,4	18 409	12,8	541	3,8	4 089	-8,4	10 303	7,0	3 595	6 709	2 851	-25,8	846	-36,2
1974	36 527	-1,7	16 064	-12,7	589	8,9	3 793	-7,2	11 133	8,1	3 290	7 843	4 229	48,3	712	-15,8
1975	34 240	-6,3	14 673	-8,7	268	-54,5	3 164	-16,6	12 145	9,1	3 524	8 621	2 630	-37,8	827	16,2
1976	38 120	11,3	16 069	9,5	340	26,9	3 686	16,5	14 002	15,3	3 579	10 424	3 014	14,6	867	4,8
1977	38 788	1,8	18 374	14,3	543	59,7	4 128	12,0	12 031	-14,1	2 964	9 067	3 245	7,7	1 009	16,4
1978	39 614	2,1	19 634	6,9	306	-43,6	3 066	-25,7	12 192	1,3	2 992	9 199	3 308	1,9	1 414	40,1
1979	46 758	18,0	21 797	11,0	501	63,7	4 109	34,0	15 831	29,8	5 418	10 413	3 496	5,7	1 483	4,9
1980	44 911	-4,0	19 344	-11,3	391	-22,0	3 799	-7,5	16 382	3,5	5 155	11 227	4 061	16,2	1 247	-15,9
1981	39 234	-12,6	17 831	-7,8	727	85,9	3 350	-11,8	13 455	-17,9	4 228	9 227	3 767	-7,2	831	-33,4
1982	38 482	-1,9	18 626	4,5	627	-13,8	2 495	-25,5	12 968	-3,6	3 826	9 142	3 447	-8,5	946	13,8
1983	29 935	-22,2	14 264	-23,4	431	-31,3	2 064	-17,3	9 113	-29,7	2 483	6 630	3 622	5,1	872	-7,8
1984	32 959	10,1	16 989	19,1	385	-10,7	2 378	15,2	8 878	-2,6	3 238	5 640	3 285	-9,3	1 430	64,0
1985	38 380	16,4	18 682	10,0	320	-16,9	2 757	15,9	11 875	33,8	3 115	8 760	3 723	13,3	1 343	-6,1
1986	36 584	-4,7	19 347	3,6	528	65,0	3 358	21,8	8 725	-26,5	2 970	5 755	4 175	12,1	979	-27,1
1987	37 026	1,2	20 793	7,5	408	-22,7	2 762	-17,7	8 329	-4,5	2 687	5 642	4 370	4,7	749	-23,5
1988	39 114	5,6	19 738	-5,1	356	-12,7	5 490	98,8	8 354	0,3	3 104	5 250	4 486	2,7	1 046	39,7
1989	36 630	-6,4	19 491	-1,3	249	-30,1	3 243	-40,9	7 920	-5,2	2 643	5 277	4 891	9,0	1 085	3,7
1990	39 340	7,4	21 788	11,8	670	169,1	2 804	-13,5	8 501	7,3	2 266	6 235	5 600	14,5	645	-40,6
1991	42 244	7,4	23 798	9,2	341	-49,1	2 161	-22,9	9 682	13,9	2 953	6 730	5 923	5,8	678	5,1
1992	41 522	-1,7	23 525	-1,1	1 091	219,9	2 358	9,1	9 035	-6,7	2 545	6 490	5 891	-0,5	713	5,2
1993	41 846	0,8	25 446	8,2	783	-28,2	1 362	-42,2	8 353	-7,5	2 198	6 155	6 104	3,6	581	-18,5
1994	41 799	-0,1	23 523	-7,6	668	-14,7	1 688	23,9	9 008	7,8	2 683	6 325	6 745	10,5	835	43,7
1995	44 404	6,2	24 227	3,0	791	18,4	2 122	25,7	9 570	6,2	2 508	7 062	7 182	6,5	1 303	56,0
1996	43 782	-1,4	22 621	-6,6	836	5,7	2 550	20,2	9 970	4,2	2 614	7 357	7 756	8,0	885	-32,1
1997	48 077	9,8	25 272	11,7	919	9,9	2 356	-7,6	10 237	2,7	2 177	8 060	8 608	11,0	1 603	81,1
1998	47 298	-1,6	22 819	-9,7	983	7,0	2 551	8,3	10 840	5,9	1 926	8 914	9 699	12,7	1 389	-13,3
1999	49 232	4,1	23 791	4,3	1 715	74,5	2 781	9,0	11 889	9,7	2 384	9 117	9 385	-3,2	1 388	-0,1

Table 12.4 – The geographic split of the maritime traffic of the port of Hamburg for the outgoing cargoes 1970-1999.

Year	Total outgoing		of which from													
			Europe				Africa	America			Asia		Australia and Oceania			
	Total		Germany		Total			North America	Central, South Am							
	1000 Tons	% Var.	1000 Tons	% Var.	1000 Tons	% Var.	1000 Tons	% Var.	1000 Tons		1000 Tons	% Var.	1000 Tons	% Var.		
1970	10 890	-	5 988	-	1 407	-	1 205	-	1 699	-	673	1 027	1 812	-	186	-
1971	10 213	-6,2	5 756	-3,9	1 425	1,3	1 190	-1,2	1 544	-9,1	644	900	1 502	-17,1	221	18,8
1972	10 674	4,5	6 355	10,4	1 420	-0,4	1 106	-7,1	1 478	-4,3	596	882	1 527	1,7	206	-6,8
1973	12 696	18,9	7 295	14,8	1 721	21,2	1 334	20,6	1 558	5,4	585	974	2 235	46,4	273	32,5
1974	15 822	24,6	8 621	18,2	1 746	1,5	1 578	18,3	2 410	54,7	857	1 553	2 850	27,5	364	33,3
1975	13 941	-11,9	8 134	-5,6	1 785	2,2	1 595	1,1	1 607	-33,3	586	1 021	2 369	-16,9	233	-36,0
1976	14 340	2,9	8 636	6,2	1 679	-5,9	1 474	-7,6	1 471	-8,5	515	957	2 494	5,3	264	13,3
1977	14 786	3,1	7 312	-15,3	1 306	-22,2	1 858	26,1	1 764	19,9	556	1 208	3 603	44,5	249	-5,7
1978	14 982	1,3	6 336	-13,3	1 137	-12,9	2 055	10,6	2 180	23,6	880	1 301	4 120	14,3	290	16,5
1979	15 892	6,1	7 404	16,9	1 229	8,1	1 925	-6,3	2 061	-5,5	620	1 441	4 142	0,5	360	24,1
1980	17 482	10,0	8 445	14,1	1 138	-7,4	2 172	12,8	1 953	-5,2	543	1 410	4 576	10,5	337	-6,4
1981	20 793	18,9	9 855	16,7	1 001	-12,0	2 868	32,0	2 191	12,2	635	1 556	5 505	20,3	373	10,7
1982	23 099	11,1	12 218	24,0	1 068	6,7	2 780	-3,1	2 102	-4,1	835	1 267	5 583	1,4	416	11,5
1983	20 696	-10,4	9 950	-18,6	1 034	-3,2	2 355	-15,3	1 540	-26,7	673	867	6 452	15,6	381	-8,4
1984	20 529	-0,8	8 568	-13,9	731	-29,3	2 323	-1,4	2 454	59,4	1 289	1 165	6 679	3,5	505	32,5
1985	21 155	3,0	9 869	15,2	627	-14,2	2 192	-5,6	2 353	-4,1	1 334	1 017	6 190	-7,3	551	9,1
1986	18 112	-14,4	6 780	-31,3	668	6,5	1 987	-9,4	2 294	-2,5	1 216	1 078	6 530	5,5	522	-5,3
1987	19 544	7,9	7 363	8,6	426	-36,2	1 915	-3,6	2 331	1,6	1 192	1 139	7 281	11,5	655	25,5
1988	19 828	1,5	7 351	-0,2	316	-25,8	2 087	9,0	2 328	-0,1	1 141	1 187	7 390	1,5	672	2,6
1989	20 952	5,7	8 182	11,3	270	-14,6	2 286	9,5	2 192	-5,8	859	1 333	7 587	2,7	706	5,1
1990	21 758	3,8	7 888	-3,6	326	20,7	2 195	-4,0	2 270	3,6	786	1 494	8 767	15,6	637	-9,8
1991	22 961	5,5	7 967	1,0	359	10,1	2 009	-8,5	2 434	7,2	789	1 645	10 025	14,3	523	-17,9
1992	23 359	1,7	9 069	13,8	368	2,5	1 790	-10,9	2 640	8,5	708	1 933	9 336	-6,9	524	0,2
1993	23 926	2,4	8 171	-9,9	239	-35,1	1 593	-11,0	3 076	16,5	825	2 251	10 594	13,5	492	-6,1
1994	26 640	11,3	8 834	8,1	425	77,8	1 583	-0,6	3 501	13,8	908	2 593	12 152	14,7	571	16,1
1995	27 785	4,3	9 213	4,3	512	20,5	2 079	31,3	3 438	-1,8	963	2 475	12 530	3,1	526	-7,9
1996	27 138	-2,3	9 302	1,0	505	-1,4	1 872	-10,0	3 536	2,9	1 074	2 462	11 915	-4,9	512	-2,7
1997	28 426	4,7	10 333	11,1	608	20,4	1 377	-26,4	3 959	12,0	1 212	2 747	12 214	2,5	544	6,3
1998	28 966	1,9	11 023	6,7	821	35,0	1 944	41,2	4 283	8,2	1 230	3 053	11 205	-8,3	511	-6,1
1999	31 805	9,8	11 080	0,5	1 019	24,1	2 222	14,3	4 173	-2,6	1 371	2 802	13 749	22,7	580	13,5

#### **12.4 The Gateway Function for the Baltic Sea Region**

The function of gateway of the seaport of Hamburg for the Baltic Sea Region BSR plays a relevant role, although if the BSR seems to be geographical differentiated into two Baltic sub-regions. During the last decade, it grew in importance the feeder services directed towards the regional and communication seaports of the BSR, as alternative to the land transport, because of the inefficient level of quality of the infrastructures on the land side.

The two Baltic sub-regions are respectively the South-West BSR and the core Mid-East BSR (Map 5 and Map 6). The former is defined as the largest geographical area of the urban agglomerations from Lillehammer, Oslo, Gøtheburg, Malmö, Copenhagen, Kiel, Lübeck, Rostock to the eastern Baltic Rim of Poland. This sub-region seems to have a great potential for the economic growth. The building of new transportation links is going to be realised very fast. The core Mid-East BSR starts from the Greater Stockholm/Uppsala conurbation and embraces the coastal cities of Aabo, Helsinki, St. Petersburg, Tallin, Riga and Klaipeda. This geographical sub-region is experiencing a different policy of economic growth. It is more based on the functional integration on a regional basis, and the promotion of the co-operation among the countries.

In order to analyse the function of gateway of the port of Hamburg for the countries of the BSR, it has been considered the traffic of goods of the seaport of Hamburg according to the data of the Statistisches Landesamt.

The Statistisches Landesamt of Hamburg defines the maritime freight traffic of the Hanseatic port according to the following methodology. The incoming cargo is defined as the total quantity of goods that are unloaded and that the seaport of Hamburg has received by sea. The outgoing cargo is defined as the total quantity of goods that are delivered towards a further destination by sea. In both cases, no activity of transshipment must be occurred between the port of Hamburg and the place of origin or destination of the freight. The quantity of the goods is expressed in terms of tons of the gross weight. The gross weight includes the weight of the vehicle of transport, as well as the loaded and empty containers, the trailer and the ship for lightening<sup>41</sup>.

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<sup>41</sup> On the contrary, the Federal statistics do not include these elements.

Figure 12.4 – The volume of freight of the maritime traffic received to the port of Hamburg from the countries of the BSR 1993-1999.

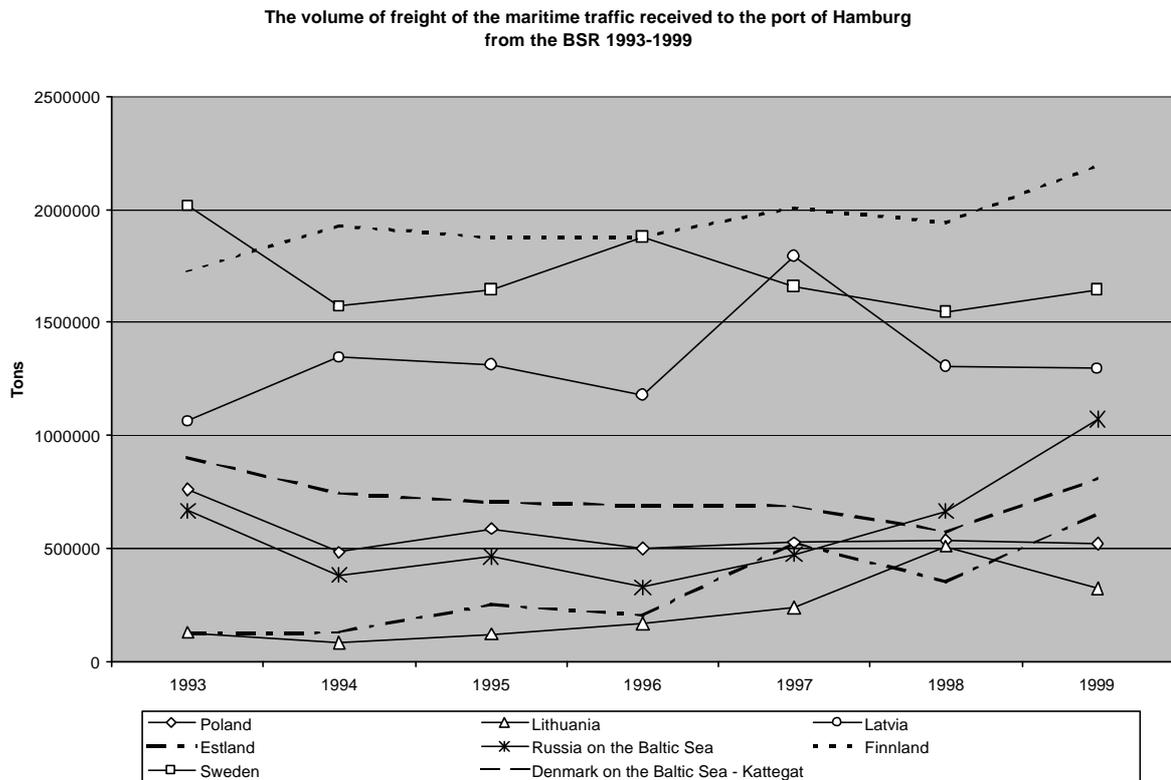
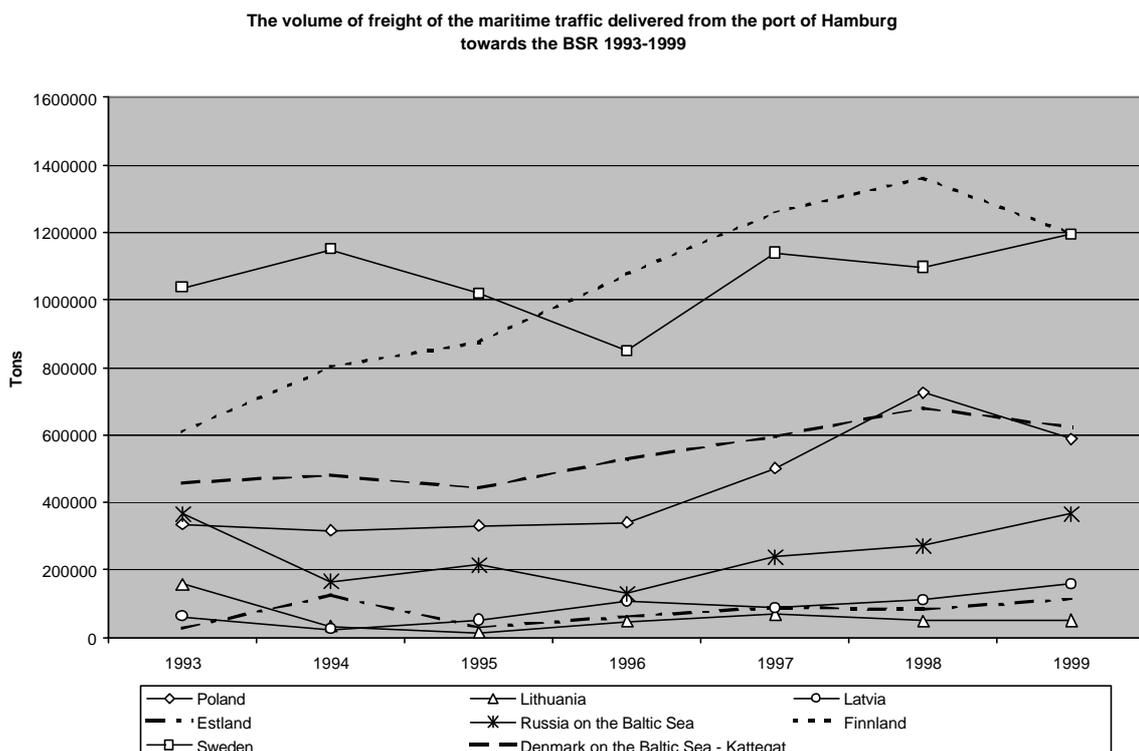


Figure 12.5 – The volume of freight of the maritime traffic delivered from the port of Hamburg towards the countries of the BSR 1993-1999.



The Figure 12.4 shows the geographical split of the volume of cargo (tons), that the port of Hamburg received from the countries of the BSR by sea, during the time 1993-1999. The Figure 12.5 shows the geographical split of the volume of cargo (tons), that was sent by sea from the port of Hamburg towards the states of the BSR, during the period 1993-1999.

The Figure 12.6 shows the geographic split of the maritime traffic of containers (TEUs), that the seaport of Hamburg received by sea to from the states of the BSR, during the period 1993-1999. The Figure 12.7 shows the geographic split of the maritime traffic of containers (TEUs), that the seaport of Hamburg delivered by sea towards the countries of the BSR, during the period 1993-1999. A logarithmic scale has been used, because of the differences in the range of the number of incoming/outgoing TEUs received from/delivered to the countries of the BSR.

The analysis of the movements of the empty containers gives some useful information on the quality of the container traffic. A economy under a process of transformation is supposed to receive a larger quantity of loaded containers, while it delivers a big number of empty containers. This consideration is true, if the country receive products of high value, that are usually containerised, and delivers bulk cargoes, that are usually not sent into the containers.

It is interesting to calculate the index of the loaded containers with respect to the empty containers for the countries of the BSR, with reference to the maritime traffic of freight of the port of Hamburg.

The index is given by the difference between the number of loaded containers and the number of empty containers, and then by dividing this result by the number of total containers handled (Equation 12.1). It has been split into incoming and outgoing cargo.

$$\begin{aligned} \text{Equation 12.1} \quad & \text{Index of loaded containers} = \\ & (\text{nr. of loaded containers} - \text{nr. of empty containers}) \\ & / (\text{total nr. of containers}) \end{aligned}$$

where:      +1 <= Index of loaded containers <= -1

Figure 12.6 – The geographic split of the maritime traffic of containers (TEUs) received to the seaport Hamburg from the BSR 1993-1999.

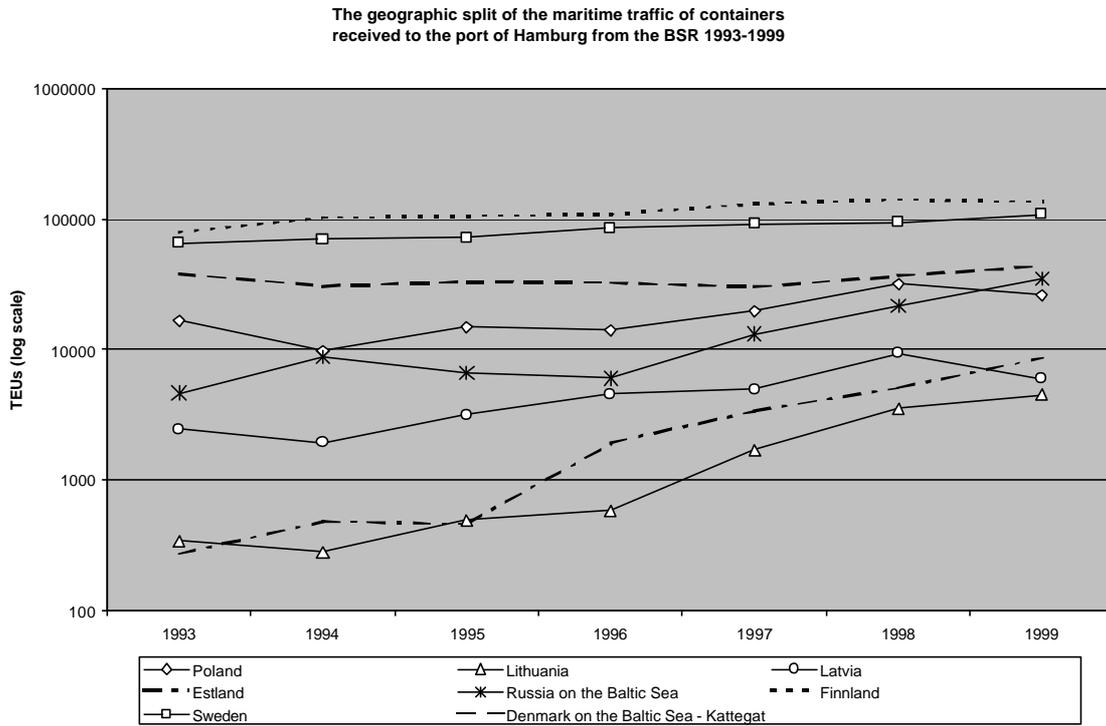
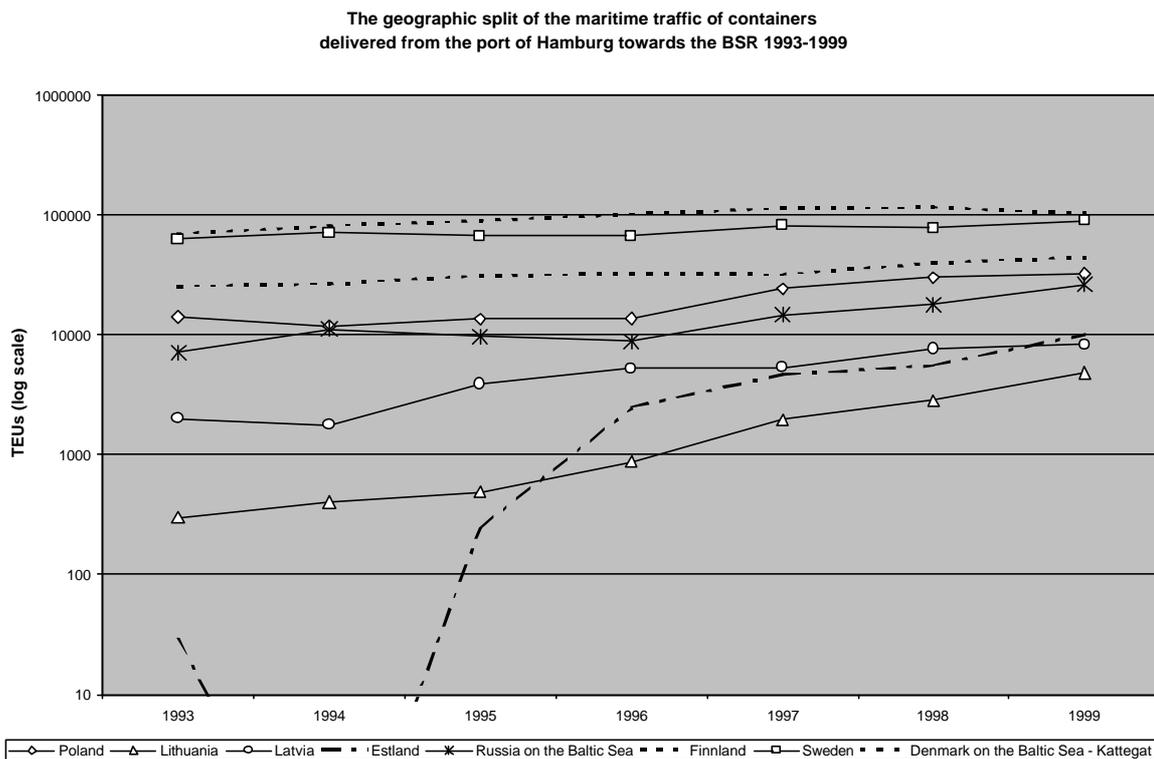


Figure 12.7 – The geographic split of the maritime traffic of containers (TEUs) delivered from the seaport of Hamburg towards the BSR 1993-1999.



The index of loaded containers assumes values between +1 and –1. If the index of loaded containers is positive, it means that there is a prevalence of the loaded containers. If the index is negative, then the empty containers dominate the traffic with respect to the total number of containers. If the value of the index is near the zero, then the number of empty and loaded containers is more or less equivalent. The proximity of the index to +1 shows the stark dominance of the loaded containers in the traffic, while the proximity of the index to –1 shows the relevant prevalence of the empty containers.

The Figure 12.8 shows the ratio of loaded containers (as number of containers), that the port of Hamburg received from the countries of the BSR during the period 1993-1999.

The Figure 12.9 shows the ratio of loaded containers (as number of containers), that the port of Hamburg delivered towards the countries of the BSR during the period 1993-1999.

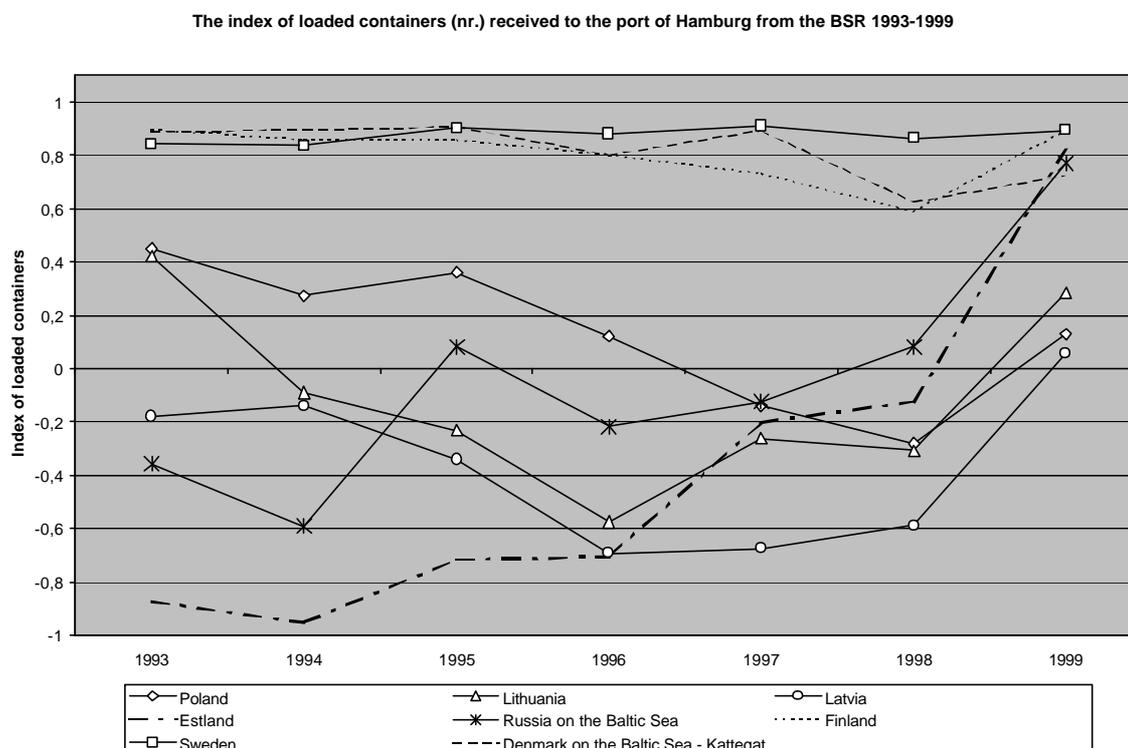
The seaport of Hamburg mostly receives by sea the bulk cargo from the countries of the BSR, which are experiencing a restructuring process of the economy. The movements of the empty containers towards the Hanseatic seaport, and the positive index of loaded containers in the opposite direction of traffic, put in evidence the phase of transition of them. Typically, a economy under restructuring is supposed to receive commodities of higher value, that are generally transported by containers, while it is supposed to deliver larger volumes of bulk cargo, which have a lower value.

Finland, Sweden and Denmark on the Baltic Sea-Kattegat are the three most important countries of origin and destination of the maritime traffic of goods of the port of Hamburg. The deliveries of general cargo from **Finland** and **Sweden** to Hamburg, as well as on the opposite direction, are of particular relevance. **Denmark on the Baltic** shows the same at a smaller scale.

The general cargo sent to **Poland** grew up to the double between 1997-1999, but on the opposite direction, Poland delivered in prevalence bulk cargo to Hamburg. The volume of the tonnage seems to be constant through the period 1993-1999.

The **Russian Federation on the Baltic Sea** have a dominant role for the deliveries by sea towards the Hanseatic port of Hamburg, in particular for the deliveries of bulk cargo. A quite constant and smaller volume of general cargo has been sent from Hamburg during the period 1993-1999.

Figure 12.8 – The index of loaded containers (nr.) received to the port of Hamburg from the countries of the BSR 1993-1999.



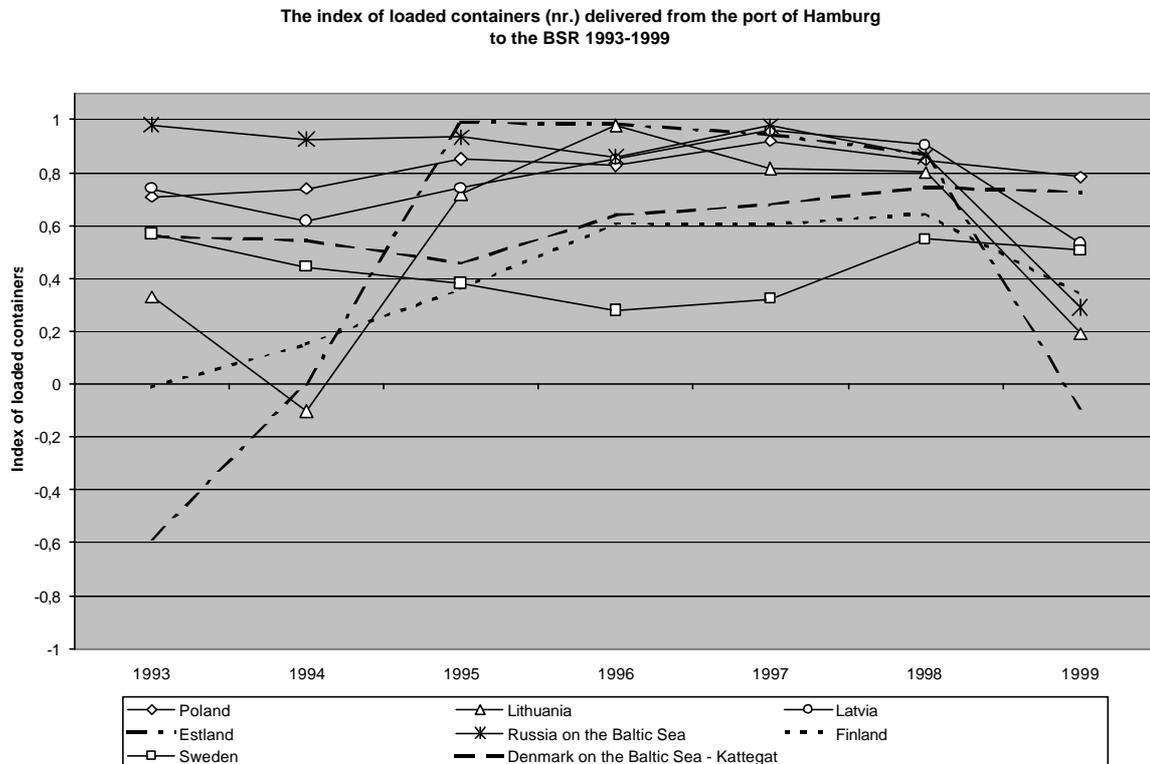
**Estonia** sent to Hamburg prevalently bulk cargo. The deliveries of bulks and general cargo from Estonia show a positive trend since 1993. In the opposite direction, the break bulk cargo are dominant. A positive trend of the deliveries from Hamburg towards this country has been seen between 1998-1999.

**Latvia** plays a relevant role with reference to the maritime deliveries of bulk cargo towards Hamburg. The volume of cargo seems to be more or less constant since 1993. There is a dominance of the deliveries of general cargo from the port of Hamburg, and they show a positive trend during the last years.

**Lithuania** sent mostly bulk cargo to Hamburg. The trend has been positive since 1993. On the opposite direction, there is a quite variable composition of the deliveries from the port of Hamburg to this country during the period 1993-1999. In the years 1998 and 1999, Hamburg sent respectively a double and triple volume of general cargo with respect to the bulks.

In general, the maritime traffic of containers has been growing since 1993. The positive trend is shown both for the incoming and outgoing traffic of the seaport of Hamburg towards the states of the BSR. The analysis of the structure of the container traffic is explained in detail the following paragraphs.

Figure 12.9 – The index of loaded containers (nr.) delivered from the port of Hamburg to the countries on the BSR 1993-1999.



**Finland** delivered goods to Hamburg for more than 2.195 thousand tons in the year 1999, and received more than 1.196 thousand tons from the Hanseatic port. The break bulk cargo are prevalent in both directions with respect to the bulk cargo. There is a positive trend in the handling of the containerised cargo from/to Hamburg. Finland received 135.172 TEUs from Hamburg in the year 1999, the index of loaded containers is equal to +0,8965; and delivered 103.256 TEUs in the same year, the index of loaded containers is equal to +0,3382.

**Sweden** sent goods to Hamburg by sea for more than 1.641 thousand tons, and received freights for more than 1.194 thousand tons in the year 1999. Also for this country, the break bulk cargo are dominant. A volume of 107.722 TEUs were delivered to Hamburg (+0,8242 is the index of loaded containers), while 90.575 TEUs were received from the Hanseatic port (+0,5043 is the index of loaded containers) in the same year.

**Denmark on the Baltic Sea-Kattegat** delivered to Hamburg in the year 1999 a total volume of goods by sea equal to 808.828 tons, while received 623.229 tons in the same year. The prevalence of the general cargo typology is clear also for this state. The volume of containers delivered to the Hanseatic port in

the year 1999 was equal to 43.579 TEUs (+0,7252 is the index of the loaded containers), while the incoming volume was of 44.390 TEUs (+0,7253 is the index of the loaded containers).

**Poland** sent to the Hanseatic port a total volume of maritime traffic equal to 519.569 tons in the year 1999, and received 589.256 tons. The structure of the cargo shows the prevalence of the bulk cargo sent from Poland to Hamburg since the year 1993 (556.656 tons in the year 1993, and 287.183 tons in the year 1999), if compared to the volume of the general cargo sent during the same period (204.947 tons in the year 1993, and 232.386 tons in the year 1999). This volumes show a negative trend of the total incoming cargo from Poland to the port of Hamburg.

On the contrary, the volume of containers delivered from Poland towards Hamburg by sea has been increased during the same period, from 16.562 TEUs in the year 1993, to 26.186 TEUs in the year 1999. The index of the loaded containers from Poland is variable, but quite low (0,1298 in the year 1999), if not negative (-0,2823 in the year 1998, -0,1404 in the year 1997).

The structure of the freights that the port of Hamburg delivered towards Poland since the year 1993 is more balanced between bulk cargo and break bulk cargo. The trend during the past years has been positive in particular with reference to the general cargo (151.811 tons in the year 1993, 385.213 in the year 1999).

The containerised goods delivered from Hamburg by sea towards Poland has also grown (14.259 TEUs in the year 1993, 32.525 TEUs in the year 1999). The index of loaded containers sent to Poland is quite stable during the same period (for example, it was equal to +0,7820 in the year 1999).

The **Russian Federation on the Baltic Sea** delivered to Hamburg a total volume of maritime traffic equal to 1.072.444 tons in the year 1999 (666.909 in the year 1993, but 326.805 tons were the lower volume in the year 1996), and received only 365.810 tons from the Hanseatic port in the same year (129.505 tons were the lower volume in the year 1996). The analysis of the incoming cargo sent from Russia to Hamburg shows the absolute prevalence of the bulk cargo with respect to the general cargo since 1993.

A change of this split is occurred since the year 1998, and in the year 1999 the two typologies of cargo were equally split with reference to the maritime deliveries of the Russia Federation on the Baltic towards Hamburg.

Furthermore, the volume of containers shows a positive trend since 1993, although the index of loaded containers sent to the Hanseatic port was negative (-0,5905 in the year 1994). Since 1998, the index assumed positive values, and in the year 1999 it was equal to +0,7721.

The analysis of the cargo structure with reference to the deliveries of the port of Hamburg towards Russia on the Baltic shows the dominance of the break bulk cargo on the bulk cargo, although if the volume of the bulk cargo sensibly grew in the year 1999 (89.034 tons) with respect to the previous year (11.846 tons). Anyway, this volume does not reach the pick of the year 1993 (143.852 tons), although it indicates a recovering after the lower volumes of the years 1994-1998.

The volumes of the general cargo do not show a great variability since 1993, while the volume of containers grew from 7.194 TEUs in 1993, to 26.408 TEUs in 1999. The index of loaded containers delivered to Russia was high and quite constant since 1993 (for example, +0,9812 in the year 1993), but drop down in the year 1999 to +0,2904. This value is related to the higher number of loaded containers received to Hamburg from Russia during the same year, and sent back as empty containers.

**Estland** delivered a total volume of freights to Hamburg by sea equal to 652.265 tons in the year 1999, and received 114.799 tons from the Hanseatic seaport in the same year. These volumes show a interesting positive dynamics of the maritime traffic of cargo from Estonia to Hamburg. In fact, if the total tonnage is compared to the year 1993, the deliveries of Estonia towards Hamburg were equal to 123.629 tons. There is a stark prevalence of the bulk cargoes that are delivered from Estland to Hamburg (524.933 tons of bulk cargo against 127.332 tons of general cargo in the year 1999).

The volume of containers delivered from this country sensibly grew since 1993. In the year 1993, the volume was of 268 TEUs, while in the year 1999 it was equal to 8.570 TEUs. The analysis of the structure of the containers shows a index of loaded containers always negative. The lower value of this index has been in the year 1994 with -0,9539. The year 1999 is the first one that shows a positive value of this index, equal to +0,8179.

The trend of the deliveries of Hamburg towards Estonia in the year 1993 corresponded to 26.230 tons. This is a lower value if compared to 1999, but the trend during the years 1993-1999 has not been regular. Also the composition of the cargo typology is not stable. The year 1994 shows the higher pick of the

bulk cargo (119.252 tons) and the lower pick of general cargo (6.034 tons), as well as no containers received from Hamburg.

The volume of containers received from the Hanseatic port grew from 29 TEUs in the year 1993 to 10.124 TEUs in the year 1999. The index of loaded containers has been positive (for example, +0,8609 in 1998), although if in the year 1999 it was negative (-0,914). As for Russia, this negative value of the index is due to the larger number of loaded containers that Estonia sent to the port of Hamburg in 1999, and that have to be sent back by sea.

**Latvia** delivered a total volume of goods to Hamburg by sea for more the 1.295 thousand tons in the year 1999, while on the opposite way, the Hanseatic port sent freights for 157.044 tons. The analysis of the structure of the cargo that Latvia sent to Hamburg shows a stark and constant dominance of the bulk cargoes (for example, 1.194.571 tons in the year 1999) against the general cargo (for example, 100.901 tons in the same year) since the year 1993.

The volume of the containers delivered from Latvia grew through the years, and reached the top in 1998 with 9.264 TEUs. The index of loaded containers has been always negative during the period 1993-1998 (-0,5872 was the value in 1998), although in 1999 it was positive for the first time (+0,0588).

Hamburg sent towards Latvia mostly break bulk cargoes (105.847 tons in the year 1998), rather than bulk cargoes (only 4.464 tons in the same year), although in the year 1999 there was a more balanced split between the two cargo typologies (81.317 tons of general cargo, and 75.727 tons of bulks).

The volume of containers in the year 1999 that Hamburg sent to Latvia was equal to 8.359 TEUs. There is a positive trend since 1993 (2.003 TEUs). Also for Latvia, the index of loaded containers is positive since 1993 (for example, +0,9029 in the year 1998). The year 1999 shows a lower value of the index (+0,5318) because of the higher number of loaded containers that Latvia sent to Hamburg, and which had to be sent back.

**Lithuania** sent to Hamburg a total volume of cargo equal to 321.026 tons, and received from the Hanseatic seaport 50. 441 tons in the year 1999. Also for the case of Lithuania, the analysis of the structure of the cargo shows the relevant prevalence of the bulk cargo delivered to Hamburg (260.185 tons in 1999) with respect to the 60.841 tons of general cargo in the same year.

The containers sent from Lithuania grew up to 4.466 TEUs in 1999 (only 339 TEUs in 1993), but the index of loaded containers has been negative from

the year 1994 to 1998, with a pick of  $-0,3064$  in the year 1996. The year 1999 shows a positive value of the index, equal to  $+0,285$ .

In the opposite direction, there is a certain variability since 1993 on the structure of the cargo that the port of Hamburg has been delivering to Latvia. Generally, the volume of containers grew from 298 TEUs in 1993 to 4840 TEUs in 1999, and the index has been positive during this period (for example,  $+0,8212$  in the year 1998). The index assumed a lower value in the year 1999 ( $+0,1914$ ) due to the higher numbers of loaded containers that Lithuania sent to Hamburg, and which had to be sent back.

## 13 The Railways Network

### ***13.1 The Deregulation of the German Railways as an Institutional Instrument of Promotion of the Entrepreneurship***

Hamburg is the most important North European railway node. According to the modal split, in the year 1999 the share of the rail modality was the 27,5% of the cargo handled through the seaport of Hamburg. It was transported a total volume of freight equal to 22,3 million tons during the year 1999. It corresponded to a negative flexion of -2,2% if compared to the previous year. About the 70% of the containerised cargo on the long distance (more than 150 km) are transported by rail. If the seaports Hamburg and Bremen are jointly considered, circa 80% of the container transport on the long distance takes place by rail (Map 1).

Nearly two fifth of the total amount of containers carried by the Deutsche Bahn Cargo AG are handled inside the Hamburg area: during the year 1990 this amount corresponded to 496.000 containers. In the year 1997 the inter-modal traffic of Hamburg counted about 700.000 TEUs; about one fifth of the total traffic volume has been handled by private inter-modal operators. There are about 165 daily arrivals or departures of freight trains from or towards the Hanseatic city-region Hamburg, which is equal to a total amount of about 4.400 rail freight wagons in transit.

A significant turning-point was the deregulation of the rail transport modality in Germany since 1<sup>st</sup> January, 1994, followed by the restructuring process in the German Railways – Deutsche Bahn. The German Railways were split into four main branches: Long Distance Passengers Traffic, Short Distance Passengers Traffic, Cargo Traffic and Carriage-Road/Infrastructures. The main change was the separation of the passengers and cargo services from the infra-structural sector [Nuhn, 1998].

The innovation regarded in particular the extension of the use of the tracks to other operators, which are different by the two sectors of production of the service (which are respectively the two branches of traffic of the passengers and cargo), under the same rights and conditions that was agreed to the German Railways. The German railway network is owned by the Deutsche Bahn AG, which operates the cargo service transport by the Deutsche Bahn Cargo, its freight subsidiary. The Deutsche Bahn AG is a private capital

company, free from any public service obligation; its aim is to co-ordinate the track use depending on the costs of realization, management and maintenance, within a free market competition framework.

### **13.1.1 The Block Train Services of Hamburg**

The rail transportation is characterized by the high incidence of the fixed costs because of the high investment costs for the infra-structural network. Due to this particular characteristic, this transport modality results to be competitive just over distances exceeding the 150/200 km. The variable costs are relatively low, therefore the average cost per unit<sup>42</sup> decreases when the output grows (TEU/km or ton/km).

The characteristics of the rail transport modality can be briefly outlined by a more rigidity of the physical network as well as by a less number of access points and terminals, if compared to the road network. Generally, the efficiency of the containerised transportation depends on two factors: the quality and number of links towards the demand/production areas; as well as on the availability of inland terminals exploiting the loading/unloading operations. The road-rail combined transport becomes competitive for distances over 350/400 km because the costs of the loading/discharge operations at the terminal points are compensated by the lower rail cost of transport.

A further transport service that may be offered using the rail network is the block train service. This is a train up to 700 m long which can load up to 60/80 TEUs. The aim of this kind of service is to reach the nodal rail terminals, to discharge the containers and to come back to the origin station. The economic advantage is given by the lower loading/unloading costs because the change of transport modality take place at the inter-modal centres.

The Transport Economy defines a block train as a freight train made up exclusively by container wagons collected at several inter-modal hubs. A block train has not to be shunted and has not to be stopped or controlled by the customs authorities at the international boundaries. Its route and its goods

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<sup>42</sup> Generally, the average cost is defined as the total production costs per unit of output. It is calculated by adding the total fixed costs to the total variable costs and dividing by the number of units produced.

yard stops are fixed in advance. The use of the containers makes the loading/unloading operations faster and easier: it makes possible an increasing efficiency in the transportation chain. It follows that this transport modality meets the VASAB goals of sustainability and of transport development that is environmental friendly. This is because if the transport flow is more fluent, then the rates of pollution and congestion decrease. These are in fact two negative externalities to fight.

Since the deregulation of the German Railways, private rail operators began to offer freight transports in particular by organising block train services towards the main European destinations. Therefore, the two private port operators of Hamburg, Eurogate (former Eurokai) and HHLA, began to develop a large number of block train services, regularly connecting the seaport to the major destinations towards the Western and Eastern European Countries, the Scandinavian States and the former Soviet Union Countries.

Burchardkai and Eurokai are the two main origin/destination terminals of the block train services due to the fact that they are the two bigger container terminals of the seaport Hamburg. At Waltersshof, there is also a further secondary rail stations – Bezirksbahnhof of Mühlenwerder. In the year 1999, the production capacity has been of 330.494 wagons, it corresponds to an improvement of +3,5% with respect to the previous year (Map 1).

An example of modal shift from the road to the rail is given by the rail shuttle service that has been realized according to the System Kombinetz 2000 Plus. It runs five times a week between the Gateway Terminal of Billwerder at Hamburg and the seaport of Rostock.

There are seven companies managing the inter-modal services of block-trains from and to Hamburg: Deutsche Bahn AG, Eurokombi Transport KgaA, HHCE Hansa-Hungaria-Container Express (HHLA), Kombiverkehr-Deutsche Gesellschaft für Kombinierten Güterverkehr mbH & Co. KG, Metrans-Internationale Speditions GmbH, Polzug Polen-Hamburg Transport GmbH, Transfracht Deutsche Transport Gesellschaft mbH.

There are about 200 weekly block-train international services towards the destination to Poland, the Czech Republic, the Slovakia, Hungary, Russia, Austria and Switzerland (Map 3), as follows:

1. Austria is daily connected by Intercontainer-Interfrigo ICF; Intercontainer Austria; Transfracht; Kombiverkehr; Eurokombi; HHLA "Star Track".

2. Switzerland is connected from Monday to Friday by ICF; Transfracht; Kombiverkehr.
3. Italy is connected twice a week by ICF and by Kombiverkehr from Monday to Friday.
4. White Russia is regularly connected by ICF and by Polzug.
5. Hungary is reached by ICF; daily from Monday to Friday by Eurokombi and by Kombiverkehr by the "Donau-Elbe-Express" through Dresden, and furthermore by the "Sprinter" service to Budapest treble a week; by the RoeEE; by HHLA; by the "Hansa-Hungaria-Container-Express" HHCE via Sopron in transit to Ukraine, Romania, Bulgaria, Greece and Turkey.
6. Bulgaria is regularly connected by ICF through Hungary.
7. CIS States are regularly connected by block-train services through Pitesti-Malaszewicze; Moscow is reached twice a week by the "Ostwind" train by ICF and Transrail. The same rail operators regularly connect 215 terminals in Russia, Ukraine, White Russia, Kazachstan, Uzbekistan, Kargisia, Tadzikistan and Turkmenia. Polzug reaches the CIS States through Warsaw and Kombiverkehr and ICF through Finland.
8. Czech Republic is connected 3-5 times a week by Metrans-Prag, ICF, Transfracht CSKD-Intrans by the "Hansa-Bohemia-Container-Express" HBCE, Kombiverkehr and Eurokombi by the "Donau-Elbe-Express".
9. Slovak Republic is daily connected from Monday to Friday both by the "Donau-Elbe-Express" Eurokombi service through Prag-Melnik and by Kombiverkehr; treble a week by Metrans; twice a week by ICF, Transfracht and CSKD-Intrans by the "Hansa-Bohemia-Container-Express" HBCE via Lovosice.
10. Rumania is regularly connected by Kombiverkehr, ICF and Eurokombi treble a week via Pitesti.
11. Ukraine is regularly reached by ICF via Sopron and by Polzug via Kattowicz towards Kiev.
12. Lithuania and the Baltic States are linked 6 times a week by Polzug.
13. Denmark is daily connected from Monday to Friday by the "Scandinavian Maritime Express" ICF service and by Kombiverkehr.

14. Finland has feeder services through Hamburg and Lübeck by ICF and Kombiverkehr.
15. Norway is daily connected from Monday to Friday by the "Scandinavian Maritime Express" ICF and 5 times per week by Polzug via Poland/Baltic States.
16. Sweden is daily linked from Monday to Friday by the "Scandinavian Maritime Express" ICF and by regular connections by Kombiverkehr.

There are over 250 weekly night block-train national services from Hamburg towards the main economical German centres as Frankfurt-on-Main, Munich and Berlin. The main national operators are:

1. Deutsche Bahn AG, Transfracht and Kombiverkehr, which manage every day a nightly service called "Interkombi Express IKE", which send every day 62 trains towards the major German economic destinations.
2. Transfracht, which daily runs the "Albatros" service towards the 15 major intermodal centres in the German Republic.
3. Kombiverkehr, which runs a working day service in Germany.
4. Eurokombi, with connections from Monday to Friday towards 14 main German cities.

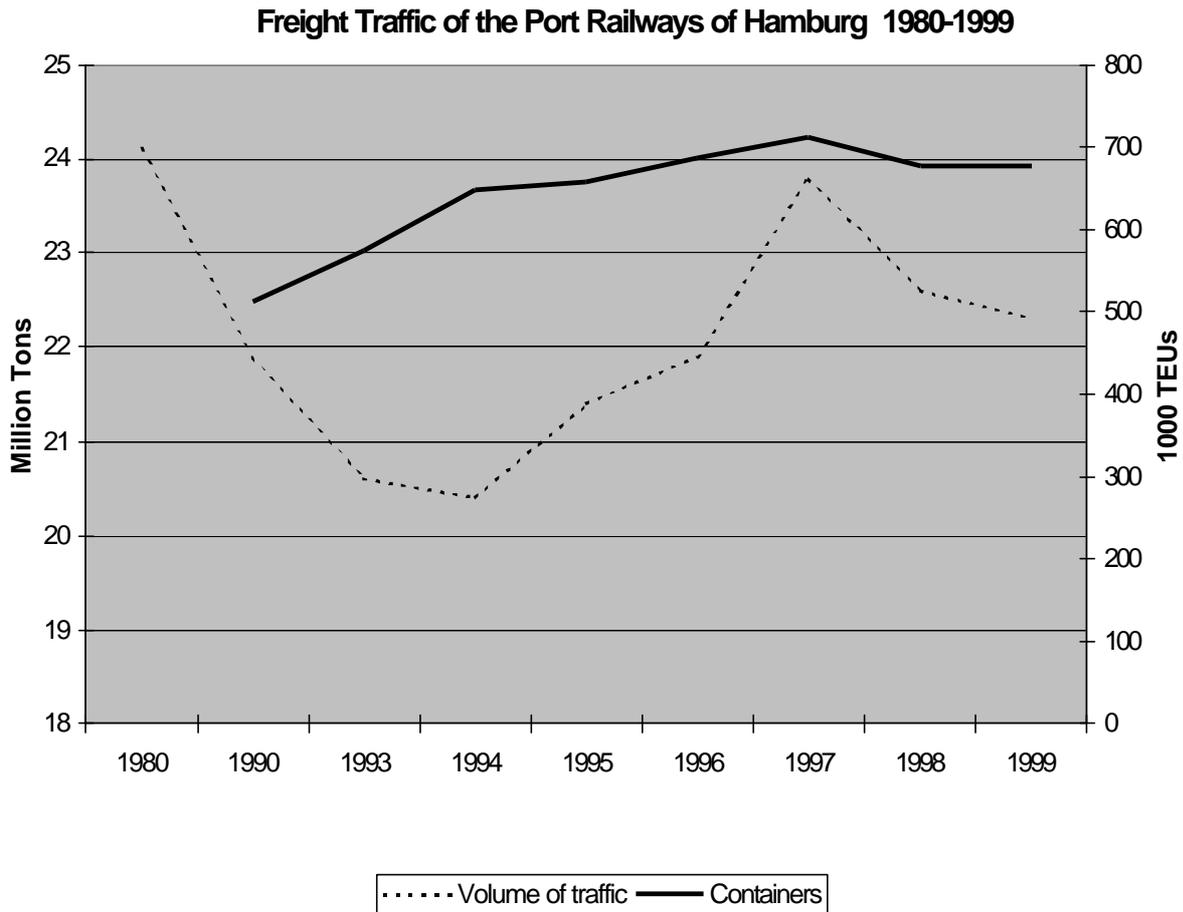
### ***13.2 The Port Railways of Hamburg as Public Local Entrepreneur***

The Railways of the Port of Hamburg – Hafenbahn are totally owned by the City of Hamburg and operated by the German Railways – Deutsche Bahn Cargo DB Cargo. The extension of the rail network inside the seaport area corresponds to about 700 km. The public sector directly runs a 386 km total length rail tracks (Map 1).

In the year 1997 it has been handled 23.8 millions tons of cargo (mainly bulk cargoes and containers); containers corresponded to about 717,2 thousand TEUs (Figure 13.1). A total amount of 1080,1 thousand freight wagons was sent and received by the Port Railways. This corresponded to the 31% of the total maritime cargoes handled by the Port of Hamburg in the year 1997. But in the year 1998 the volume of traffic drop to 22,6 millions tons, equivalent to 677,6

thousand TEUs, corresponding to 1030,9 thousand of incoming/outgoing wagons [HVVW, 1999]. The Port Railways loses in the year 1998 a traffic volume share of  $-5,04\%$  with respect to the year 1997, equivalent to a TEU variation of  $-5,52\%$ , that is a decrease of  $-4,55\%$  in the number of wagons.

Figure 13.1 – The freight traffic of the Port Railways of Hamburg 1980-1999.



During the year 1999, the cargo volume handled by the local Port Railways felt down to around 22,3 millions tons, that is  $-1,4\%$  with respect to the previous year. The number of wagons was 967.816, that is  $-6,1\%$  with respect to the year 1998. The number of containers handled in the year 1999 was 499.080 (505.391 containers in the year 1998) equivalent to 677.617 TEUs, that is just a soft decrease of  $-0,003\%$  TEU with respect to the 677.634 TEUs handled in the year 1998.

The operations related to the rail movements are better co-ordinated and put in synchrony by the use of the HABIS information system developed by DAKOSY. This software application links the ship side of the transport chain to the German Railways and the terminal operators.

The HABIS system is connected to the national software network in order to realise the interchange of information between the various origin/destination centres; the aim is to improve the efficiency in the inter-modal operations along the transport chain. Through the electronic data interchange, the rail cargo documentation can be sent/received before the train arrives: the loading/unloading operations at the next inter-modal node can be properly organized in advance. This specific application of the information technology provides a relevant contribution to the improvement of the hinterland connections by rail from Hamburg towards Europe and the BSR.

There are 4 main rail stations at Hamburg: Hamburg-Waltershof, Hamburg-Hohe Schaar, Hamburg-Süd and Hamburg-Untereibe (Map 1).

By using the traditional shunting system, at the seaport Hamburg the trains arrive to the main station – Haupthafenbahnhof from the federal rail network and the wagons are shunted at first. Then the wagons are sent to the secondary stations – Bezirksbahnhof for a further shunt. At the end, they are directed to the loading/unloading terminal points – Ladestelle. The 25% of the total amount of containers handled at the seaport of Hamburg are moved by train.

The main rail station of the Port Railway system of Hamburg is the Maschen shunting yard, located about 12 km South of Hamburg. Its principal function is to link the incoming/outgoing rail traffic to/from Hamburg to the German federal railway network. Its computerized control system is able to form 285 trains daily, that are about 11.000 freight wagons.

### ***13.2.1 The Rail Station “Alte Süderelbe” as Gateway for Waltershof***

The modernized Alte Süderelbe port rail station is recently become operative. This rail station functions as shunting yard of the port rail system at Waltershof and it is named the “gateway rail station of Waltershof” (Map 1). The block trains incoming/outgoing from the two major container terminals located at Waltershof have to make use of this entry freight station to leave the port area.

Therefore, the potential capacity of the whole container terminal rail system at Waltershof has been absolutely increased after that the gateway Alte Süderelbe has become operative. The year 1999 signed a rise of +6% of the total TEUs handled at the rail station of Waltershof (549.952 TEUs against 519.060 TEUs in the year 1998).

The Alte Süderelbe port rail station is also the transit freight station for the block trains coming from the Hansaport terminal. At this rail port terminal, around 5/6 block trains per day are formed and send to the main destinations towards Braunschweig, Hanover, Mehrum, Wolfsburg to satisfy the demand of coal and metal minerals of the local industry. The total volume of cargo handled at the Hansaport rail station increased in the year 1999 of +6,7%, that are 7.544.928 tons against the 7.072.706 tons in the previous year. The Alte Süderelbe rail station will become obviously the gateway station for the new close seaport logistic area of Altenwerder under construction (Map 1).

### **13.2.2 The Rail Station of “Hamburg-Süd”**

At the Eastern port area there are the main rail station of Hamburg-South – Hamburg-Süd, and 7 further secondary rail stations; the loading/unloading points are more than 500. The seaport functions which take place at this area of the seaport are quite various. General cargo, distribution services, seaport industries, as well as others activities are located in this area (Map 1).

During the year 1999, a total freight volume of 2.496.409 tons was handled by the Port Railways at this station, it was a decrease of –16,9% with respect to the previous year. The container traffic decreased of –19,8% (114.656 TEUs versus 142.872 of the year 1998).

The main two problems at this seaport area are the long shunting times because of the high rate of dispersion of the loading/unloading points; as well as the lack in the balance between the traffic flows both in terms of a) traffic volume entry/traffic volume exit; and b) flow of empty containers/flow of full containers. This means that 1) the wagons for the import are loaded/unloaded at one point, while the wagons for the export are loaded/unloaded at another point; or 2) a train is loaded with containers directed to two different terminals. In terms of time costs, it means that the delivery time of a container may be 3 times longer than the delivery time exploited at an inland terminal.

A solution should be the organization of a central loading/unloading container station, but the transport towards/from the terminal points would be made by trucks, that is not an environmental friendly transport modality. It has been forecasted an increase in the daily road traffic volume between +5% and +10%.

### ***13.2.3 The Railways Development Plans at the Seaport of Hamburg***

In order to improve the economic efficiency and the quality of the service offered by the Port Railways of Hamburg, investments for 0,3 milliards German marks have been fixed in the Traffic Development Plan Hamburg 1999 by the local government for the following works [Baubehörde, 1999]:

- 1) improvement of the city Port Railways;
- 2) betterment of the port rail track between the freight rail stations of Harburg and Rothenburgsort in order to obtain a rail cargo transit independent by the passenger transit;
- 3) the laying of the second track between Rothenburgsort and Horn;
- 4) the improvement of the rail track between Horn and Eidelstedt.

At a local level, the major improvement project under study is the realization of the railway freight truck from the gateway Alte Süderelbe railway station towards the Baltic Sea Region bypassing the bottleneck at the Wilhelmsburg railway station.

In fact, the railway transport modality loses in efficiency because at Wilhelmsburg the freight trains have to use the same tracks of the passenger trains. Therefore, the cargo trains slack down because of the waiting times when they have to transit through the Wilhelmsburg railway station.

Two further bottlenecks between the Alte Süderelbe and the Wilhelmsburg railway stations are the Kattwyk-Hubbrücke and the Reiherstieg-Schleusenbrücke.

The former should be bypassed by the building of a new 400 m long and 150 m high bridge equipped with two separate lane for the rail and the road transit<sup>43</sup>, or alternatively by a tunnel. It is also desirable a transit speed along the whole rail truck of about 50/60 km per hour, against the present 30/40 km per hour.

### ***13.3 The Plans for the Improvement of the Inter-regional Railways***

When looking at the Eastern European hinterland of the city-region of Hamburg, the following rail strings need to be improved in the near future:

1. Hamburg-Büchen-Berlin: laying of a second track and complete electrification to enable a speed of 160 km/h. [Baubehörde, 1999].
2. Hamburg-Hanover: laying of a fourth track to connect the Maschen/Uelzen shunting yard. This project is under discussion.
3. Hamburg-Kiel: electrification of this track.
4. Hamburg-Lübeck: electrification of this track and therefore of the Lübeck–Puttgarden rail track in order to sustain the growing container traffic towards Denmark and the Baltic Sea Region.

The BVWP 1992 fixed the new laying or improvement of 4.000 km of rail tracks; around 50% should be able to reach a speed of more than 200 km/h [Nuhn, 1998].

These works of improvement are necessary both to the city-region of Hamburg and to the Baltic Sea Region, because of the synergy effects carried on through the improvement in the efficiency of the transport network.

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<sup>43</sup> The Kattwyk-Hubbrücke is usually opened twice a day to allow the rail transit on its single truck because the same lane is used both for the rail and the road traffic.

# 14 The Inland Waterways Network

## 14.1 *The Inter-modal Transport Integration at the Seaport Hamburg*

The transportation mode of the inland waterways meets well both the principles of sustainable regional development and of environmental friendly transport modality, as it was promoted by the two European instruments of transport policy and regional integration INTERREG II C and VASAB 2010. In fact, the inland waterway ships have a considerable capacity to transport large volumes of cargo, with a relative low consumption of energy. If compared to the road transport modality, a truck makes use of 29 kW/h for 100 ton/km carried, while a inland waterway barge needs only 10 kW/h. It follows that the related energy consumption and the environmental costs for 1000 ton/km of goods transported are equal to 42,69 DM for trucks, while they correspond just to 2,26 DM for inland waterway barges [Nuhn, 1998].

Other advantages of this transport modality, which makes it to be environmental friendly, are the low level of noise pollution, which is limited to the surrounding around the inland waterways links, as well as the low level of air, water, and land pollution through the emissions [Nuhn, 1998]. Traditionally, this transport modality has been used for the transport of bulk cargoes. An improvement of the container transportation by barges is really desirable in order to achieve the modal shift from the less environmental friendly road transportation. The low accident rate suggests the use of this mobility transport mode as a desirable alternative to the road modality also for the transportation of dangerous goods.

It is useful to remark that this transport modality may lose its attractiveness due to the following reasons: the relative low average speed of the barges, i.e. circa 8-12 km/hour; the rigidity of the inter-modal terminals of this mobility network, and subsequently the necessity in the co-ordination of the information flow (for example: schedules) with respect to the others transport modalities (i.e. road, and rail) at the inter-modal terminals; the presence of lock chambers along the inland waterway links, which are one of the major causes of delay in the transit time of the barges [Nuhn, 1998].

The seaport of Hamburg has a long tradition in the inland waterway transportation. This transport modality is becoming more and more environmental sound, as well as it allows a more efficient connection towards the new Central and Eastern European countries (Map 1 and Map 3).

Ten feeder services leave daily Hamburg to reach their destinations on the North Sea and Baltic Sea, the latter through the Kiel Canal. With reference to the modal split between transport carriers at the seaport of Hamburg, circa 12,5% of the total cargo handled at the seaport during the year 1999 used barges. At the local level, there are around 260 berths inside the seaport Hamburg dedicated to the inland waterway craft, all of them supplied by water and electric power. At the inter-regional level, there are three inland waterway links, which connect the seaport of Hamburg to the network of the German inland waterways.

1. The Elbe Lateral Canal (Elbe-Seiten Kanal), connecting Hamburg to Dresden, Halle, Leipzig, Magdeburg and Prague through the Mittelland Kanal. Since 1995, a container transport service runs weekly from Hamburg to Prague through Dresden.
2. Through the Elbe Lateral Canal it is possible to reach the industrial areas of Low Saxon and the Ruhr area by transit through the Mittelland Canal.
3. The Elbe-Havel Canal is a direct waterway link towards the capital city Berlin, as well as towards Poland.

In order to minimising the operative costs on the cargo loading/discharge at the nodal points of the transport chain, which are the quays in the case of the inland waterway transport modality, the handling of the cargo should have to take place at the same terminal where the deep sea ships dock, as well as where the rail infrastructures and services are available<sup>44</sup>. A possible future integration between the two transport modalities of the railways and the inland waterways is under study, to exploit the lower transport costs of the inland waterways vessels, in order to manage the transfer of the empty containers.

About the change of modality between inland waterway barges and deep sea vessels, the different heights of the fenders is an obstacle to tying up ships so diverse in size at the same wharf. The costs of the terminal operations to loading/unloading the cargo in the inland waterway barges have to be kept as lower as possible to maintain the competitiveness of this transport modality. In order to solve these problems, a suitable infra-structural facility will be built at the new Container Terminal Altenwerder CTA, where a 300 m length quay wall will be available for mooring the barges. In order to promote the transport of the

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<sup>44</sup> Due to the high flexibility in the road transport modality, which is anyway the less environmental friendly mode, it seems negligible to refer to it in this context.

containers by barges, as well as to get over the obstacles for changing the transport modality, this infra-structural facility has been projected to enable the contemporary docking of the deep sea ships and the barges, because it is adaptable to the tide variations, as well as to the height of the freeboard.

An alternative as well as complementary solution was proposed by the European Development Centre for Inland Waterway and Coastal Shipping - Europäisches Entwicklungszentrum für Binnen- und Küstenschifffahrt in Duisburg. This engineering innovation suggests the use of a support floating unity between the deep sea vessel and the barge, with the aim to bypass the fenders problem. By using cranes, the container cargo can be discharged from the deep sea ship to the parallel buffer unity, then in sequence loaded in the inland waterway barge.

#### **14.2 *The Inter-regional Network: the River Elbe***

With reference to the inter-regional level, the total amount of investments planned in order to improve the inland waterway network in the Federal Republic of Germany was equal to 30,3 milliards DM in the BVWP 1992. On the basis of the year 1988, until the year 2010 it has been forecasted a +84% ton/km growth in freight transport by inland waterways: from 63 milliards ton/km in the year 1988 to 116 milliards ton/km in the year 2010 [Nuhn, 1998]. In the year 1995, this value was equal to 31,6 milliards ton/km.

The river Elbe is the major potential link from the seaport of Hamburg towards the Central and Eastern Europe. The river Elbe flows down to the North Sea, is 1.091 km long, and runs for 727,7 km in the Federal Republic of Germany. The Elbe river is an important transport link, which connects the city-region of Hamburg to the North Sea, as well as to its European natural hinterland, through the mobility network of inland waterways. Due to the fall of the Berlin Wall, and the consequent geopolitical redefinition of the social and economic relationships in the European continent, the river Elbe can play again its natural role of transport and communication link along the North-South axes, from Hamburg to Prague, the city-capital of the Czech Republic (Map 3).

The Elbe is a navigable river during the winter and spring times due to the high water levels, while in summer the low level of the water does not allow the navigation to the deeper Europe inland barges. A project mentioned as "urgent" in the BVWP 1992 was the maintenance of the river Elbe for the stretch

that flows on the territory of the Eastern Germany. It is called Ober Elbe - Upper Elbe, and it is not suitable for the commercial inland navigation. The aim of the plan was to deep the draught of the river between 2-2,5 meters to allow the navigation of the so called "Europe" barges directed to the Czech Republic. The Europe barges are 85 meters long, and 9,50 meters large; they have an empty depth of 2,50 meters, and a cargo capacity of 1350 tons.

#### ***14.2.1 The Environmental Sound Technological Innovations***

In the year 1996, an agreement between the Federal Government and the Environmentalist Associations was reached in order to guarantee the preservation of the Elbe river at its natural state, as well as to turn it into a transport link. From an ecological point of view, the Upper Elbe is still naturalistically untouched. In particular, there are two natural parks along the Elbe river: the Naturpark Elbetal between Niedersachsen and Mecklemburg-Vorpommern; and the Naturpark Elbeufer-Drawen in Niedersachsen.

The Elbe river has a total amount of 6903 groynes, 1559 of them were hardly damaged because of the scarce maintenance works during the post-war period. Circa 500 groynes were absolutely not usable anymore for any hydraulic purpose. The agreement between the two parties<sup>45</sup> was an environmental sound solution because it was decided to renew the hydraulic works already in existence but neglected during the last half century. Therefore, circa 43% of the groynes were repaired. Consequently, the navigability of the Elbe river grew to circa 80%, while the draught rose to 1,60 meters during the whole year.

Furthermore, a research project promoted by the Bundesministerium für Bildung und Forschung BMBF called "Flexible Transport Chain along the Elbe" involved the Deutsche Binnenreederei GmbH, the Sächsischen Binnenhäfen Oberelbe GmbH (inland waterway ports of Dresden, Riesa and Torgau), and DAKOSY Datenkommunikationssystem GmbH of Hamburg. The aim of this research program was to develop the container transportation by using inland waterways barges, in order to achieve the integration of this transport modality, environmental friendly, with the road and the rail transportation systems. The seaport of Hamburg is supposed to hold the gateway function for its German and Czech hinterland. Therefore, the efficiency of this inland waterway

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<sup>45</sup> That are the Federal Government of Germany and the Environmentalist Associations.

link should be promoted also by the transit through the Elbe Lateral Canal, in order to promote the integration of these regions, as well as to stimulate their regional development and prosperity [VASAB 2010, 1994], [VASAB 2010, 1996].

In order to be attractive and competitive to the clients of the transport sector, the service will be guaranteed during the whole year. Furthermore, a complete range of logistics services will be supplied. The use and development of the software package BARGE seems to be a necessary technological tool for the reliability of this transport service.

The implementation and launch of the Elbe Container Line ECL, which is operative since March 1999, is a concrete way of promoting the networking process between Hamburg and the Central and Eastern Europe (484 TEUs handled in March 1999, 2175 TEUs in November 1999). This is a line service among the inland ports of Hamburg, Torgau, Dresden and Riesa. It is supplied by the so called Produkt ECL 2000 by DAKOSY. From January to October 1999, circa 11.500 TEUs were handled; conventional cargo and project cargo were also shipped. The aim was to reduce the transit time along the inland waterway route Hamburg-Riesa-Hamburg from 10,5 days to 7 days, in order to supply a just-in-time service for the transport of the containers by the inland waterways.

At the same time, the Deutsche Binnenreederei GmbH introduced two technical innovations in the inland shipping, which improved the efficiency in the barges. Firstly, the navigation time was cut because of the improvement and renewal in the electric, electronic and hydraulic elements of the shallow-draft Elbe push-barges. A power of 1.100 HP instead of the previous 600 HP was achieved. Secondly, the capacity of the barges grew up to 3 container rows with just 80 cm draught. Hence, along the reach Hamburg-Wittenberge, it is possible to transport up to 240 TEUs per barge, while along the reach Wittenberge-Magdeburg up to 192 TEUs.

This seems to be a transportation solution that is environmental sound, because of the consequent reduction in the intensity of the road transit of trucks per same volume of containers. Furthermore, it is improved the efficiency of the transport by barges, if it is compared to the Elbe Lateral Canal. The Elbe Lateral Canal is narrower than the river Elbe, therefore the width of the barges is limited, and the transport volume allowed is just of 96 TEUs. In the year 1998, the Deutsche Binnenreederei shipped by barges a volume of containers equal to circa 1.700 TEUs towards the domestic market. During the year 1999, the traffic

volume grew up to circa 18.000-20.000 TEUs, which is equivalent to more than 10.000 trucks, if the volume of containers is changed into road traffic units.

In fact, an inland waterway barge has an average volume capacity of around 150 TEUs, then it is possible to replace the equivalent transport volume of 150 trucks or three block-trains<sup>46</sup> [Nuhn, 1998].

#### **14.2.2 The Projects of Improvement**

In order to sustain the growing commercial flow along the Upper Elbe, two further necessary measures should be realised in the next future. First, the construction of a lock – Schleusenkammer at Uelzen (South from Lüneburg). Second, the building of the facilities at Scharnebeck to lift up the large motorized barges. These inland vessels are 110 meters long, 11,40 meters large, have an empty depth of 2,80 meters, and a 2100 tons loading capacity.

A further project is developing to promote the combined transport, as well as the shift towards the transport modalities that seems to be more environmental friendly [VASAB 2010, 1994], [VASAB 2010, 1996]. The Deutsche Binnenreederei GmbH, DAKOSY, the inland port of Hanover, the Hafенbetriebgesellschaft Braunschweig, and the Franzius-Institut (as project leader) are jointly organising a transport line service among the inland ports of Hamburg, Hanover and Braunschweig [Dakosy, 1999]. The transport link which is involved in this improvement program embraces the Upper Elbe, the Elbe-Seiten Canal, as well as the Mittelland Canal.

The relevance of the software system integration for a better co-ordination in the loading/unloading operations, as well as the further delivery/shipment towards/from the hinterland locations of origin/destination must be underlined, in order to ensure the higher efficiency at the critical inter-modal nodes, where the change from the inland waterway to the land transport modality takes place. With reference to the inland waterways network, that links the city-region of Hamburg to its hinterland, two further transport links may be mentioned: the unsatisfactory connection between the Elbe Lateral Canal and the city of Lübeck (no improvement project was planned in the BVWP 1992); and the Kiel

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<sup>46</sup> 1-TEU-standard container allows a maximum loading capacity of 20 tons of cargo, while the maximum loading capacity of a 2-TEUs-standard container is just 30 tons [Degrassi, 1997/98].

Canal, which performs a good connection between the North Sea (i.e. the port of Brunsbüttel on the Elbe) and the Baltic Sea (i.e. the seaport of Kiel).

An other "urgent" project mentioned in the BVWP 1992 was the realization of the Magdeburg Waterway Junction, with a volume of investment equal to DM 500 millions. The goal of this investment was to guarantee a full navigability during all the year along the inland waterways which link Magdeburg, Berlin, and the Elbe Lateral Canal. Their depth had to be initially equal to 2 meters, then had to rise to 2,5 meters in the near future. The following recommendations are warmly suggested: the maintenance of the Elbe Lateral Canal, of the Mittelland Canal, of the Elbe-Havel Canal, and of the Havel Canal, nearby Berlin, as well as of the Neuendorfer Canal, which should enable the transit to the 2000 tons barges. Furthermore, it should be useful to build a junction between the low Saale and the Mittelland Canal, in order to have a new connection towards the Elbe Lateral Canal.

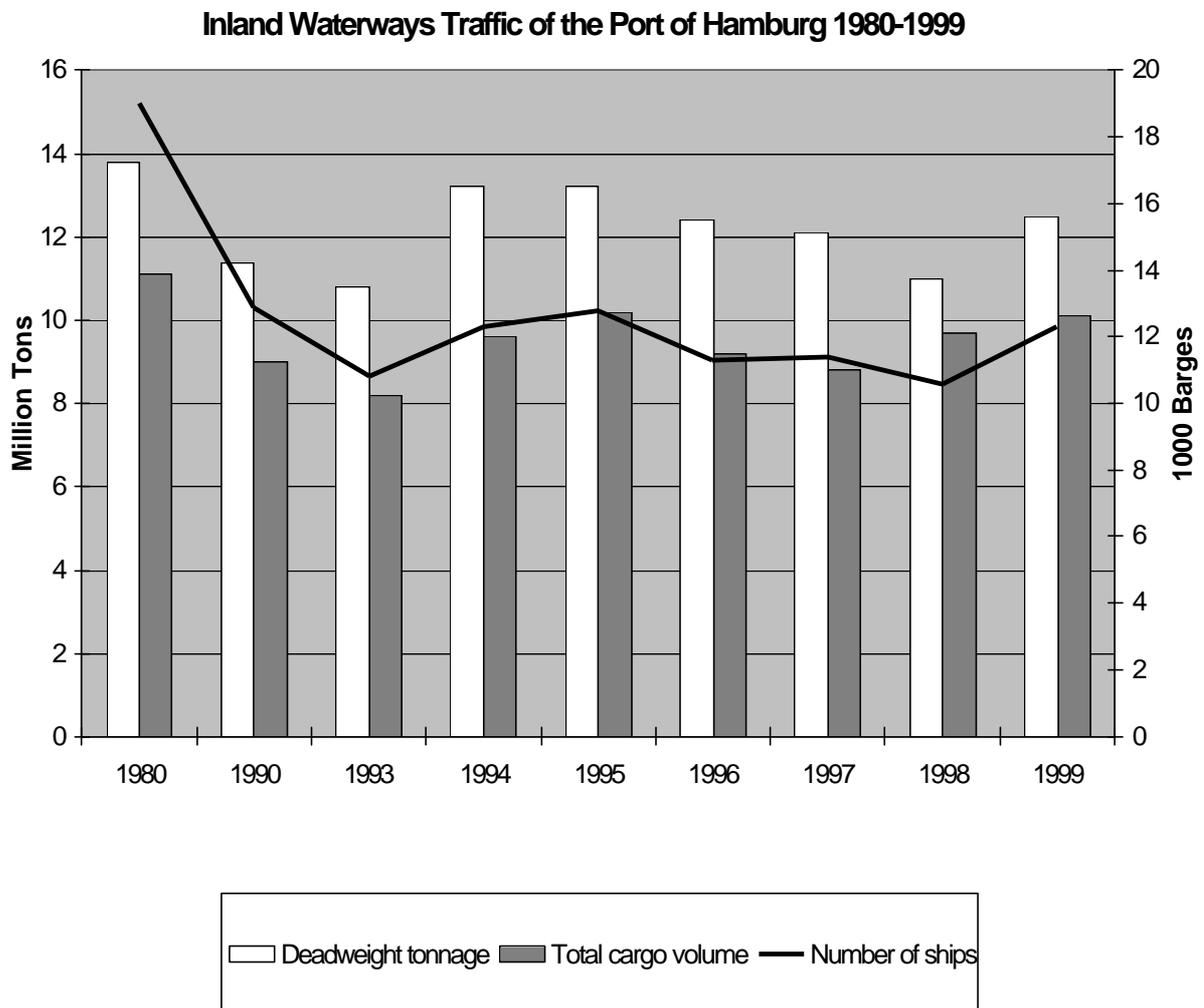
### **14.3 The Analysis of the Commercial Traffic**

During the year 1998 the inland waterway traffic of the seaport Hamburg corresponded to 10.645 thousand barges, with a drop of –6,7% with respect to the year 1997 (10.998 million tons of dead weight tonnage in the year 1998, with a drop of –9% with respect to the year 1997), while 9.665,5 thousand of tons of goods handled in the year 1998, therefore there was an increase of +10,2% with respect to the year 1997 [Statistisches Landesamt Hamburg, 1999].

In the year 1999, the number of barges was equal to 12.342, hence there was a growth of +15,9% with respect to the previous year. The total dead weight tonnage in the year 1999 also grew up to 12.537 with a growth of +14% with respect to the year 1998. The tonnage of the cargo handled by the inland waterway transport modality in the year 1999 rose of +4,8%, equal to more than 10.000 tons of commodities.

The Figure 14.1 shows the traffic through inland waterways of the seaport of Hamburg since the year 1980 to the year 1999. It is forecasted a positive trend during the next years, because of the technological and logistical improvements mentioned above.

Figure 14.1 – The traffic along the inland waterway network of Hamburg 1980-1999.



The inland waterway transportation at the seaport of Hamburg is perceived as an inter-regional transport modality. Unfortunately, inside the seaport area the freight transportation does not make use of this environmental sound modality, but prefers the most flexible, time-saving and more polluting road transportation.

It should be seriously evaluated the possibility to improve the freight movements by barges between the maritime port terminals inside the harbour, in order to exploit the local channel network at the best, In fact, it could be possible to reduce the intensity of the road traffic by trucks.

### **14.3.1 The Structure of the Cargo and the Geographic Split**

The analysis of the structure of the cargoes shipped by inland waterways, with reference to the volume of commodities, reveals that this transport modality is mainly used for the transport of bulk cargoes. This is due to the low speed of the barges, as well as to the insufficient number of inter-modal nodes along the inland waterway network. This transport modality exploit the economies of scale in the transport of low value cargo, which do not have to meet the just-in-time requirements in distribution, while they exploit the lower transport costs.

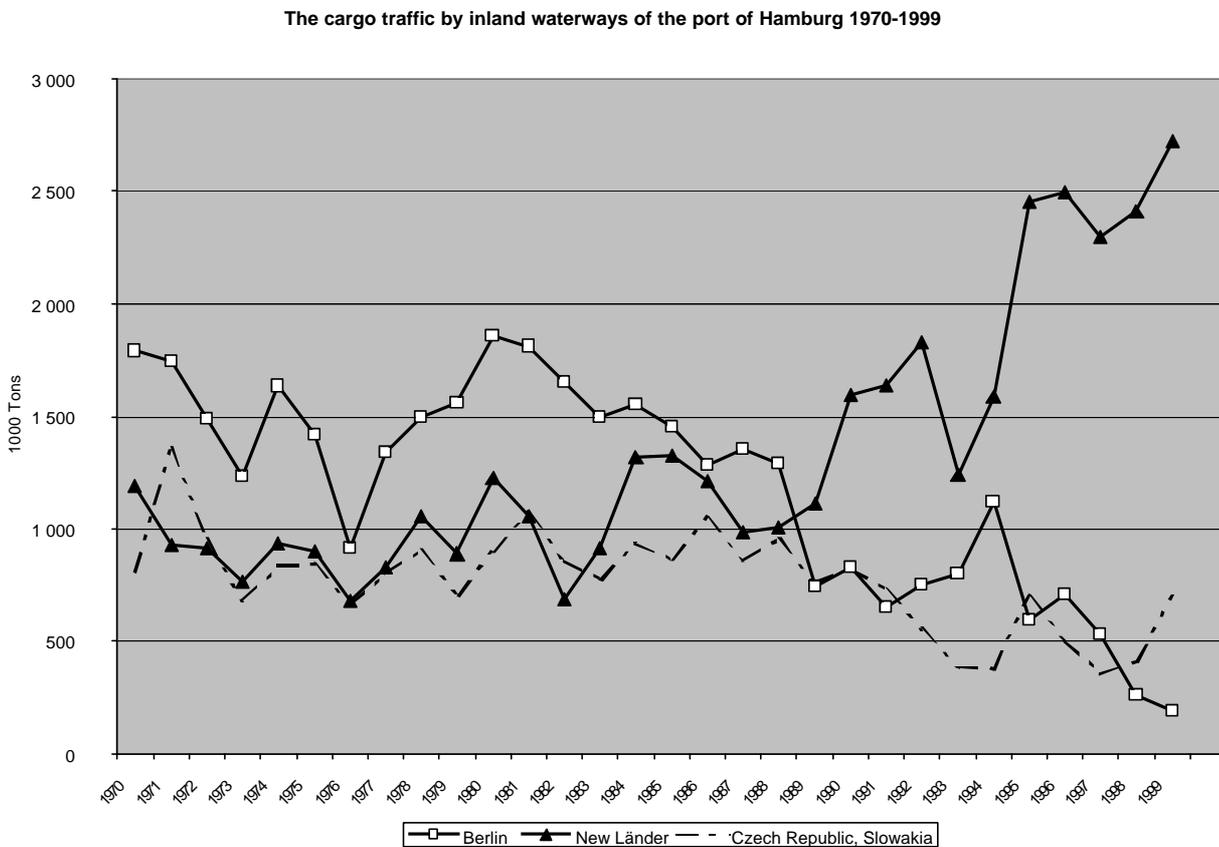
The most important cargo handled at the seaport of Hamburg are oil products, sand, gravel, fertilisers and animal feeds. The volume of fuels and heating oils corresponded to circa 3,8 million tons in the year 1999, coal and coke to around 1 million tons, grain to around 1,3 million tons, and a total volume of circa 1,2 million tons of feed stuffs and oilseeds was mainly shipped to the Czech Republic.

The total volume of the non-bulk cargo was about 150.000 tons in the year 1999, which is not a relevant amount if compared to the larger quantities mentioned above. On the contrary, a positive forecast can be made on the future growth in the volume of general cargo, that the new Elbe Container Line ECL should potentially handle. The ECL makes use of the inland waterway network, which is an environmental friendly transport modality, for shipping containers since the year 1999.

The inland waterway freight traffic sharply increased towards Lübeck of +58,1% in the year 1998 (176,4 thousand tons) with respect to the year 1997, and of +9,6% in the year 1999 (193,3 thousand tons). It has to be noted that along the Hamburg-Lübeck inland waterway route, the deliveries of the seaport of Hamburg sharply rose of +236,5% in the year 1998 with respect to the year 1997 (91,2 thousand tons delivered in the year 1998 with respect to 27,1 in the year 1997), and of +49,6% during the year 1999 (136,4 thousand tons).

The shipments of the seaport of Hamburg increased of +0,9% in the year 1998 with respect to the year 1997 (85,2 thousand tons in the year 1998 with respect to 84,4 thousand tons in the year 1997), but decreased of –33,1% (57 thousand tons) during the year 1999. The traffic along this mobility network towards Berlin decreased of –50,8% in the year 1998 with respect to the year 1997 (260,6 thousand tons in the year 1998 with respect to 529,5 thousand tons in the year 1997) [Degrassi, 1997/98].

Figure 14.2 – The cargo traffic by inland waterways of the port of Hamburg 1970-1999.



If this variation is analysed, then it has to be noted that the deliveries of the seaport Hamburg grew of +13,2% (41,1 thousand tons in the year 1998 with respect to 36,3 thousand tons in the year 1997), while the shipments drop of –55,5% in the year 1998 (219,4 thousand tons in the year 1998 with respect to 493,3 thousand tons in the year 1997). A further decrease of –25,8% (193,4 thousand tons) was registered during the year 1999: the deliveries felt down of –5,1% (39 thousand tons), while the shipments drop of –29,6% (154,4 thousand tons).

By considering the traffic towards the so called Neue Länder (East Germany), the deliveries of the city-region Hamburg mounted up to +64,8% in the year 1998 (1.359,2 thousand tons) with respect to the year 1997 (824,9 thousand tons) and to +21,8% in the year 1999 (1.655,4 thousand tons). The shipments of the seaport Hamburg unfortunately decreased of –28,6% in 1998 (1.050,8 thousand tons) with respect to 1997 (1.472,7 thousand tons), while they grew a bit up (+1,7%) during the 1999 (1.068,2 thousand tons).

The commercial traffic through the Elbe Lateral Canal grew in the year 1998 of +8,6% (5.732,2 thousand tons in the year 1998 with respect to 5.279 thousand tons in the year 1997), and of +3,8% in the year 1999 (5.952,4 thousand tons).

The deliveries of the city-region Hamburg in the year 1998 rose of +29,2% (1.895,3 thousand tons) with respect to the year 1997 (1.466,9 thousand tons) and of +22% in the year 1999 (2.313,1 thousand tons); the shipments just of +0,7% in the year 1998 (3.836,8 thousand tons) with respect to the year 1997 (3.812 thousand tons), while they decreased of –5,1% during the year 1999 (3.639,3 thousand tons).

In the year 1998, the Elbe Lateral Canal freight traffic was equal to 62,3% of the inland waterway deliveries of the seaport Hamburg in the same year along the Upper Elbe (3.043,8 thousand tons in the year 1998), and to 78,5% of the shipments in the year 1998 (4.888,6 thousand tons through the Upper Elbe).

During the year 1999, the share of the deliveries grew up to 64,3% (3.599,3 thousand tons), while the shipments share fell a bit down to 78,3% (4.648,4 thousand tons) [Statistisches Landesamt Hamburg, 1999]. During the year 1994, it was delivered the 67,6% and shipped the 70,5% of the total cargo traffic by waterways through the Elbe Lateral Canal; in the year 1995, it was delivered the 54,2% and shipped the 63% of the whole freight traffic on the Upper Elbe.

Therefore, between the years 1994/1995 the deliveries fell of –19,8% and the shipments of –10,64%, but the trend of the very last years shows a shift in favour of this transport modality along this route [Degrassi, 1997/98].

A most significant shift may be referred to the traffic through the Mittelland Canal (+31,4% in the year 1998 with respect to the year 1997, with 3.435,7 thousand tons handled during the year 1998, but a decrease in the year 1999 of –6,5% to 3.213,8 thousand tons), and the inland waterways towards the Czech Republic. The latter went up to +16,1% in the year 1998 with respect to the year 1997, and to +69,5% in the year 1999; it corresponded to 413,3 thousand tons handled in 1998, and to 700,7 thousand tons in the year 1999.

The deliveries of the city-region of Hamburg in the year 1998 rose of +34,8% (181,8 thousand tons in the year 1998 with respect to 134,9 thousand tons in the year 1997), and in the year 1999 of +137% (430,9 thousand tons); the shipments in the year 1998 grew of +4,8% with respect to the year 1997

(231,5 thousand tons in the year 1998, 221 thousand tons in the year 1997), and in the year 1999 of +16,5% (269,8 thousand tons). The traffic growth towards the Czech Republic can be explained by the implementation of the new Elbe Container Line mentioned above.

The Table 14.1 and the Table 14.2 show the geographical split of the freight traffic by inland waterways, incoming and outgoing respectively, of the port of Hamburg during the period 1970 to 1999.

Table 14.1 – The geographic split of the incoming cargo traffic by inland waterways of the port of Hamburg 1970-1999.

Year	Total incoming cargo traffic		Elbe Lateral Canal		Low Elbe		Upper Elbe					
							Total		Middle Land Canal	Berlin	New Länder	Czech R., Slovakia
	1000 Tons	% Var.	1000 Tons	% Var.	1000 Tons	% Var.	1000 Tons	% Var.	1000 Tons			
1970	4 489	-	-	-	1 353	-	3 136	-	207	149	369	344
1971	4 828	7,6	-	-	1 414	4,5	3 414	8,9	159	164	236	446
1972	4 570	-5,3	-	-	1 474	4,2	3 096	-9,3	152	150	312	336
1973	4 583	0,3	-	-	1 831	24,2	2 752	-11,1	130	148	275	264
1974	5 029	9,7	-	-	1 942	6,1	3 087	12,2	247	179	266	259
1975	4 359	-13,3	-	-	1 776	-8,5	2 583	-16,3	228	157	202	266
1976	3 774	-13,4	-	-	1 384	-22,1	2 390	-7,5	187	113	127	245
1977	3 990	5,7	505	-	1 183	-14,5	2 807	17,4	479	152	235	275
1978	4 703	17,9	1 405	178,2	1 062	-10,2	3 641	29,7	1 097	198	301	399
1979	4 360	-7,3	1 481	5,4	1 017	-4,2	3 343	-8,2	1 208	176	238	285
1980	4 649	6,6	1 372	-7,4	1 110	9,1	3 539	5,9	1 140	571	247	307
1981	4 857	4,5	1 572	14,6	1 251	12,7	3 606	1,9	1 187	503	343	445
1982	4 446	-8,5	2 042	29,9	927	-25,9	3 519	-2,4	1 396	537	305	321
1983	4 578	3,0	1 950	-4,5	1 051	13,4	3 527	0,2	1 275	407	471	308
1984	5 155	12,6	2 066	5,9	1 081	2,9	4 074	15,5	1 349	472	806	360
1985	4 432	-14,0	1 958	-5,2	1 040	-3,8	3 393	-16,7	1 300	251	656	320
1986	4 569	3,1	1 747	-10,8	1 260	21,2	3 309	-2,5	1 181	132	633	424
1987	4 102	-10,2	1 539	-11,9	1 192	-5,4	2 910	-12,1	1 053	120	492	398
1988	4 578	11,6	2 013	30,8	1 160	-2,7	3 417	17,4	1 090	86	637	429
1989	4 166	-9,0	1 901	-5,6	1 084	-6,6	3 082	-9,8	946	88	676	338
1990	4 595	10,3	2 235	17,6	1 196	10,3	3 399	10,3	947	99	974	342
1991	4 528	-1,5	2 363	5,7	1 158	-3,2	3 370	-0,9	927	117	1 185	310
1992	4 491	-0,8	2 277	-3,6	1 073	-7,3	3 418	1,4	956	187	1 094	273
1993	3 893	-13,3	1 985	-12,8	1 016	-5,3	2 877	-15,8	952	148	664	136
1994	4 617	18,6	2 272	14,5	1 257	23,7	3 361	16,8	935	153	1 013	160
1995	4 600	-0,4	1 983	-12,7	940	-25,2	3 660	8,9	596	104	1 234	443
1996	3 995	-13,2	1 606	-19,0	940	0,0	3 056	-16,5	491	95	1 324	246
1997	3 100	-22,4	1 467	-8,7	842	-10,4	2 258	-26,1	395	36	825	135
1998	4 066	31,2	1 895	29,2	1 022	21,4	3 044	34,8	539	41	1 359	182
1999	4 667	14,8	2 313	22,1	1 068	4,5	3 599	18,2	627	39	1 655	431

Table 14.2 – The geographic split of the outgoing cargo traffic by inland waterways of the port of Hamburg 1970-1999.

Year	Total outgoing cargo traffic		Elbe Lateral Canal		Lower Elbe		Upper Elbe					
	1000 Tons	% Var.	1000 Tons	% Var.	1000 Tons	% Var.	Total		Mittelland Canal	Berlin	New Länder	Czech R., Slovakia
							1000 Tons	% Var.	1000 Tons			
1970	2 261	-	3 600	-	168	-	1 641	-	823	466	5 861	-
1971	2 166	-4,2	3 593	-0,2	83	-50,6	1 581	-3,7	691	914	5 759	-
1972	2 084	-3,8	3 007	-16,3	201	142,2	1 341	-15,2	601	618	5 091	-
1973	2 378	14,1	2 426	-19,3	122	-39,3	1 084	-19,2	490	416	4 804	-
1974	2 360	-0,8	3 192	31,6	119	-2,5	1 455	34,2	672	575	5 552	-
1975	2 074	-12,1	2 992	-6,3	111	-6,7	1 259	-13,5	699	578	5 066	-
1976	1 984	-4,3	2 332	-22,1	160	44,1	803	-36,2	556	415	4 316	.
1977	1 690	-14,8	3 519	50,9	744	365,0	1 186	47,7	594	525	5 209	832
1978	1 860	10,1	4 859	38,1	1 653	122,2	1 297	9,4	758	508	6 719	2 081
1979	1 734	-6,8	4 240	-12,7	1 107	-33,0	1 386	6,9	653	420	5 974	1 796
1980	1 671	-3,6	4 785	12,9	1 152	4,1	1 286	-7,2	981	591	6 456	1 557
1981	1 518	-9,2	4 422	-7,6	1 035	-10,2	1 308	1,7	712	627	5 940	1 400
1982	1 156	-23,8	3 593	-18,7	915	-11,6	1 116	-14,7	384	537	4 750	1 789
1983	1 118	-3,3	3 483	-3,1	996	8,9	1 093	-2,1	443	468	4 601	1 611
1984	1 024	-8,4	3 659	5,1	1 046	5,0	1 083	-0,9	512	574	4 683	1 609
1985	904	-11,7	3 826	4,6	1 027	-1,8	1 203	11,1	669	544	4 730	1 864
1986	1 000	10,6	4 115	7,6	1 365	32,9	1 153	-4,2	580	628	5 115	2 026
1987	910	-9,0	3 699	-10,1	1 112	-18,5	1 234	7,0	491	462	4 609	1 574
1988	899	-1,2	3 960	7,1	1 286	15,6	1 206	-2,3	367	527	4 859	2 357
1989	1 005	11,8	3 126	-21,1	1 055	-18,0	656	-45,6	439	420	4 131	1 827
1990	892	-11,2	3 544	13,4	1 209	14,6	728	11,0	622	482	4 437	2 296
1991	1 040	16,6	3 353	-5,4	1 490	23,2	534	-26,6	455	421	4 393	2 581
1992	1 023	-1,6	3 603	7,5	1 519	1,9	563	5,4	736	283	4 626	2 591
1993	1 017	-0,6	3 304	-8,3	1 235	-18,7	651	15,6	577	250	4 321	2 188
1994	866	-14,8	4 163	26,0	1 674	35,5	968	48,7	573	219	5 029	2 937
1995	985	13,7	4 653	11,8	2 158	28,9	493	-49,1	1 218	261	5 638	2 934
1996	789	-19,9	4 375	-6,0	1 939	-10,1	612	24,1	1 170	261	5 164	2 870
1997	776	-1,6	4 891	11,8	2 219	14,4	493	-19,4	1 473	221	5 668	3 812
1998	711	-8,4	4 889	0,0	2 897	30,6	219	-55,6	1 051	232	5 600	3 837
1999	810	13,9	4 648	-4,9	2 587	-10,7	154	-29,7	1 068	270	5 458	3 639



## 15 The Road Transport Network

In a macroeconomic context, the road transportation is the most expensive transport modality with reference to its social and environmental external costs. This is due to the higher incidence of the variable costs with respect to the fixed costs. It follows that it is difficult to keep the average costs<sup>47</sup> of transport per unit at a low level as the output grows. For example, with reference to the containerised transport, the average cost of transport per unit is estimated in terms of TEU/km. In the case of bulk cargo, the average costs of transport per unit is calculated in terms of ton/km.

A further remark to make is the following. It is not possible to use the technological economies of scale related to the possibility to use lorries of larger dimensions in the road transport, as it happened both for the larger tankers and for the larger container ships, for the two following reasons. First, it is due to the nature of the road transport modality itself. Second, the EU legislation aims to preserve the security on the roadways, hence it imposes limitations on the carrying capacity of the trucks.

The road transport is competitive on the short distance, that is 150/200 km from the inter-modal centre. This transport modality performs a great flexibility due to the extension of the road network, as well as to the absolutely high number of access points. The speed of the trucks is higher with respect to the other transport modalities. All of these qualitative factors play a decisive role for choosing the more efficient transport modality .

For example, the containers commute between Hamburg and Bremen by lorries rather than by rail, in spite of the more expensive transport costs (circa 100 DM) (Map 2). The operators prefer the road because the empty containers are immediately available after the unloaded of the cargo. When the just-in-time distribution and logistics principles have to be matched, the economies of time play a major role with respect to the classical transport costs related to the geographical distance between origin and destination.

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<sup>47</sup> Generally, the average cost is defined as the total production costs per unit of output. It is calculated by adding the total fixed costs to the total variable costs and dividing by the number of units produced.

More than 300 transport firms with more than 8000 employees operate in Hamburg. Around the 62% of them are medium size firms; the number of employees per each enterprise swing between 5 and 30. But there are a great number of independent operators.

It has to be noted that since the middle of the year 1998 the coasting trade<sup>48</sup> within the seaport area has become cheaper due to the liberalization of this activity in the EU, and the consequently entry on the local market of a number of independent truck operators especially from the Eastern Europe. They are able to offer the road transport services at a competitive price because of the lower fixed costs of their trucks, usually relatively old. It should be useful to give an evaluation of the environmental impact in terms of the costs suffered because of the generation of such negative externalities as emissions and congestion.

### **15.1 The City-Regional Road Network**

According to the "Verkehrsentwicklungsplanung 1990-2010" – "Traffic development plan 1990-2010", the Economic Ministry of Hamburg forecasted in the year 1993 an economic growth of +2,25% per year in terms of Gross Domestic Product GDP of the pearl Hamburg during the period 1990-2010 and a co-related growth of the traffic volume of +14%.

The aim of the local authority was to limit the grew of the road traffic just to +3%. But during the period 1990-1997, the road traffic grew up to +7% inside the Hamburg city-region, mainly due to the more extensive use of the road transport modality for the freight movements inside the metropolitan city-region Hamburg (Map 1).

This transport mode meets the requirements of flexibility and just-in-time delivery of goods in a range of 150 km, that is a short distance from the inter-modal terminals of the seaport. This means that a growing turnover of the cargo in the seaport of Hamburg entails a growing volume of the traffic, both inside the metropolitan city-region, and along the transport links towards its more extended hinterland.

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<sup>48</sup> It is defined as the transportation of goods or passengers within one country by vehicles, ships or air-crafts which are foreign-owned.

The new edition of the Traffic Plan of Hamburg - November, 1999 makes provision of three different forecasting scenes, as well as a growth in the freight handled between 20-30% during the period 1990-2010. The local authority discussed these traffic provisions during the year 2000 in order to adjust the local traffic policy to be able to achieve the two main social goals to assure and increase the employment, as well as to improve the living quality in the metropolitan city-region Hamburg. These are two values that meet the VASAB goals because of the synergy effects spreading out this central place, as well as the urging role of the city-region Hamburg as propulsive social and economic centre for the Northern German region, as well as for the BSR.

The city-region of Hamburg suffers of congestion problems with reference to the road links, due to the growing commercial activity of its maritime port. Furthermore, congestion is also due to the consequent increase in the number of commercial vehicles. They are used both a) on the short distance, for the transport inside the metropolitan city-region; and b) on the long distance<sup>49</sup>, for the transport of the cargo in transit towards the hinterland. Congestion means jam costs and pollution costs. They are two negative externalities for the city-region itself, as well as for the mobility network as a whole, because they imply a lack in the transport efficiency.

VASAB aims to the sustainable development. Therefore, congestion is an important externality to solve, not only through the improvement plans in the road mobility network, but also, and more decidedly, by promoting alternative sustainable transport solutions, in particular to sustain the forecasted growth of the transit traffic volume along the North-South axes after the year 2001, and after that the new connections between the Kattegat countries will become operative (Map 5 and Map 6).

If the freight transportation is the focus, then inside the port area of Hamburg (Map 1) two transport solutions could be alternative and environmental sound, in order to decongest the volume of the road traffic. The first should be the exploitation of the existing network of the port railways. The second, the use of the wide number of inland navigable canals. At the urban level, it could be useful the application of the principles of the city logistics, to deliver the goods towards the most direct hinterland, by the pursue of the local distribution in a

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<sup>49</sup> More than 150 km.

efficient and sustainable way. The following sections give an essential overview about the main transport links of the regional road network Hamburg.

### **15.1.1 The Elbe Tunnel**

Since the year 1975, the highway A7 (E45) has been running under the river Elbe through the Elbe Tunnel - Elbtunnel, formed by three separate double way tunnels. The Elbe Tunnel was projected to sustain a daily traffic volume of about 70.000 units, but the present daily average is equal to circa 110.000 units (Map 1).

In the year 1997, the top transit volume of 138.956 units was reached. The average transit volume during the working days from Monday to Friday with reference to the year 1998 was equal to 113.000 units, with a share of trucks in transit equal to 15% [Baubehörde, 1999].

During the rush hours the average length of the waiting queue for motor vehicles is equal to about 3 km along the South-North direction, where 4 lanes are usually available; and it is about 7 km long along the North-South direction, where 2 lanes are usually available. During the year 1997, circa 1.400 hours of traffic jam were recorded [Baubehörde, 1999].

The trade activity of the city-region of Hamburg shows a positive trend. It means that the intensity of the commercial traffic is growing, towards the regional, national, and European hinterland of the Hanseatic port. In order to sustain the higher volume of traffic, it was decided the expansion of the Elbtunnel by the excavation of the fourth tunnel, now under construction. The total investment costs correspond to 970 millions German Marks [Baubehörde, 1999].

According to the working plan, the fourth tunnel should be operative during the year 2003. It will be certainly helpful for the road traffic along the North-South direction. This new tunnel will be equipped with two running lanes, one emergency lane, and one waiting lane. The fourth tunnel will be 4,90 meters high and 4.402,5 meters long; the highway stretch inside the Elbe Tunnel will be 3.100,75 meters long.

Anyway, due to the forecasted increasing traffic volume, the construction of the fourth tunnel under the Elbe river probably will not bring a long term solution.

### **15.1.2 The Elbe Bridge**

The Elbe Bridge - Elbbrücke is the most important bridge on the Elbe river. The highway A1 runs on it. This bridge sustains an average traffic volume of around 100.000 units daily, but it is forecasted a doubling of the number of cars within the next 7 years (Map 1).

The increment in the volume of the road traffic will bring obviously a relevant congestion problem. In the year 1998, the average volume of transit during the working days from Monday to Friday was equal to 131.000 units<sup>50</sup> in transit on the Elbe Bridge [Baubehörde, 1999].

### **15.1.3 The Highway Ring Project**

As previously mentioned, the BVWP 1992 referred to a further project, which is the building of a Highway Ring around the metropolitan city-region of Hamburg. The aim would be to lighten the traffic route usually congested by the traffic flow that reaches the A1 Lübeck-Bremen in proximity of Hamburg from East, as well as to lighten the daily traffic jams on the A7 highway along the Elbe Tunnel.

The Highway Ring would be realised: at South-East of Hamburg, by the highway A250 Hamburg-Lüneburg by crossing the Elbe river at Geesthacht towards the highway A24 Hamburg-Berlin; at East, by the motorway A21 by building the B404 stretch between the A24 and the A1 towards Bargteheide at North, and furthermore towards the A7 at Kaltenkirchen (construction of the A263 highway by-pass between the highway A24 Hamburg-Berlin).

The Highway Ring would be completed at North and West of Hamburg by the realization of the A20 project. The highway A20 should pass the two towns Bad Segeberg and Pinneberg, reach the city-region of Hamburg at about 30 km West nearby the Elbe, and then cross the river (Map 1 and Map 2).

Four possible alternatives were suggested in order to choose the most favourable point to cross the Elbe river: the first would be through the island of Lühesand, the second through the island of Pagensand, and other two further possibilities nearby the town of Glückstadt: one of the two latter alternatives proposes the building of a rail bridge crossing the Elbe.

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<sup>50</sup> No truck share is available.

The alternative route by passing through the island of Lühesand would be the closer to the city-region Hamburg. This stretch would circumscribe the North-West area of Hamburg within an arc – Ring passing through the town Hetlingen and crossing the island of Lühesand through a tunnel under the Elbe river, then by building a connection to the A1 at the motorway by crossing the town of Heidenau.

This highway stretch could be full operative for the year 2010. It was estimated a traffic volume of the daily transit through the tunnel of circa 36.000 units. Following this prevision of traffic growth, the Elbe Tunnel might be decongested of around 16.000 traffic units per day.

The construction of the new tunnel under the Elbe river would be financed by private investments. The estimated costs for the 3,1 km long tunnel were equal to circa 600 millions DM. It should be requested a 5 DM toll payment to the trucks, and a 12 DM toll payment to the cars. It should be granted a 30% reduction in favour of the regular users of the tunnel. But it was also forecasted that just one third of the total volume of motor vehicles should make use of this new toll tunnel. It follows that the private investments might be attracted just if the Government gave at least a 20% subsidy share on the total costs of construction, which corresponds to an expenditure of about 120 millions DM.

A further necessary measure to guarantee the efficiency of the Highway Ring should be the construction inside the seaport area of the Port Cross Highway – Hafenuerspange A252, which would realise a 4 km road link approach between the Exit 6 HH-Georgswerder on the A252 and the Exit 3 HH-Wilhelmsburg-South in connection to the highway A253 (Map 1).

But the project to build up a Western fast straight crossing through the Elbe might not be an efficient solution to the congestion problems of the metropolitan city-region Hamburg. The construction of this straight crossing link might not be an effective alternative instrument in order to ensure the shift of the traffic volume in transit away from the others motorways, due to the following reasons.

First, because of the high volume in the building investments required, and second because of the expensive toll the users of the tunnel had to pay for. The development of the metropolitan regional connections towards Denmark, Lübeck, as well as the Eastern German area could be better realised through the improvement and development of the links at the Eastern area of Hamburg.

This is due to the geographical proximity of this area to the Eastern hinterland destinations with reference to the commercial traffic, as well as because the accessibility towards the hinterland is given by a set of infrastructures already operative, such as the inter-regional highways links (Map 2 and Map 6).

#### **15.1.4 The Spatial Impact of the City Logistics**

Inside the seaport area of Hamburg, the freight movements from one terminal to another occurs mainly by trucks. The distribution of goods towards the metropolitan city-region is also made mainly by road carriers. The explanation for choosing the road is the higher efficiency of this transport modality on the short distances, both in terms of time and of transport flexibility.

The negative externalities in terms of congestion and pollution are social costs which have absolutely to be taken into account. At the urban level, the transport policy of the local government of the metropolitan city-region Hamburg had to follow the city logistics concept or freight distribution centres approach – Güterverteilzentren GVZ, in order to achieve the reduction in the distribution costs, as well as the rationalization in the transport chain [Baubehörde, 1999].

There are three locations suitable to build such distribution centres, as following: the new seaport location Altenwerder close to the motorway A7, which is under construction; the location of Moorfleet, between the two highways A1 and A25; and the possibility to build a distribution centre equipped for logistics functions at Hamburg-East in proximity of the two freight transfer rail stations of the German Railway at Billwerder and Billbrook (Map 1).

The distribution centres play a remarkable role for two reasons. From an economic point of view, because of the higher efficiency and optimisation in the transport chain they realise, hence the distribution and transport costs are reduced. From an ecological point of view, because the traffic intensity is reduced, hence the polluting emissions from the motor vehicles are reduced.

### **15.2 The Road Network on the Long Distance**

The 49% of the freight traffic during the year 1999 towards and from the seaport of Hamburg was sent by road. The quality of the road links, which connect Hamburg both to the local road network and to the federal highways, is very good. As already mentioned, the improvement in the transport networks was one of the instruments of economic policy used by the local government during the last decades in order to promote the economic growth of the seaport city-region as well as the welfare of its citizens.

Hamburg is a nodal point for the following highways (Map 1 and Map 3):

1. The highway A1 (E22) on the North East – West direction (Lübeck-Bremen-Osnabrück).
2. The highway A7 (E45) on the North – South direction (Denmark-Kiel-Hanover).
3. The highway A23 for the North – West direction till the town Itzehoe.
4. The highway A24 (E26), which is the direct motorway link towards Berlin.

The link between Hamburg and Cuxhaven is made by the road B73. The Regional Government of Hamburg promotes the construction of the highway A26, at least for the stretch between Hamburg and Stade. On the other side of the Elbe river, the connections between Hamburg and Brunsbüttel are supported by the highway A23. A further development of this route from Itzehoe to Heide was realised (Map 2).

Kiel can be reached from Hamburg by the highways A7, A215 and A210. A general improvement in the traffic conditions should be obtained through the betterment of the road connection to the ferry terminals, by opening of the fourth tunnel under the Elbe river, as well as by the general improvement of the road network between the German maritime ports (Map 2).

Hamburg is connected to Lübeck by the A1 motorway stretch, but this highway stretch loses in efficiency nearby the city Lübeck (Map 2). It would be very useful to find an alternative solution to this problem in order to meet both the economic needs of this city, as well as to protect the environment from the external costs of the pollution due to the congestion traffic problems during the hours and the pick traffic days.

### **15.2.1 The Accessibility by Road towards Denmark**

With refer to the connections towards Denmark, two possible routes are available to reach Copenhagen from Germany: one is the so called Vogelfluglinie, which runs through Puttgarden and Rødbyhavn. It reaches the Danish capital after 163 km. A total travel time of 8 hours is required (Map 6).

The second one is the classic route through the Seeland-Fünen-Jütland. It reaches Malmø by ferry and by the new bridge opened since the 1<sup>st</sup> July, 1999. The latter is 140 km longer than the former, and it takes 16 hours travel time. It is useful to remember that since the 14<sup>th</sup> June, 1998 the 1.624 m long bridge on the Großen Belt has become operative, by linking through a fixed toll junction the Jütland peninsula towards the Danish capital.

The new Øresund crossing is 15,8 km long. The total cost was equal to circa 6 billions DM. A 430 m long artificial island nearby the Danish coast was build, which enables to reach a 3.510 m long tunnel equipped with four transit ways. The crossing travel goes further on to a second artificial island 4.055 m long, then to a 3.014 m long low bridge, and further to a 1.082 m long high bridge. At the end, the Sweden coast may be reached by a last 3.739 m long low bridge. The one-way transit toll for a car costs 62 DM, and special monthly tickets are offered to the commuters which make regularly use of the Øresund crossing.

The alternative ferry service between the two port terminals of Helsingør in Denmark and Helsingborg in Sweden is operated by the shipping company Scandlines<sup>51</sup>. During the year 1999, the volume of passenger in transit along this route grew up to +7%, i.e. circa 10,5 million passengers. Around 1,5 million people leave in the Copenhagen area, while in the Malmö area circa 800.000 people live.

The potential synergy effects, as well as the social and cultural integration promoted by this link might be limited by the expensive tolls to transit on the Øresund crossing. Puttgarden is a terminal point for the ferry links towards Denmark. In this case, the highway A1 ends at the Exit 11

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<sup>51</sup> The shipping company Scandlines is owned for the 50% by Denmark, and for the 50% by the German Railways.

Oldenburg i. Holstein-Süd, and Puttgarden can be reached by the federal road B207 after about 40 km (Map 2).

A proposal to build a tunnel under the Fehmarn Belt between Germany and Denmark in order to construct also in this area a fixed transport link between the two countries is promoted by the Danish authorities. The aim of this fixed crossing should be to support the mobility of people and goods through a direct transit fast way from Scandinavia to the European continent.

The tunnel would be 24 km long and it would allow a saving time in transit of about 2 hours for trains and 1 hour 30 minutes for cars and trucks. Denmark and Germany should co-finance this project by private firms investments. It might be operative in the year 2013. The total building costs are forecasted to be around 6 billions DM. The one-way transit toll for a car should be equal to circa 182 DM. After the realization of this project, it might be forecasted a shift of the traffic of freight and passenger in transit, from the ferry modality to the road and rail modes, in proximity of Lübeck and the Nykøbing-Falster area.

The project is nowadays under appraisal of the Danish and German authorities. From an ecological point of view, the two areas of Puttgarden and Rødby are naturalistically attractive. The construction of the 40 km motorway stretch up to Puttgarden would certainly go to impair the natural environmental balance of the surrounding district because of the new inhabited settlements build up along the route due to the growth pole function usually a new road link exerts.

Moreover, the increased forecasted motor traffic flow would rise the pollution rate due to the emissions of the motor vehicles, that is not an environmental sound solution.

The function of social integration the tunnel should exploit between the population of the two Danish and German areas should be submitted to an economical evaluation too by taking as indicator the amount of the transit toll requested. This amount could be relative expensive particularly for the local people, and could become actually a barrier to the transit and integration rather than an instrument for promoting the cohesiveness between the two areas.

In fact, the density of the population leaving in these two areas is quite low, and no relevant commuter movements towards an attractive neighbouring urban conurbation, as in the case of Copenhagen and Malmø, might be pointed out and forecasted (Map 6).

The alternative transport way given by the more environmental friendly ferry connections between Puttgarden and Rødby seems to be more competitive and satisfactory. The Scandlines operator is going to enforce the frequency of the links on this route with 6 new ferries, to improve the quality of the ferry service with a transit time of just 20 minutes, as well as to offer a cheaper transit toll equal to the half price of the forecasted bridge toll. The passenger transit volume along this ferry route grew up to +5,9% in the year 1999, that was equal to a total volume of 991.644 passengers in transit.

### **15.2.2 The Highway A20 – Via Baltica**

The construction of the highway A20 – Via Baltica is one of the 17 Federal Traffic Projects – BVWP 1992. The highway A20 should realise the corridor connection between Lübeck and the Polish city Stettin by transit through Rostock. In this way, the motorway A20 should connect the Northern region Mecklemburg-Vorpommern, the Northern-Eastern region Brandenburg, Poland, White Russia, as well as the Baltic States to the Western European traffic network, by exploiting a concrete contribute to the integration of the Baltic cities into the European economy [VASAB 2010, 1994], [VASAB 2010, 1996]. The Via Baltica road link should be full operational in the year 2010.

Towards West, the A20 will be connected with the A1 Hamburg-Lübeck, and towards East with the A11 Berlin-Stettin. The total cost for its construction is forecasted to be 4,7 milliard DM [Degrassi, 1997/98]. The Via Baltica will be 324 km long with 4 lanes, and the project should be completed for the year 2005. The Via Baltica highway will be 324 km long; a stretch of 17 km will run through Schleswig-Holstein, a stretch of 282 km through Mecklemburg-Vorpommern, and a stretch of 25 km through Brandenburg (Map 5 and Map 6).

The first stretch of the A20 will be built in the Schleswig-Holstein Land, will be 6,4 km long and will start from the A1 motorway crossing at Hamberge, then crossing the river Trave. The construction works of this first highway stretch begun in June 1998 and the Ministry of Transport forecasted it will be operative during the year 2001. After the realization of the A20 highway, it might be developed a potential industrial area equal to circa 70 hectares, while the number of new jobs for the city Lübeck might swing between 3500-4000 [Degrassi, 1997/98].

In May 1998, the Administrative Federal Tribunal – Bundesverwaltungsgericht of Berlin allowed the beginning of the construction of the first stretch of the A20 in the Land Schleswig-Holstein, after few months of suspension because of the action of protest of the local ecological federations. The matter was about the crossing of the river Wakenitz-Tal inside the Wakenitz-Niederung area. Because this natural area is not protected, the Tribunal ruled that the highway stretch crossing the Wakenitz-Tal did not clash against the European Directive Fauna-Flora-Habitat FFH 1992. Finally, in January 2002 it has been definitively rejected any objection and it has been given the go-ahead for the building of it.

There could be two solutions to cross the Wakenitz-Tal: the building of a bridge, or a 800-1.300 meters long tunnel under the river. The latter is the most environmental friendly solution, but it is 180 millions DM more expensive than the former. In May 1994 the construction of the first highway bridge begun in the Wismar area. During the year 1995 the soil preparation and excavation works for the Gravesmühlen-Wismar Eastern stretch (between Lübeck and Wismar) started and since the beginning of 1998, this 26,4 km highway stretch has been fully operating. The total cost corresponded to 360 million DM.

About the connections between Strassuld and the island of Rügen, one of the Northern European favourite summer holiday destinations, it has to be noticed that the financial investments to build the highway stretch towards the two ferry ports of Saßnitz-Mukran would be probably not available before the year 2005, just after the completion of the A20 - Via Baltica (Map 2).

It might be necessary to realise first of all the so called Pommernkreuz from Grimmen<sup>52</sup> to Strassuld, then to go on with the construction towards Rügen. During March 1998, a public collection of signatures called "Pro-A20" was promoted. A total amount of 9.000 signatures were collected in favour of the construction of this highway stretch; it should be co-financed by European Union funds, together with the Federal Government funds, as well as with private investments.

It is important to evaluate the ecological impact of these infra-structural works towards Rügen as well as on the island itself, because it may be forecasted that a certain amount of negative externalities in terms of pollution and congestion costs will be induced.

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<sup>52</sup> It is located 20 km South from Strassuld.

Since the German Unification, the island has suffered a spatial and functional restructuring process, due to the aim of the local authorities to promote the transit function of the two ferry ports, thanks to the favourable geographical location of the island in the BSR, as well as the tourism on the island.

A further spatial impact of this restructuring process was the expansion of new settlements at expenses of the green areas and forests of the island. This building activity should be limited in order to preserve the natural environmental capital of Rügen, and a compromise solution should be found to address the functional development of the island towards a sustainable growth path.

A further naturalistic area touched by the building of the A20 is the Niedermoorgebiet along the Peenetal river, South from Greifswald. In this case, a compromise solution was reached by constructing the new highway close to the existing road B96, which runs along the North-South direction to Berlin.

Two forecasts should be made with respect to the traffic on the new highway A20: in the first case, the daily volume of the road traffic might increase to about 25.000 units; in the second case, the growth of the traffic volume might be limited to the transit movements between Poland and the Scandinavian States.

Due to the geographical central position of the city-region Hamburg between the North Sea and the Baltic Sea, the construction of the highway A20 should create an infra-structural land bridge, which could promote the substitution of a big portion of the ferry connections with the road carriers along its West-East axes route.

A sustainable inter-modal transport solution should encourage the balanced use of each transport modality [VASAB 2010, 1994], [VASAB 2010, 1994]. Hence, a preferential shift towards the road transport is not desirable.

It should be promoted the usage of the maritime navigation inside the Baltic Sea Region between the ports that exploits communication functions, because this transport alternative is the cheaper (in terms both of internal and external costs), as well as the most environmental sound.

The modal choice at the inter-modal port terminal should be addressed to the use of a sustainable transport alternative such as the rail transportation or the inland waterways navigation, where available, in order to deliver the goods towards the economic hinterland destinations.

Therefore, the process of regional restructuring of the Baltic seaports follows two complementary ways: at a regional level, the restructuring of the regional functions of each seaport city is locally promoted; at an inter-regional level, an environmental sound set of links from each port maritime site is going to improve the mobility of people and goods towards the maritime and inland urban locations of the hinterland.

The aims of this restructuring process are to promote a synergy mobility network inside the BSR, as well as to integrate the two Baltic sub-regions in a sustainable Baltic economic area as a whole.

The Via Baltica should reach the two Baltic cities Riga and Tallinn by passing through Lithuania and the Russian area, then through Poland to Stettin, and finally by linking the A20 Stettin-Lübeck. The Via Baltica should go further on towards St. Petersburg. In Poland it should be connected to the capital city Warsaw (Map 6).

## **Section 7**

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## **Hamburg as Seaport Network**

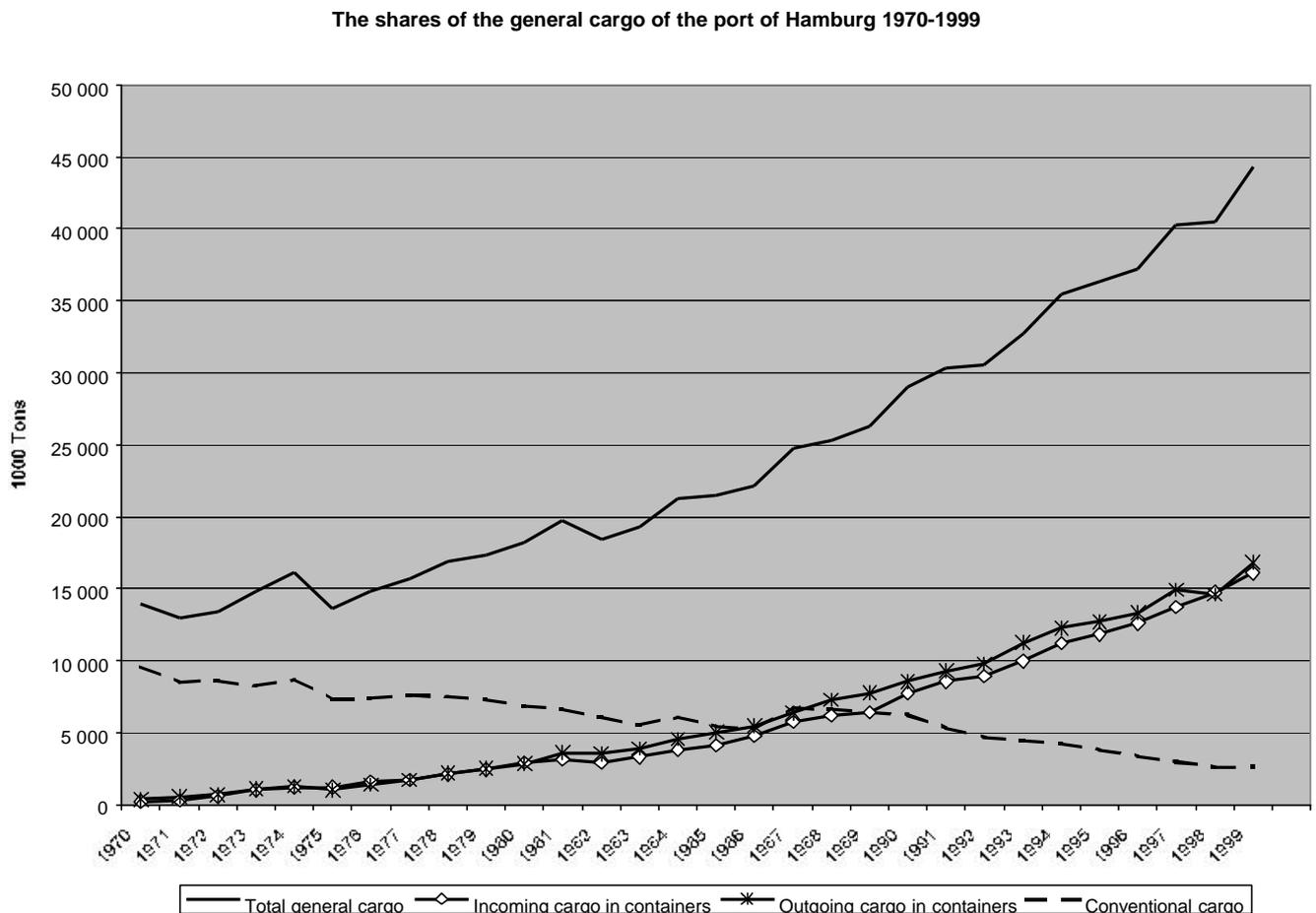


# 16 The New Functional Nodes of the Seaport Network

## 16.1 The Plan for a New Deep-Sea Container Terminal

The three German Länder of Hamburg, Bremen-Bremerhaven and Low Saxony are involved in a jointly decision in order to establish a seaport network between the two main ports of Hamburg and Bremerhaven, and a new deep sea container terminal on the German coast on the North Sea, at Wilhelmshaven or Cuxhaven, for the containers ships with a loading capacity of more then 10.000 TEUs. The volume of investments is equal to 700 millions Euro. The analysis of the structure of the turn-over of the general cargo at the port of Hamburg remarks the growing importance of the role of the containers in the cargo handling (Figure 16.1, source: Statistisches Landesamt Hamburg).

Figure 16.1 – The structure of the handling of general cargo at Hamburg 1970-1999.



The debate about the construction of a deep-sea container terminal on the littoral coast of Germany on the North Sea is not yet concluded. The three federal states of the Free and Hanseatic City-State of Hamburg, Bremen, and Low Saxony are involved in a joint consultation in order to define the plan to build this new facility. On the 30th March, 2001 the following five points were highlighted by the three heads of governments [UV HH, 2001].

- The necessity of building a deep-sea container terminal on the German Bay of the North Sea. The location choice was made in favour of the maritime site of Wilhelmshaven.
- The necessity of further deepening the two rivers Elbe and Weser. The economic and ecologic impacts have to be properly evaluated.
- The necessity of a jointly investment between private (50%) and public (50%) sector in the building of the deep-sea container terminal on the North Sea. In particular, the entrepreneurs of the three states of Hamburg, Bremen and Low Saxony have to support jointly the financial expenditures for the construction of this new facility.
- It has been founded a society for the development of the project with a majority share owned by the state of Low Saxony, in order to define the concept for the development of the project, as well as to promote the very first steps for its realization.
- Cuxhaven might be eligible as location site for the construction of the deep-sea container terminal, in the case that the location choice of Wilhelmshaven could not be realised.

The location choice of the new deep-sea container terminal does not depend only by the port of Hamburg itself, rather then by the jointly decision of the governments of the three Länder. This is quite a good example of how the external economic and political agents are able to influence the port economy of a maritime site. The political elections in Hamburg in September 2001 signed a historical turn in the government of the Hanseatic City-State after more then 40 years. The new coalition CDU-Schill's Party-FDP, and the HHLA Group are going to evaluate the opportunity to invest into this project, as well as the location choice of Cuxhaven as alternative site to Wilhelmshaven. In fact, the seaport of Cuxhaven benefits from the geographic proximity to Hamburg, while the maritime site of Wilhelmshaven is spatially closed to Bremerhaven.

From a spatial perspective, the seaport of Hamburg might establish a mini-land bridge towards the new functional node by developing a rail link or a road

connection. Obviously, the rail link is much more desirable, because this transport mode is more environmental friendly with respect to the road. This step represents a stage of evolution of the seaport of Hamburg in a seaport network towards the North Sea.

It is of fundamental importance the improvement of the transport links between the seaport of Hamburg and the new deep-sea container terminal. In particular, the establishment of a rail link for the transport of the containers from the deep-sea terminal to the main port is a recommendation to give, in order to promote a sustainable transport connection on the land side. In the case of Wilhelmshaven, the shuttle service by rail should take advantage of the new “Y-link” in plan. If Cuxhaven would be chosen, then it should be build a direct rail truck for freights to connect the new functional node of the seaport network to Hamburg.

The site of Cuxhaven seems to be a natural choice for Hamburg, due to the geographical proximity to the main port and to historical reasons. In fact, there is a historical relationship between the two ports. On the 1<sup>st</sup> April, 1938 it was founded the so-called “Great Hamburg”-“Groß Hamburg”. The former Prussian cities of Altona, Harburg and Wandsbek, as well as few other rural areas, were joint together with the Hanseatic City. Hamburg gave back, among other territories, the town of Cuxhaven. Around 15 years ago, Hamburg left the last terminals at Cuxhaven.

The works of improvement of the Mittle Weser, as well as of the inland waterways crossing at Minden are going to be jointly proved by the Land of Bremen and the Federal Ministry of Traffic - *Bundesverkehrsministerium*. The aim of these works is to make possible the transit of the 135-meters-long barges. The final decision will be taken within a year. The approval will give a further support to the choice of Wilhelmshaven as the site for the building of the deep-sea container terminal.

The use of the inland waterways modality for the transport of containers is an environmental friendly alternative to the rail and the road. For example, the forwarder Lexzau, Scharbau & Co. based at Bremen recently extended its shuttle service by barges between Hamburg, Cuxhaven and Brunsbüttel. It runs three times a week, and is mainly dedicated to the transfer of chemical products. A similar link could be established between Cuxhaven and Bremerhaven, due to the fact that Cuxhaven is geographically located at a more central position between the two main ports of Hamburg and Bremerhaven, with respect to Wilhelmshaven.

The port authority of Cuxhaven is effectively searching for investors for building a new deep-sea container terminal at the Amerikahafen. The support of the seaport of Hamburg seems to be absolutely relevant. The site of Cuxhaven might be better linked both to the port of Hamburg and Bremerhaven, if the rail connections and the inland waterways links were improved, and if efficient shuttle services were promoted. The building of the infrastructures for the deep-sea container terminal at the site of Cuxhaven would have to foresee also the construction of such environmental friendly transport links, as dedicated railway tracks for the transit of cargo towards the main ports, and the improvement of shuttle services by barges (the latter is very easy to realise in the very short time). The intensification of the transfer of the containers by trucks between the two main ports and the new functional node can be absolutely prevented, if the three Länder involved will take the proper measures of transport policy.

### ***16.2 The Mini-Land Bridges by Rail towards the Baltic Sea***

The HHLA Group of the port of Hamburg is planning to build a new container terminal on the River Trave, nearby Lübeck. The permission to build the terminal was formally granted, and the construction of the quay wall for this facility has already began. This intermodal link between the two seaports of Hamburg and Lübeck may be defined as a mini-land bridge by rail. The building of this new facility is going to enforce the market position of the HHLA Group simultaneously on the two seas, the North Sea and the Baltic Sea.

For the seaport of Hamburg itself, the new mini-land bridge by rail represents the step to turn into a seaport network. In fact, the geographic distance between the main port on the river Elbe and the new facility on the river Trave may be compared with the spatial distance between Rotterdam-Maasvlakte and the Rail Service Centre of Rotterdam.

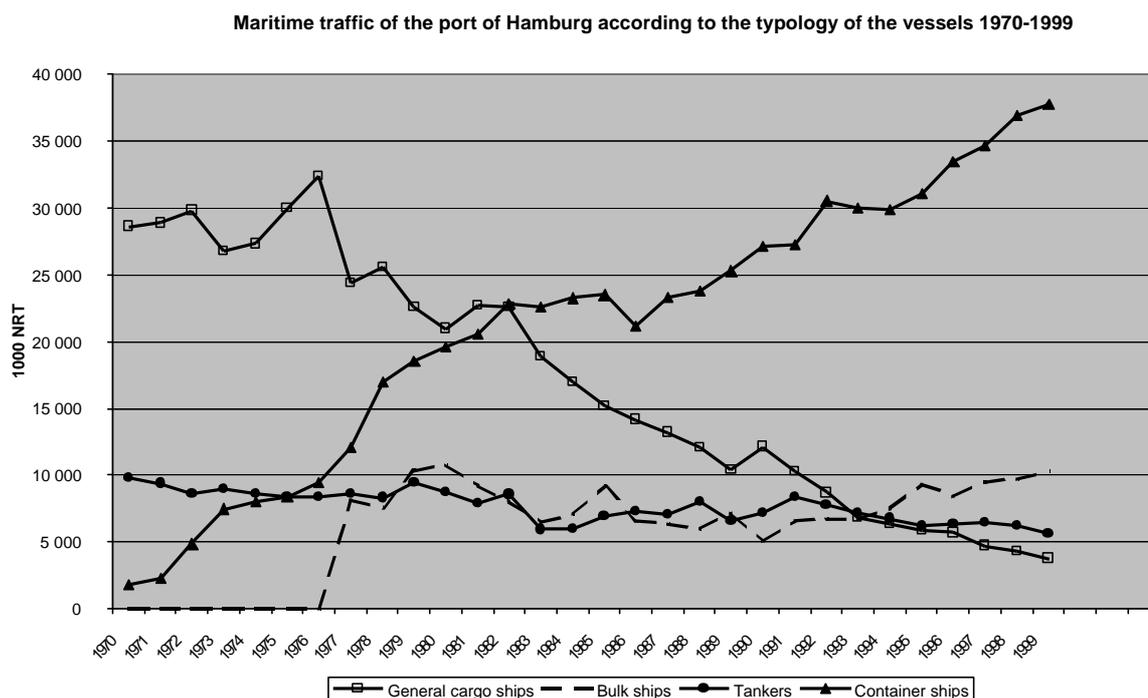
The improvement of the connections towards the hinterland of the seaport of Hamburg plays an important role for the HHLA Group, in particular for the transit of containers. The HHLA Group send around 400.000 TEUs per year towards the final destination in the hinterland. In particular, the aim of the HHLA Group is to achieve the vertical integration within the transport chain between the sea-side and the land-side. This strategy is pursued by the improvement of the hinterland connections towards the European continent. A particular relevance is given to the improvement of the links by rail between the port of Hamburg and the other seaports on the North Sea.

# 17 Further Strategies of Transport and Port Policy

## 17.1 The Deepening of the River Elbe

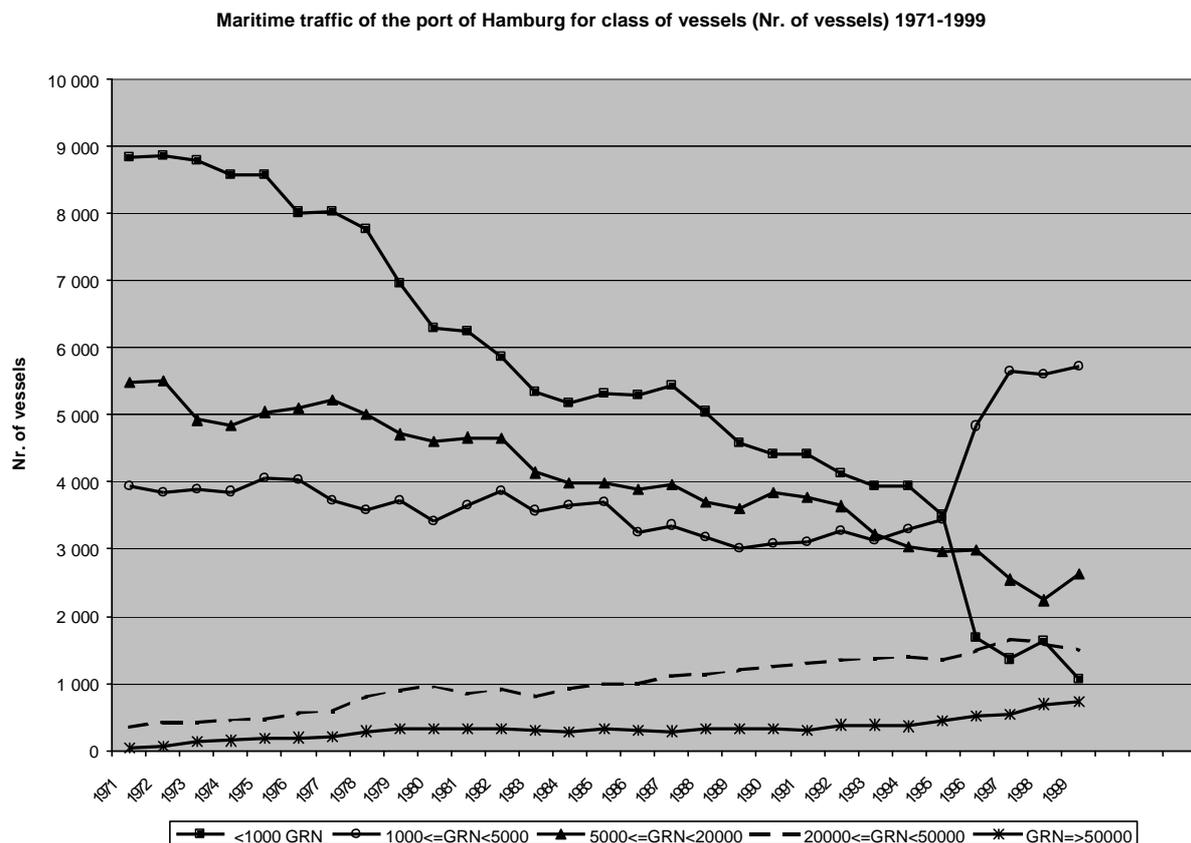
Beside the building of a new transport node at Wilhelmshaven, or alternatively at Cuxhaven, the next priority is the deepening of the river Elbe along its stretch towards Cuxhaven - the so called Upper Elbe-*Untere Elbe*. The incoming/outgoing vessels transit from the ocean towards the seaport of Hamburg through the Upper Elbe. The analysis of the typology of the ships since the year 1970 is shown in the Figure 17.1 (during the period 1970-1976 the statistics on the bulk ships were included in the class of the general cargo ships). The growth in the Net Register Tonnage NRT of the container ships reflects the dominant role of the transport of goods in containers, with respect to the decreasing NRT of the vessels used for the transport of general cargoes. The turning point for the port of Hamburg was the year 1962, after then it can be remarked the inverse correlation between the container ships and the general cargo vessels in transit.

Figure 17.1 – The maritime traffic of the port of Hamburg according to the typology of the vessels (NRT) 1970-1999.



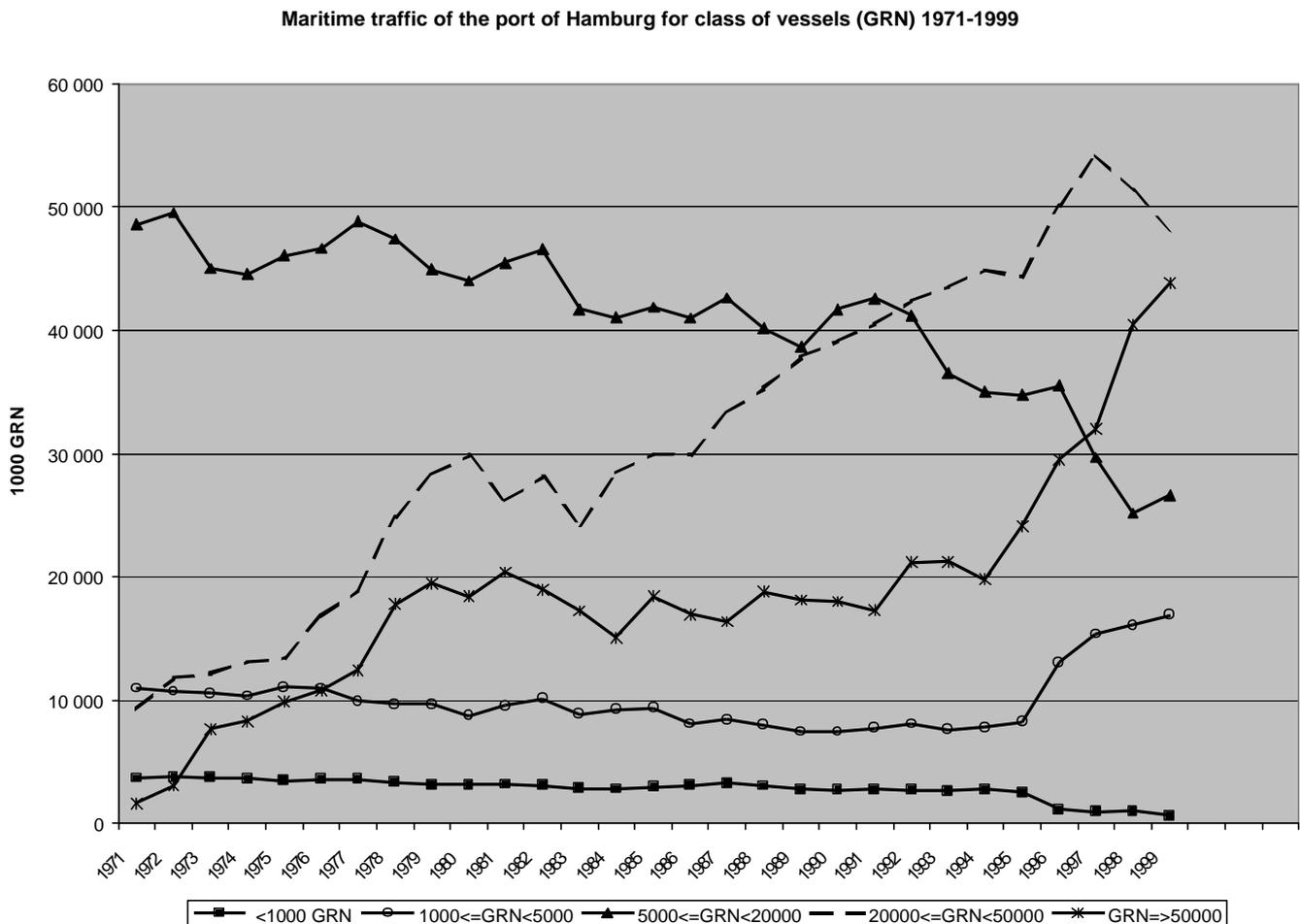
The next figure (Figure 17.2) shows the maritime traffic of the seaport of Hamburg for class of vessels in terms of number of ships. The classes are expressed here in terms of Gross Registered Number GRN. The year 1995 seems to be the turning point from the class of ships <1000 GRN to the class of ships  $1000 \leq \text{GRN} < 5000$ . It can be noted a constant decline in the number of vessels of the smaller class (<1000 GRN) and of the class of ships between 5000 and 20000 GRN during the last 30 years. On the contrary, there is a constant positive trend of the maritime traffic with reference to the two upper classes of ships, with a dominance of the class of vessels between 20000 and 50000 GRN. The data demonstrate the preference to use ships of a bigger loading capacity in order to reach the main port, while the feeder vessels of smaller dimensions have to distribute the cargoes towards the regional ports, according to the hub & spoke system. This is shown by the convergence of the traffic of ships of the two classes of vessels between 5000 and 20000 GRN, and the class of smaller vessels between 1000 and 5000 GRN till the year 1993, that was the turning point in favour of the latter.

Figure 17.2 – The maritime traffic of the port of Hamburg for class of vessels in terms of number of vessels 1971-1999.



The interpretation of the data of the Figure 17.2 is confirmed by the data expressed in the Figure 17.3 on the maritime traffic of the port of Hamburg for class of vessels, here in terms of GRN, for the period 1971-1999.

Figure 17.3 – The maritime traffic of the port of Hamburg for class of vessels in terms of GRN 1971-1999.



The maritime traffic of the smaller vessels <1000 GRN declined during the last decade, while the second class of ships (between 1000 and 5000 GRN) gained in terms of GRN at the port of Hamburg after the year 1995. At the same time, it seems to be a convergence between the second and third class of vessels in the very recent years in terms of GRN. It has to be remarked the wider range of the third class of vessels (15000 GRN), with respect to the range of the second class (just 4000 GRN). This explain the supremacy, in terms of GRN, of the class of ships between 5000 and 20000 GRN in the traffic of the port of Hamburg, on the traffic of the smaller class of ships with the GRN between 1000 and 5000.

The vessels of the second class are in a greater number (see Figure 17.2), but the GRN of the third class is absolutely higher. On the other side, there is also a constant trend of growth with reference to the GRN of the bigger vessels of the two upper classes, when the maritime traffic of the port of Hamburg is analysed.

By the analysis of the data, it can be argued that there is a trend to use the larger freight carriers in order to transport the cargo along the intercontinental routes. Then, the container vessels make their stops at few selected main ports of each continent. This point is expressed for Hamburg in the Figure 17.3, in which the third and fourth classes of vessels sum together for a GRN > 20000 of the whole maritime traffic of the port, since the middle of the 70s.

The delivery of the goods is completed on the maritime side by the feeder vessels, which have a smaller loading capacity, but that are able to offer a more frequent service between the hub port and the regional ports of the maritime network. The data of the Figure 17.2 refer to the number of vessels of the maritime traffic of Hamburg, and they show the dominance of the number of vessels (over 3000 ships per year) of the first three classes, at least till the middle of the 90s. This is an example of a hub & spoke transport network, with reference to the transshipment of containers.

In order to assure the accessibility of the port of Hamburg to the freight vessels of bigger loading capacity, and to guarantee the competitiveness of the Hanseatic seaport with respect to the other main ports of the European Northern Range, the deepening of the Elbe is a necessity to realize. The impact of this transport work on the ecosystem of the Elbe must be carefully evaluated, and must be sustainable for the seaport region. The last works of deepening of the river Elbe were completed during the year 2001.

### ***17.2 The Functional Restructuring of the Seaport Area***

In order to expand the availability of land for the handling of the containers, the seaport of Hamburg is undergoing the following projects.

- 1) Expansion of 180 m of the wharf of the container terminal Eurogate till to the entrance of the Petroleumhafen.  
Building cost: 15 millions DM.
- 2) Expansion of 44 m of the anchorage at the container terminal Tollerort TCT.  
Building cost: 5 millions DM.

- 3) Filling up of the Vulkanhafen. The TCT will have available further 12 ha of land for the operations related to the handling of the containers.  
Building cost: 31 millions DM.
- 4) Filling up of the Kohlenschiffhafen. TCT will have available further 20 ha.  
Building cost: 50 millions DM.
- 5) Improvement of the accessibility to the 30 ha-large Südwest- Indiahafen by the building of a new road, hence new land will be available for the operations of handling.  
Building cost: 80 millions DM.
- 6) Reinforcement and deepening to 13 m under the normal zero of the northern anchorage at Kamerunkai.  
Building cost: 13 millions DM.
- 7) Filling up of the Leichterkanal, demolition of the existing bridge over it and, afterwards, building of a road link over it.  
Building cost: 3,2 millions DM.
- 8) Change in the destination of use of 19 ha of land on the Dradenau, for commercial and industrial purposes.  
Building cost: 5 millions DM.
- 9) Improvement of the first Ellerholzrampe, which is part of the main route of the port.  
Building cost: 16 millions DM.
- 10) Improvement of the barrage at the Billwerder Bucht.  
Building cost: 60 millions DM.

### ***17.2.1 The New Multifunctional Port Terminal of Altenwerder***

In the year 1989, the Senat of Hamburg planned the expansion of the port of Hamburg at Altenwerder. The decision was to build a huge centre for the logistics services [Wirtschaftsbehörde, 1997]. The aim of the Senat was to build a modern container terminal with logistics functions, in order to be able to sustain the growth in the container traffic in the near future. The terminal of Altenwerder covers a surface of 215 hectares. It will be equipped with the most technological advanced equipments for the transshipment activity; with warehouses and distribution depots, which generate value added; with a distribution centre for the combined freight traffic. The building cost is around 513 millions DM.

The aim of the Senat of Hamburg was to build an integrated port centre, where can be performed all the economic functions of the port economy, such as

transshipment, warehousing, manufacturing and transfer of the goods. At the same time, the spatial clustering at this location is supposed to promote the positive effects of synergy and the cooperation between the entrepreneurs. In turn, they are supposed to have a positive influence on the port economy as a whole. Furthermore, it is forecasted the expansion of the demand of port labour, and the creation of new job opportunities. The HHLA is going to employ 272 workers at the new CTA for the end of the year 2002, of which 204 will be port workers (according to the GHB).

The spatial proximity and the local networking process between each sector of the port services are supposed to improve the efficiency of the use of the land areas, of the time and the energy, hence to reduce the expenditures in general. Furthermore, it will be avoid the transit of the transport operators from one terminal of the port to another, on the other side of the port. A positive impact on the ecological system is forecasted, in terms of a reduction of the polluting staff from the road traffic. The terminal Altenwerder will be directly linked to the railway system.

### ***17.2.2 The Two Areas of Expansion of Moorburg and Francop***

The area of expansion of the port of Hamburg embraces also the Central-Western area of Moorburg and the Eastern area of Francop. This area of port expansion is closely related to the new multifunctional site of Altenwerder. The aim of the Senat was to realize an integrated site for the combined traffic, in order to assure the competitiveness of the port of Hamburg with respect to the other main ports of the European Northern Range [Wirtschaftsbehörde, 1997].

The area of Moorburg Centre should be adequately equipped to receive the larger container vessels, as the new CTA. The spatial proximity to Altenwerder is supposed to promote the development of a network of economic relationships between the two new port sites. The plan of expansion includes the building of areas for the activity of transshipment, and for the port services, as well as for the port entrepreneurs.

The two adjoining areas of Moorburg West and Francop East should become part of the expansion area of the port in the long term. It is planned the development of an area for the maritime traffic of the industrial and professional activities. It is forecasted a growth in their demand within the year 2030.

# Conclusions

The seaport of Hamburg continues to grow. According to the very last data<sup>53</sup>, the volume of the freights handled at the Hanseatic port in the year 2001 was equal to 92,4 millions tons, which corresponded to a growth of +8,5% with respect to the previous year. The volume of the handling of containers reached 4,7 millions TEUs, that was equal to a growth of +10,4% with respect to the year 2000. The gross rate of containerisation was very close to the 94% in the 2001.

The analysis of the statistical data of the Statistisches Landesamt der Freien und Hansestadt Hamburg points out the important role of the local entrepreneurs of Hamburg for the growth of the maritime region, and the well established intercontinental network of trade relationships overseas. Furthermore, the hinterland of the seaport of Hamburg refers the European Union, and has been enlarged towards the Scandinavian countries, in particular during the last two decades.

At the regional level, it is remarkable the positive role of the local entrepreneurship, that is defined as the commercial business and producers, as well as the importers/exporters, which are posted in Hamburg. In this sense, the economic network of the seaport region of Hamburg has been reinforced during the years. In fact, the Hanseatic seaport exploits more and more the function of gateway for the local entrepreneurs of Hamburg, especially for their imports.

The geographical split of the commercial network of Hamburg points out the close relationship of the Hanseatic seaport with respect to the hinterland on the European continent, in particular with the countries of the European Union. Since the 80s and especially during the 90s, the maritime transit of cargo towards Scandinavia grew up in both directions, and the trade relationships became stronger, in particular with Finland. The freight transit by road is particularly increased in the year 1999 with respect to Denmark and Sweden. The special trade of Hamburg towards France and The Netherlands has been always relevant, and its monetary value grew up further on since the 1995.

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<sup>53</sup> The source of the very last data is the Hamburger Abendblatt, January-February 2002, on the basis of the declarations of the Senator for the Economy of Hamburg, Mr. Gunnar Uldall. The publication of the Statistisches Landesamt of Hamburg on the last data is not yet available.

The foreland of Hamburg with respect to its foreign trade includes the countries of the Far East, in particular China and Japan as countries of production, and the American continent. It has to be noted the remarkable positive trend of the special trade of Hamburg towards the countries of the Far East after the 1989, and towards the U.S.A. since the 1997.

The fall of the Berlin Wall did not have such extraordinary repercussions on the hinterland of the seaport of Hamburg, as it could be expected. The commercial network between the local firms of Hamburg and the countries of the Central and Eastern Europe has not been changed so much after the 1989. The value of the exports towards those countries seems to be slightly increased during the last decade, while the value of the imports from the Central and Eastern Europe does not show a relevant variability during the last thirty years. The monetary value of the special trade of Hamburg towards the Central and Eastern Europe increased after the year 1992, but afterwards it was almost stable on constant values.

The variations in the maritime transit of goods reflect the different dynamics in the economies of the countries of the Baltic Sea Region BSR. For example, the maritime transit towards Russia sensibly increased in the 1999. It reflects also the preference to use this transport modality, because of the low quality of the transport infrastructures on the land side in this area. In the Baltic Sea Region, Latvia has a remarkable third position as country of origin for the maritime traffic of freights towards the port of Hamburg, just after Finland and Sweden, although it refers to the huge tonnage of bulk cargo that Latvia delivers.

Estonia and Lithuania deliver to Hamburg mainly bulk cargo, while the traffic of loaded containers is more intensive in the opposite direction. Since the year 1998, Russia, Estonia, Lithuania and Latvia have been shown a positive rate of loaded containers sent to Hamburg. Poland showed a positive trend during the last decade as country of origin for the maritime transit of cargo through Hamburg, while the transit by road and inland waterways decreased in the last years. The modal choice finds an explanation because of the inadequacy of the land infrastructures of the transport network in this area.

The geographical proximity of the Czech Republic, Slovakia, and Austria is reflected by the similar trend in the use of the port of Hamburg as a maritime node for the transit of their cargo. Since the 80s, these three countries progressively decreased the use of the Hanseatic seaport as a node of maritime transit, in particular for their deliveries. On the opposite direction, the port operators of Hamburg established a network of block-train services from the

Hanseatic seaport towards Poland, the Czech Republic, Slovakia and Hungary, with the aim to penetrate and consolidate the hinterland.

After the 1989, the traffic of freights, mainly bulk cargo, by inland waterways decreased sensibly towards the Czech Republic and Slovakia, while the relevance of the road transit became stronger. In the more recent years, the establishment of the new Elbe Container Line ECL promoted the transit of containers by barges towards the Czech Republic, thanks to the application of several environmental friendly transport solutions. This step was quite important for Hamburg, in order to integrate the inland waterways into the inter-modal transport network of the seaport. Unfortunately, the modal split of Hamburg denotes the competition between the rails and the inland waterways, which are two transport modalities that are both environmental friendly, rather than the roads. The modal shift between the railways and the inland waterways points out the high capacity of the road transport modality to hide the full social cost of transportation with respect to the other transport modes. The under-pricing in the road transport sector is plain.

The local entrepreneurs of Hamburg play a remarkable role for the maritime region in terms of the value that their activities of production, business, and import/export generate at the local level. The economic network of the seaport region of Hamburg is well established and confirms the existence of a pole of economic growth at the maritime region.

Since the year 1970, an opposite trend is referred to the role of the seaport of Hamburg as gateway for the foreign trade of Germany, which includes all the countries of origin and destination of the German foreign trade. At this level of analysis, the trend has been negative during the last thirty years. Even though the German foreign trade through the port of Hamburg grew in terms of monetary value (around +430% during the last thirty years), the share on the German foreign trade had a negative trend (around -30% since the 1970). The statistical data show that Germany reduced the use of the port of Hamburg as gateway for the national foreign trade since the 70s, in particular with reference to the share of the exports.

The role of the port of Hamburg as gateway for the foreign trade of the German Länder decreased, with respect to the German foreign trade, from a share of 8,3% in the year 1970 to 6,5% in the 1999. The seaport of Hamburg exploits the function of gateway more for the imports of goods of the German Länder rather than for their exports. The statistical data show the reduction in the volume of the exports originated from the German Länder from a share of 9,8% in the year

1970 to 6,7% in the 1999 with respect to the total foreign trade of Germany. In the opposite direction, the share of the volume of the imports of the German Länder grew up from 4,7% in the 1970 to 6% in the 1999, with respect to the total foreign trade of Germany.

In terms of the volume of the cargo, the foreign trade of the Old German Länder through the port of Hamburg grew up since the 70s. The only exceptions are the two Länder of Berlin and Hamburg itself. The fall has to be referred to the volume of the exports from these two Länder. In particular for Hamburg, the exports of the Hanseatic City through its own port drop of around –34% with respect to the volume of the 1970.

Before the German Reunification and with reference to the exports of the German capital, the commercial network between Berlin and Hamburg was much stronger then afterwards. The imports of Berlin was always stable on low volumes of goods, with the exception of the remarkable positive pick in the year 1991. After the 1989, the traffic of freights by inland waterways decreased sensibly towards Berlin, while it increased sharply towards the New Länder.

The function of gateway of the port of Hamburg for the foreign trade of the New German Länder shows opposite trends depending on the direction of the flow of the goods. The volume of the imports of Saxony-Anhalt and, at a lower scale, of the imports of Saxony build up a consolidated commercial network with the Hanseatic seaport. On the other direction, the exports of Brandenburg through the Hanseatic seaport grew since the year 1995, as well as the exports of Thuringia since the German Reunification. Mecklenburg-Vorpommern progressively relaxed the commercial links with Hamburg for its imports.

The analysis of the foreland of the seaport of Hamburg points out the strong commercial network of the port with the Far East and the American continent. In the year 2001, almost 50% of the total handling of containers of the port of Hamburg was referred to Asia (+7,3% with respect to the 2000), while the traffic of containers with America was equal to a share of 15,2% (it was 13,9% in the year 2000). The traffic along the intercontinental routes is going to be dominated by freight vessels of bigger and bigger loading capacity, especially with reference to the container ships of the last generations. The higher efficiency of the inter-modal transport is confirmed by the growth of the rate of containerisation of the cargo handled at the seaport of Hamburg during the last decades.

All these points highlight the intercontinental role of the Hanseatic seaport, and the necessity for the port to assure its accessibility to the container ships of the very last generation, which will be used more and more on the transoceanic routes. It follows that the river Elbe have to be maintained deep enough in order to allow the transit of the transoceanic container ships, with the ecological impact kept to the minimum.

The handling of the containers is a land intensive activity, and the supply of free land at the seaport is submitted to the territorial limits of the seaport location. Undoubtedly, the lack of free areas at the port site has a negative impact on the accessibility to the seaport resources. For this reason, the seaport of Hamburg is undergoing several projects of expansion and restructuring of the port area. The most relevant is the project of the Container Terminal Altenwerder CTA. Furthermore, Hamburg is now beginning the redevelopment of the waterfront with the Project "Hafencity" for tourist and business purposes.

At the local level, the role exploited by the Port Railways of Hamburg will be stimulated during the next years thanks to the plans for the improvements of the network of the rail infrastructures, as well as thanks to the wider application of the information technology by DAKOSY. The promotion of the city logistics is strictly dependent on the starting initiative of the public sector. In fact, its application should be evaluated in order to minimising the external social costs of the road transport of freights within the urban area. In particular, the public logistics terminals seems to be a quite helpful instrument of transport policy [Taniguchi et al., 2000]. With reference to the road network within the port of Hamburg, it can be recommended the building of the link of the A252 – *Hafenquerspange*, in order to improve the efficiency of the transport of goods by road within the port area and towards the Central and Eastern Europe.

A particular recommendation to be made is the promotion of the use of the wide network of inland waterways inside the seaport area, for the freight transport between the terminals. It is absolutely an environmental sound alternative to the lorries. The shift from the road to the inland waterways may help to reduce such external costs, as pollution and congestion, on the road network of Hamburg, especially inside the seaport and its surrounding area. This recommendation is supported by the fact that, at the new CTA, it will be possible to tranship the cargo directly from the container ships to the barges. This innovation will assure the growth in efficiency of the inter-modal network, at the interregional level and, hopefully, at the local level.

The network of transport infrastructures have to be reinforced on the land side towards the geographic area of origin and destination of the cargo of the seaport of Hamburg. In fact, the accessibility to the hinterland is a complementary condition for a multi-modal node of transport such as Hamburg, in order to achieve the higher level of efficiency in the inter-modal activity.

The accessibility to the seaport of Hamburg is an imperative condition for two reasons: first, because the port of Hamburg has to mitigate the negative patterns which are related to its geographic location, that is quite decentralized with respect to the European hinterland; second, because the Hanseatic seaport has to stay in competition with the other European main ports of the Northern Range. The competition should be more a competition between the two pairs of main ports Rotterdam-Antwerp and Hamburg-Bremen-Bremerhaven, rather than a competition between each of them.

The handling of containers is capital intensive and, at the same time, requires the supply of port workers with a high degree of specialization. On the other side, the exploitation of the activities of distribution and logistics stimulates the economic growth of the seaport region, because they generate added value. Therefore, the port policy of the Senat is aimed to attract the relocation of such port related activities towards the Hanseatic region, in order to promote Hamburg as a distribution and logistics node.

At the European level, it is stressed the necessity to build up an efficient inter-modal system of transportation through the establishment of the distribution and inter-modal centres. The seaports should promote the settlement of such public logistics terminals PLT at the level of the maritime region. In fact, the PLT are instruments to promote the local entrepreneurship, as well as to reduce the environmental impact of the freight transport within the urban area.

By starting from these points it follows that, in the long term, it will be more and more necessary the collaboration between the German seaports on the North Sea, if they want to stay in competition with the other main ports of the Northern Range of Europe. At the same time, it will be necessary the building of a deep-sea terminal on the German littoral on the North Sea for the handling of the containers, in order to avoid the problems of accessibility which can be forecasted in the long term, in particular with reference to the Hanseatic seaport of Hamburg.

The Land of Hamburg is involved in the planning of a new deep-sea container terminal on the German littoral, together with the land of Low Saxony and the

Land of Bremen. If the collaboration of the three Länder will continue, it could be signed an important stage in the development of the seaports, for two reasons: first, it should be created a new port terminal outside the administrative territory of the two main ports of Hamburg and Bremen-Bremerhaven, which should be functional related to both of them; second, it should be overcome the strength parochialism that is a traditional characteristic of every port in the world. The latter is the most difficult step to do, because it is strictly related to the strategies of port policy that are proper of each port administration, which is usually in competition with the others. Furthermore, the mutual collaboration among the three Länder seems to avoid the possibility of failures in the allocation of the economic resources.

The establishment of the functional seaport network of Hamburg is dependent on the building of a land bridge between the new functional node on the North Sea, and the Hanseatic seaport. The preference in the modal choice favours the rail modality, because it is environmental friendly. Recently, the seaport of Hamburg has established a mini-land bridge by rail with Lübeck, that is a good example of a functional node of the seaport network.

The decision about the location of the new deep-sea container terminal is going to favour the maritime location of Wilhelmshaven, rather than Cuxhaven. At the beginning of the year 2002, it was mentioned the possibility of exclusion of the Land of Hamburg from the mutual participation to the project. The other two Länder were available to consider the financial support of a private investor, such as a shipping company like Maersk, in the case that the Senat of Hamburg and the HHLA Group deny the investments for Wilhelmshaven.

The locational choice in favour of Wilhelmshaven seems to strengthen the competitiveness of the German seaports, because the time of navigation of the container ships would be reduced of about 5 hours, with respect to the time of navigation necessary to reach Hamburg. If compared to Cuxhaven, then Wilhelmshaven is located at a more central position with respect to the European hinterland. On the contrary, the geographical location of the maritime site of Cuxhaven is clearly closer to Hamburg, but at the same time it is located at a more central position between the two main ports. In fact, Cuxhaven seems to be the natural location for a functional node of the seaport network of the Hanseatic City of Hamburg.

The intercontinental network of trade relationships of the port of Hamburg points out the necessity to be accessible to the big container ships which are used on the transoceanic routes. The debate about the opportunity to build the giants of

the sea with a loading capacity exceeding the 10.000 TEUs involves the economic agents that are external to the port itself. In fact, the economic agents of the seaport location seem to have no power of influence on such a decision. Therefore, the choice of Hamburg to build a deep sea container terminal should be taken with respect to other factors.

The continuous growth of the rate of containerisation of the port of Hamburg implies the urgent demand of more and more services related to the handling of the containers, which are operations typically land extensive and capital intensive. It follows that the development of a functional node outside the administrative territory of the Hanseatic port of Hamburg seems to be imperative in the long term, due to the limited supply of free territory inside of the administrative port area. In fact, the main port can benefit from the derived traffic of the new functional maritime node.

The subsequent problem is to choose the location for the new functional site, hence the location outside the administrative territory of the Land of Hamburg where to invest: at Wilhelmshaven or at Cuxhaven. This strategic decision implies the evaluation of the different scales of competition between the seaports of the Northern Range and their hinterlands.

If the competition refers to the two couples of main ports Rotterdam-Antwerp and Hamburg-Bremen-Bremerhaven, then the building of the deep sea container terminal at Wilhelmshaven should be favoured, because it is supposed to reinforce the market position of the German seaports as a whole in order to penetrate the European hinterland.

On the contrary, this locational choice might stress the unfavourable position of Hamburg with respect to the countries of the European Union EU. As already explained, and according to the statistical data, the hinterland of Hamburg is firstly oriented towards the seaport city-region itself, the Scandinavian countries and the EU. It follows that the locational choice of Wilhelmshaven might be unfavourable for Hamburg, because of the foreseeable superimposition of their hinterlands, and the lack of complementary functions between them. In particular with respect to the hinterland towards the EU, Hamburg might lose the patterns of accessibility in favour of a maritime site better located. This forecast is supported by the statistical data on the declining role of Hamburg for the foreign trade of Germany, and by the strengthening of the inner European market. Due to these reasons, the location of Cuxhaven seems to be more suitable to become a functional node of the seaport network of Hamburg.

# Appendix 1 - The Technological Change

The technological change can be split into two processes that take place over a time period, the innovation process and the technology transfer [Krugman, 1990]. The innovation process is the process by which new products are created. This is the primary idea that may be transformed in reality by an *invention*. Through the imitation process of other economical actors, the *diffusion* of the invention takes place. The process of innovation implies a growth in the number of goods produced over time.

The technology transfer is the process by which new products are transformed into old products over a time period. It is assumed that a technical progress takes place only when the availability of *new products* occurs. Therefore it is not stressed the increase in the quantity of output of old products in such a model, but the growth in the number of new products added to the market. This meaning has to be kept distinguished by the technological progress as the increase in productivity in the output of a certain range of (old) goods.

It is possible to argue that a positive relationship exists between the number of new products invented and the number of old products  $n$  already developed. Therefore the higher the level of knowledge, the higher the probability to increase the know-how. The following equation can be written, where  $i$  is the innovation factor:

$$n' = i \cdot n$$

The rate of innovation  $n'$  represents the assumption of directly proportionality of the innovation to the number of old products  $n$  already in existence. This assumption causes a long-run steady state in the conventional models of economic growth, by which the technological change is assumed to be exponential over the time.

The technological transfer may be interpreted as the process to turn new goods produced as in a monopoly market, into old goods  $n_o$  produced as in an imperfect competition framework. The following equation shows this sort of radioactive decay from invention to old products related by the factor  $t_t$  of technological transfer:

$$n'_n = t_t \cdot n_o$$

The diffusion of the invention to other economical agents needs a certain period of time, called as imitation gap. The average imitation gap can be written by the

rate  $(1 / t_t)$ . It is easy to calculate the rate of change  $n'_o$  of the number of new products that occurs in the monopolistic framework. It is given by the difference between the rate of innovation  $n'$  and the rate of technological transfer  $n'_n$ , as it follows: 
$$n'_o = (i * n) - (t_t * n_o)$$

The system composed by the two previous equations is not stable because of the continuous growth of the technological progress, although the structure of the stock of goods affected by the new developments is relatively balanced and stable over the time. The share of new goods  $s$  can be written: 
$$s = n_o / n$$

It is easy to derive the ratio  $s'$  of the share of new goods, as follows: 
$$s' = [n'_o - (s * n')] / n = i - s (t + i)$$

The equilibrium of the system is reached for  $s = i / (t + i)$ . The ratio of new to old goods  $(n_o/n_n)$  determines both the relative wages between two countries or regions and the relationship  $(i/t)$  between the innovation factor and the technological factor in equilibrium, as follows: 
$$(n_o / n_n) = s / (1 - s) = i / t$$

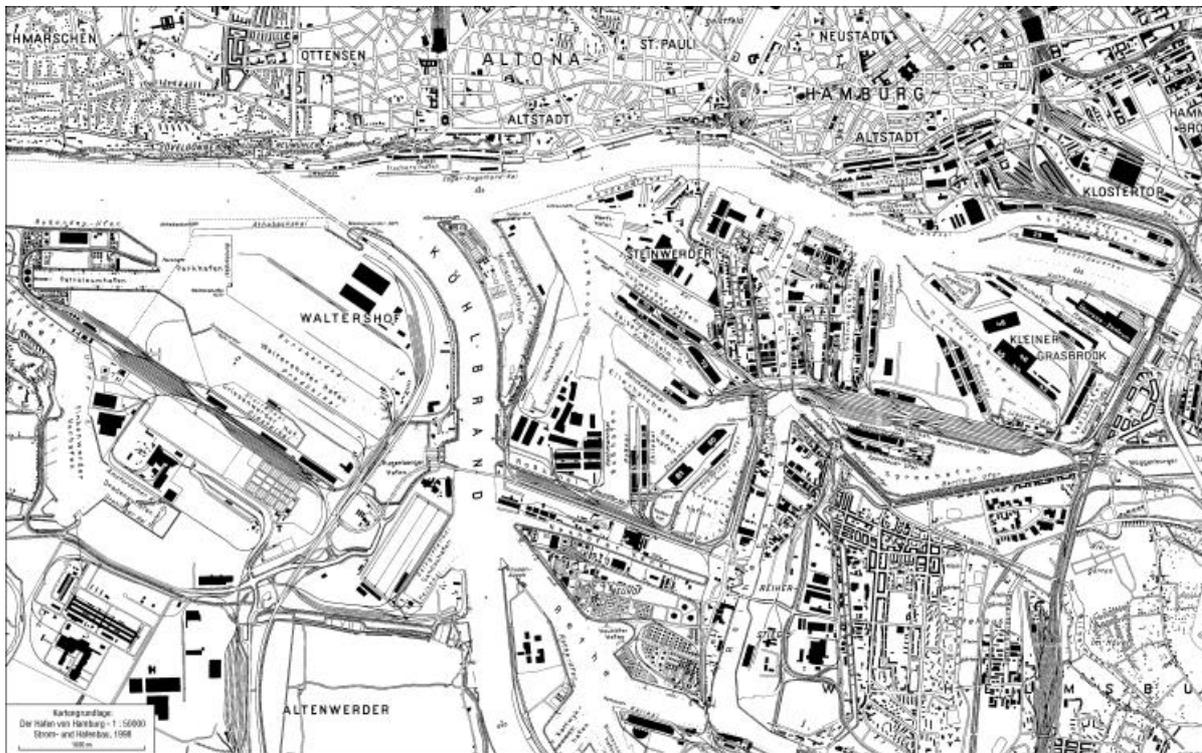
Due to the ratio  $(i/t)$ , the world economy tends towards a steady state or moving equilibrium. Both innovation and technological transfer improve the efficiency in the production of goods, hence they induce an increase in the world output. A further impact is on the distribution of income at the world level.

The innovation process introduces new products on the market. This enlargement of the range of goods may bring a benefit to the countries or regions that imitate the production. The technological transfer instead simply induces a shift of the production of new good from the innovative country or region towards which imitates the invention. The diffusion of the production induces a redistribution process between the innovative and the imitating regions.

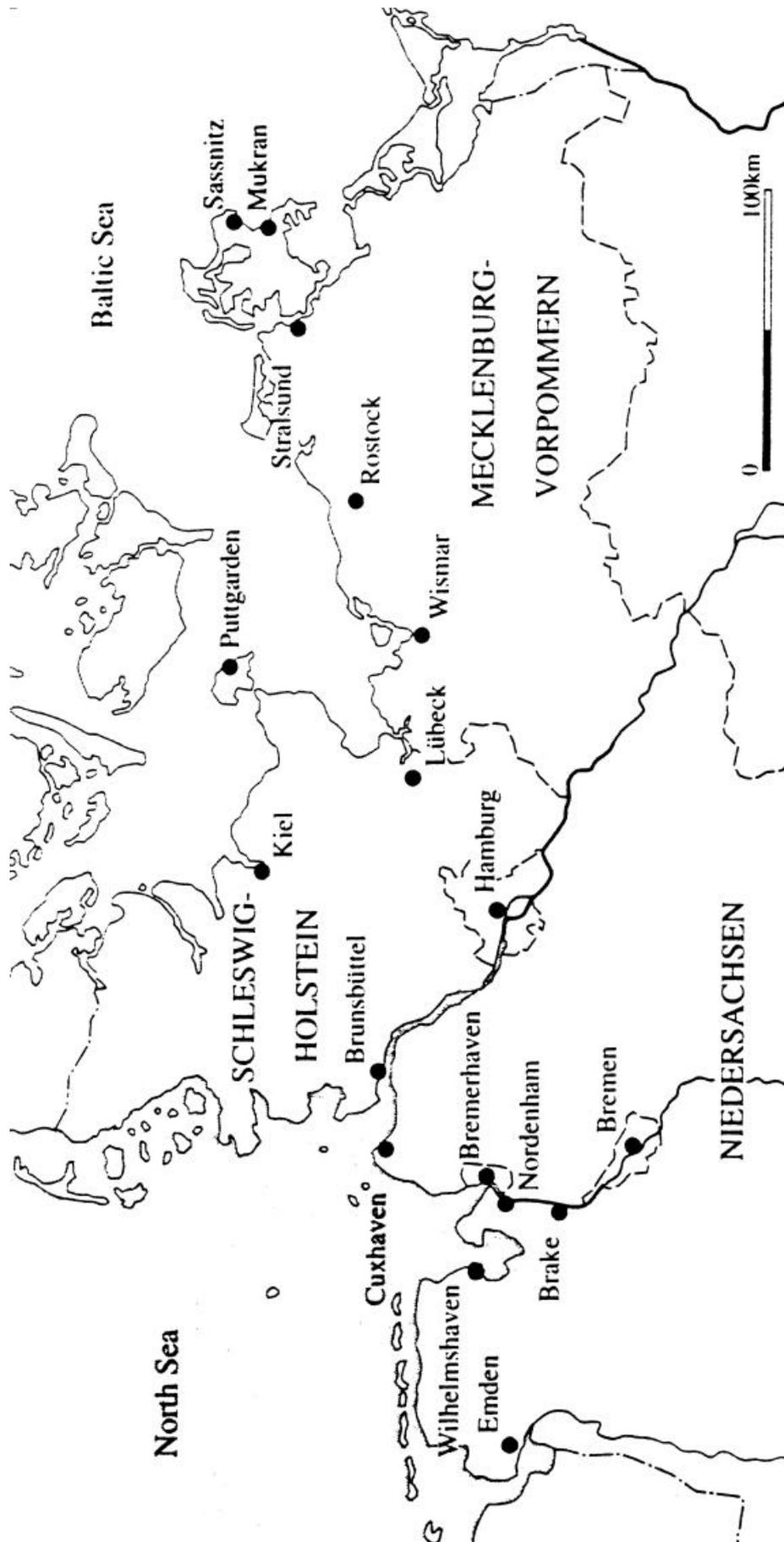
The interesting point to highlight is that the incomes of the innovative country depend on the rents gained from the monopoly framework they operate. Due to the assumption of continuous technological progress, the erosion of the monopolist rates through the diffusion process has to be counteracted by a dynamic development of new products, hence by a never-ending renewal innovation process.

# Appendix 2 - Maps

Map 1 - The geographical location of the seaport Hamburg.



Map 2 - The seaports of the Northern Germany.  
Source: Nuhn, 1999.



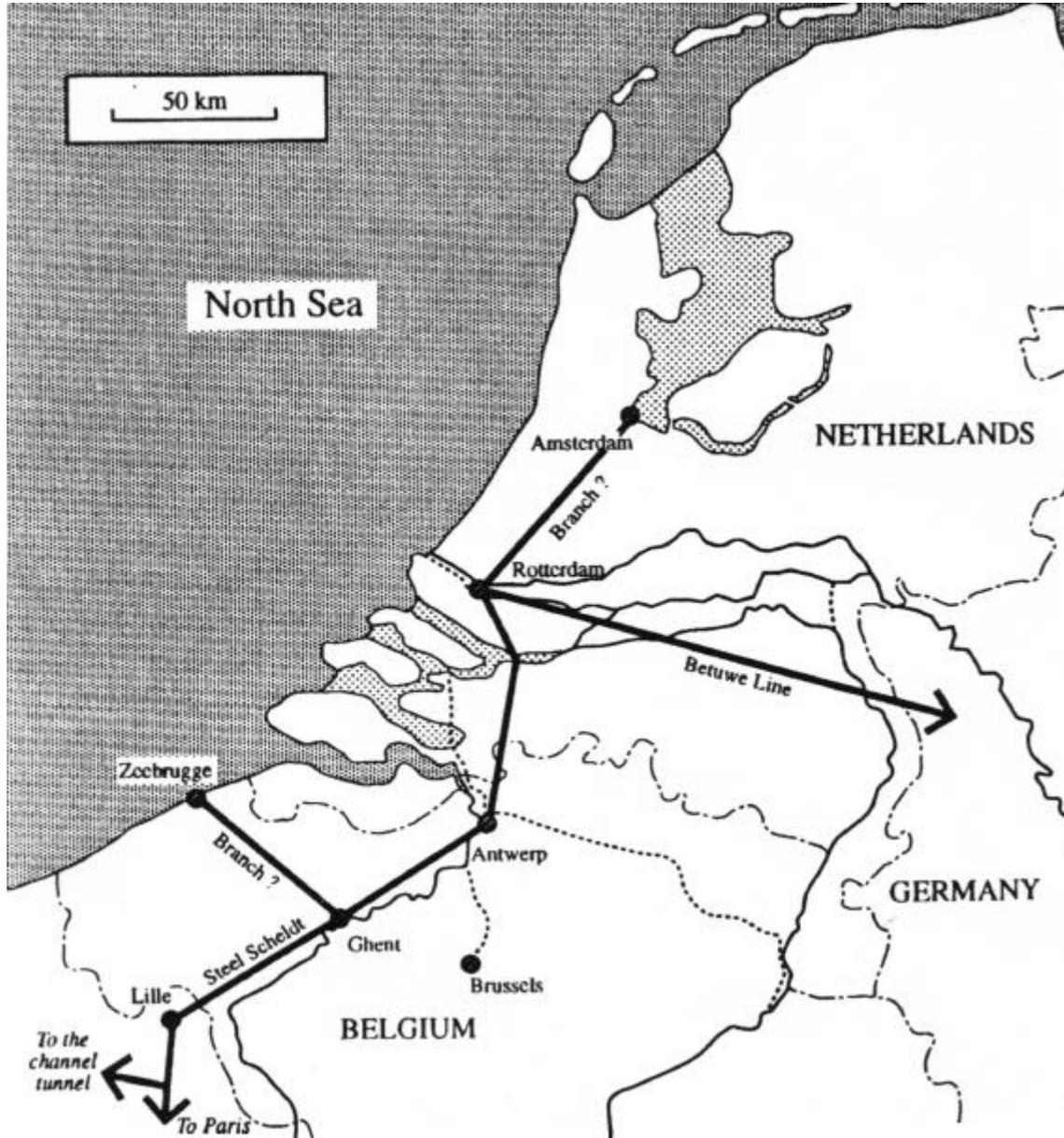
Map 3 - The political geography of the European continent.

Source: Stenning, Bradshaw, 1999, p.98.



Map 4 - The Benelux seaport system and the railway links.

Source: Charlier, 1996, p. 319.



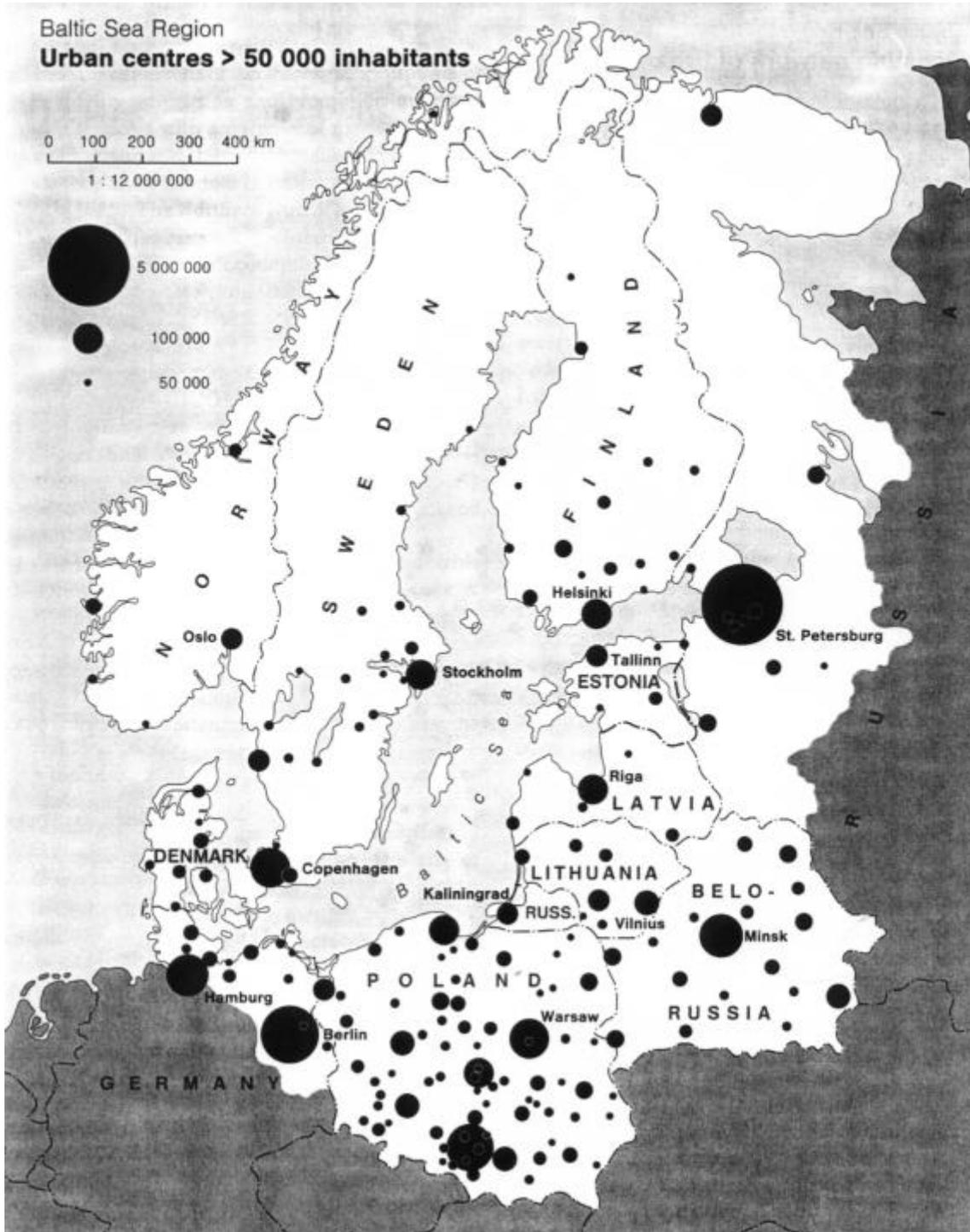
Map 5 - The geographical dimension of the Baltic Sea Region.

Source: Hamburgische Landesbank, 1997, p.7.



Map 6 - The urban agglomeration in the Baltic Sea Region.

Source: VASAB 2010, 1994.



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# Bibliography

- ALONSO W., FRIEDMANN J.R.** (1964) *Regional Development and Planning*. Cambridge-Massachusetts, The M.I.T. Press, 78-106.
- BANISTER D., MAGGI R., NIJKAMP P., VICKERMAN R.** (1999) *Actors and Factors in the Integration of Strategic Infrastructure Networks in Europe*. In: *New Contributions to Transportation Analysis in Europe*, Ed. by P. Beuthe & P. Nijkamp, Aldershot, England, 17-44.
- BAUBEHÖRDE DER FREIE UND HANSESTADT HAMBURG** (1999) *Verkehrsentwicklungsplanung Hamburg – Leitlinien und Handlungskonzept für eine an Arbeit und Umwelt orientierte Verkehrspolitik in Hamburg (Traffic development plan Hamburg – Guidelines and action plan for an employment and environmental oriented traffic policy in Hamburg)*, Hamburg, November 1999.
- BERENTSEN W.H., CROCKER J.E.** (1998) *Accessibility between the European Union and East-Central Europe: Analysis of Market Potential and Aggregate Travel*. In: *Post-Soviet Geography and Economics*, Formerly *Post-Soviet Geography* 39(1), 19-44.
- BIRD J.** (1965) *The Foundation of Australian Seaports Capitals*. *Economic Geography* 41, 283-299.
- BIRD J.** (1970) *Seaports are not Aberrant Cases*. *Area* 4, 65-68.
- BIRD J.** (1971) *Seaports and Seaports Terminals*. London, Hutchinson University Library.
- BIRD J.** (1973) *Of Central Places, Cities and Seaports*. *Geography* 58, 105-118.
- BIRD J.** (1977b) *Centralities and Cities*. London, Routledge & Kegan Paul.
- BIRD J.** (1983) *Gateways: Slow Recognition but Irresistible Rise*. *TESG - Tijdschrift voor Economische en Sociale Geografie* 74(3), 196-202.

- BIRD J., POLLOCK E.E.** (1978) *The Future of Seaports in the European Communities*. Geographical Journal 144, 23-48.
- BOERMANN W.E.** (1952) *The Need for Special Examination of Particular Aspects of Port Geography*. Washington, Preliminary Report of the Commission on Industrial Ports, International Geographical Union Congress, 347-349.
- BORRUSO G.** (1971) *La containerizzazione: una moderna tecnica per il trasporto combinato delle merci (Containerisation: a Modern Technic for the combined freight transport)*. University of Triest-Italy, Faculty of Economics and Trade, Department of Economics, Udine-Italy, Del Bianco Editore.
- BOUCHAUD J.-P., MÉZARD M.** (2000) *Wealth Condensation in a Simple Model of Economy*. Physica A 282(3-4), 536-545.
- BRAESS D.** (1968) *Über ein Paradoxon der Verkehrsplanung*. Unternehmensforschung 12, 258-268.
- BRAUNILL S.** (1988) *The People's Plan for the Royal Docks. Some Contradictions in Popular Planning*. Planning Practice and Research 3, 15-21.
- BRAUNILL S.** (1990) *Developing London's Docklands*. London.
- BRUTTOMESSO R.** (1993) (Eds.) *Waterfronts-A New Frontier for Cities on Water*. Venice.
- BUCHHOFER E.** (1995) *Transport Infrastructure in the Baltic States during the Transformation to the Market Economies*. Journal of Transport Geography 3(1), 69-75.
- BUKOLD S.** (1996) *Kombinierte Verkehr Schiene/Straße in Europa. Eine vergleichende Studie zur Transformation von Gütertransportsystemen, Frankfurt-Berlin-New York-Paris-Wien*.
- BUKOLD S.** et al. (1993) *Logistikstrategien im Hamburger Hafen*. In: Küstenregionen im Strukturwandel, W. Karr, Nürnberg, 83-113.
- BUKOLD S., DEECKE H., LÄPPLE D.** (1991) *Der Hamburger Hafen und das Regime der Logistik zum Strukturwandel im Güterverkehr und seinen Auswirkungen auf die Hamburger Hafenwirtschaft*. Institut für Stadt-,

Regional- und Transportforschung, Arbeitsbereich Stadtökonomie der Technischen Universität Hamburg Harburg, Hamburg.

**BURGHARDT A.F.** (1959) *The Location of River Towns in the Central Lowland of the United States*. *Annals of the Association of American Geographers* 49, 305-323.

**BURGHARDT A.F.** (1971) *A Hypothesis about Gateway Cities*. *Annals of the Association of American Geographers* 61, 269-285.

**BUTTON K., NIJKAMP P., PRIEMUS H.** (Edited by) (1998) *Transport Networks in Europe-Concepts Analysis and Policies*, Glos-UK, Edward Elgar.

**CAPINERI C., KAMANN D.J.** (1998) *Synergy in Networks: Concepts*. In: *Transport Networks in Europe*, Ed. by K. Button, P. Nijkamp and H. Premius, Cheltenham UK-Northampton MA, USA, 35-56.

**CAPELLO R., RIETVELD P.** (1998) *The concept of Network Synergies in Economic Theory: Policy Implications*. In: *Transport Networks in Europe*, Ed. by K. Button, P. Nijkamp and H. Premius, Cheltenham UK-Northampton MA, USA, 57-83.

**CHARLIER J.** (1992b) *Ports and Hinterland Connections*. In: *Ports as Nodal Points in a Global System*. A. Dolman, J. van Hettinger, Oxford, Pergamon Press.

**CHARLIER J.** (1992) *The Regeneration of Old Port Areas for New Port Uses*. In: *European Port Cities in Transition*. B.S. Hoyle & D.A. Pinder, London, Belhaven Press, 137-154.

**CHARLIER J.** (1996) *The Benelux Seaport System*. *TESG- Tijdschrift voor Economische en Sociale Geografie* 87(4), 310-321.

**CHARLIER J., HOYLE B.S.** (1995) *Inter-port Competition in Developing Countries: an East African Case Study*. *Journal of Transport Geography* 3, 87-103.

**CHRISTALLER W.** (1933) *Die Zentralen Orte in Süddeutschland. Eine ökonomisch-geographische Untersuchung über die Gesetzmäßigkeit der Verbreitung und Entwicklung der Siedlungen mit städtischen Funktionen*, Jena.

- CHRISTALLER W.** (1950) *Das Grundgerüst der räumlichen Ordnung in Europa. Die Systeme der europäischen zentralen Orte*, Frankfurt am Main, Kramer, Frankfurter Geographische Hefte.
- CHRISTALLER W.** (1977) *Christaller Central Places Structures. An Introduction Statement*, Northwestern University. Study in Geography 22, Evanston, Department in Geography.
- COBB J.B.** et al. (1989) *For the Common Good: Redirecting the Economy towards Community, the Environment and a Sustainable Future*. Environmental Science, 28, 146-151.
- CONFETRA Confederazione Generale Italiana del Traffico e dei Trasporti** (1994) *L'Operatore in Trasporto Multimodale (MTO) e l'Operatore Logistico (LO) (The Multi-modal Transport Operator MTO and the Logistics Operator LO)*. Quaderno Nr. 88, Milano, May 1994.
- CONFETRA Confederazione Generale Italiana del Traffico e dei Trasporti** (1997) *Indagine sulla domanda di servizi logistici e di trasporto (Research on the demand of logistics and transport services)*. Quaderno Nr. 101, Milano, July 1997.
- CONFETRA Confederazione Generale Italiana del Traffico e dei Trasporti** (1997) *Il trasporto marittimo (The Maritime Transport)*. Quaderno Nr. 102, Milano, September 1997.
- DAKOSY Datenkommunikationssystem des Hafen Hamburg GmbH** (1995-1999) *DAKOSY News*, Hamburg.
- DEECKE H., LÄPPLE D.** (1996) *German Seaports in a Period of Restructuring*. TEGS - Tijdschrift voor Economische en Sociale Geografie 87(4), 332-341.
- DEGRASSI S.** (1997/98) *Amburgo alle soglie del 2000: studio geografico-economico sulla struttura del sito portuale anseatico e sulle tendenze future di sviluppo in rapporto con il suo hinterland (Hamburg close to the year 2000: geographical-economical study on the structure of the hanseatic port site and on the future development trends in relation to its hinterland)*, University of Triest-Italy, Faculty of Political Science, Tesi di Laurea in Political and Economic Geography, Triest, Academic Year 1997/98.

- DEGRASSI S.** (2000) *Deliverable 9.1 - Report on Port related Processes of Regional Restructuring*. BALTICOM Project – INTERREG II C, Work Package 9 - Regional Case Study N. 2: Impacts of maritime transport and communication technologies in port areas of Northern Germany. <http://www.balticom.org>
- DEGRASSI S.** (2001) *Deliverable 9.2 – Recommendation for Spatial Planning Issues*. BALTICOM Project – INTERREG II C, Work Package 9 - Regional Case Study N. 2: Impacts of maritime transport and communication technologies in port areas of Northern Germany. <http://www.balticom.org>
- DE LANGE P.W.** (1999) *Governments and Markets in the Port Arena*. Paper presented at the Geographentag in Hamburg, October 4-7, 1999.
- DE LIGHT T.J.** (1994) *Main Port Rotterdam in a Fast Changing World*. In: *Gateways to the European Market: Case Studies from The Netherlands and Germany*. Münster-Hamburg, 9-32.
- DIXIT A.K., STIGLITZ J.E.** (1977) *Monopolistic Competition and Optimum Product Diversity*. A.E.R. 67, 297-308,
- ELLIOTT N.R.** (1969) *Hinterland and Foreland as illustrated by the Port of Tyne*. Institute of British Geographers Transactions 47, 153-170.
- ENGLER D.** (1979) *Die Entwicklungsdeterminanten der deutschen Nordseehäfen und der Rhein-Schelde-Häfen unter besonderer Berücksichtigung der Wettbewerbsfaktoren*. Köln.
- ENTE AUTONOMO DEL PORTO DI TRIESTE** (no year) *Glossario della terminologia portuale (Glossary of the Maritime Terminology)*. Trieste-Italy.
- EUROPEAN COMMISSION** (1997) *Towards a Pan-European Transport Network*. February 20, 1997.
- FAßMANN H.** (1994) *Transformation in Ostmitteleuropa*. Geographische Rundschau 46, 685-691.
- FICK K.E.** (1986) *Lübeck, Rostock, Stettin, Danzig. Strukturen und Funktionen einst und heute*. In: *Beiträge zur Geographie der Kulturerdteile*, B. Hofmeister, F. Voss, Berlin, Berliner Geographische Studien, 121-146.

- FLEMING D.K.** (1988) *The Port Community: Seaport Character and Public/Private Tensions*. In: *Urban Ports and Harbour Management. Responding to Change along U.S. Waterfronts*, New York, Taylor & Francis, Ed. by M.J. Hershman, 57-76.
- FORKENBROCK D.J.** (1999) *External Costs of Intercity Truck Freight Transportation*. *Transportation Research A* 33, 505-526.
- FORWARD C.N.** (1968) *Waterfront Land Use in Metropolitan Vancouver, British Columbia*. Geographical Paper 41, Ottawa, Ontario.
- FORWARD C.N.** (1969) *A Comparison of Waterfront Land Use in Four Canadian Ports: St. John's, Saint John, Halifax, and Victoria*. *Economic Geography* 45, 155-169.
- FORWARD C.N.** (1970) *Waterfront Land Use in Six Australian State Capitals*. *Annals of the Association of American Geographers* 60, 517-531.
- FREY A.E.** (1973) *The Teaching of Regional Geography*. *Geography* 58, 119-128.
- FRIEDMANN J.R.** (1956) *Locational Aspects of Economic Development*. *Land Economics* 32, 213-227.
- FRIEDMANN J.R.** (1966) *Regional Development Policy: a Case Study of Venezuela*. Massachusetts, The M.I.T. Press, 20.
- FRIEDMANN J.R.** (1967) *A General Theory of Polarized Development*. Ford Foundation, Urban and Regional Development Advisory Program in Chile, Santiago.
- FRIEDMANN J.R.** (1969) *A General Theory of Polarized Development, Growth Centres in Regional Economic Development*. New York, Ed. by N.M. Hansen.
- FZH Fortbildungszentrum Hafen Hamburg e.V.** (1997-2000), several brochures, Hamburg.
- GIULIANO G.** (1995) *Land Use Impacts on Transportation Investments, Highway and Transit*. In: *The Geography of Urban Transportation*, Second Edition, New York, Ed. by S. Hanson, 305-341.

- HAMBURGISCHE LANDESBANK** (1997) *Hamburg und die Ostseeraum*. Wirtschaftsanalysen 2/1997. Hamburg.
- HANNEMANN M.** (1928) *Die Seehäfen von Texas, ihre geographischen Grundlagen, ihre Entwicklung und Bedeutung*. Frankfurter Geographische Hefte 2, Heft 1, Frankfurt am Main.
- HAX H.** et al. (1996) *Economic Transformation in Eastern Europe and East Asia. A Challenge for Japan and Germany*. Springer.
- HAYASHI S.** (1976) *Siberian Land-bridge: Present and Future*. In: Sister Ports Seminar-Kobe, Seattle, Rotterdam, Conference Papers, Port of Rotterdam, 19-23.
- HAYUTH Y.** (1981) *Containerisation and the Load Centre Concept*. Economic Geography 57, 160-175.
- HAYUTH Y.** (1982a) *Inter-modal Transportation and the Hinterland Concept*. TEGS - Tijdschrift voor Economische en Sociale Geografie 73(1), 13-21.
- HAYUTH Y.** (1982b) *The Port-Urban Interface: an Area in Transition*. Area 14, 219-224.
- HAYUTH Y.** (1987) *Inter-modality: Concept and Practice*. London, Lloyd's of London Press.
- HAYUTH Y.** (1988) *Rationalization and de-concentration in the U.S. Container Port System*. The Professional Geographer 40, 279-288.
- HAYUTH Y.** (1995) *Container Traffic in Ocean Shipping Policy*. International Conference Ports for Europe, Zeehaven BruggeVZW, Brugge.
- HERRMANN H.** (1996) *Die Regionen der Hafenstandorte*. In: Landesentwicklung in Norddeutschland-Funktionen und Hinterlandanbindung der Häfen an Nord- und Ostsee, Hannover, Akademie für Raumforschung und Landesplanung, 102-118.
- HERSHMAN M.J.** (1988) *Harbour Management: a New Role for the Public Port*. In: Urban Ports and Harbour Management. Responding to Change along U.S. Waterfronts, New York, Taylor & Francis, Ed. by M.J. Hershman, 3-28.
- HOYLE B.S.** (1973) *Transport and Development*. London, Macmillan.

- HOYLE B.S.** (1996) (Eds.) *Cityports, coastal zones and regional change*. Chichester.
- HOYLE B.S., HILLING D.** (1984) *Seaport System and Spatial Change. Technology, Industry and Development Stages*. Chichester, Hoyle & Hilling Eds.
- HOYLE B.S., KNOWLES R.D.** (1992) *Modern Transport Geography*. London-New York, Hoyle & Knowles Eds.
- HOYLE B.S., PINDER D.** et al. (1981) *City-port Industrialization and Regional Development-Spatial Analysis and Planning Strategies*. University of Southampton, Ed. Hoyle & Pinder.
- HOYLE B.S.** (1988) *Development Dynamics at the Port-city Interface*. In: *Revitalising the Waterfront: International Dimensions of Dockland Redevelopment*, B.S. Hoyle, D.A. Pinder, M.S. Husain (Eds.), London-Belhaven.
- HOYLE B.S., PINDER D.** et al. (1992) *European Port Cities in Transition*. London, Hoyle & Pinder Eds.
- HHW Hafen Hamburg Verkaufsförderung und Werbung AG** (May 1999) *Port of Hamburg Handbook 1999/2000*, United Kingdom, Compass Publication Limited.
- HHW Hafen Hamburg Verkaufsförderung und Werbung AG** (1996-1999) *Port of Hamburg Magazine*.
- INFORMARE** (1997-2001) <http://www.informare.it/>
- INTERREG II C Baltic Sea Region** (1997) *Community Initiative concerning Trans-national Co-operation on Spatial Planning*, European Commission Operational Programme 1997-1999.
- INTERREG III B Baltic Sea Region** (2000) *Community Initiative Programme 2000-2006, Second Comprehensive Draft*, European Commission, Copenhagen, September 11-12, 2000.
- JÄGER-ROSCHKO O., HERRMANN H., LEWANDOWSKI A.R.** (1996) *Szenarienkünftiger Handelsbeziehungen im Ostseeraum-Konsequenzen für die Verkehrsströme über die Ostsee und für die Ostseehäfen*. In: *Landesentwicklung in Norddeutschland-Funktionen und*

Hinterlandanbindung der Häfen an Nord- und Ostsee, Hannover, Akademie für Raumforschung und Landesplanung, 78-101.

**JELEN I.** (1988) *Teorizzazione e territorio. Uno studio sulla struttura urbana della Svizzera orientale in termini geografici e teoretici (Theorization and Territory. A Geographic and Theoretical Case Study on the Urban Structure of East Switzerland)*. Triest, University of Trieste, Department of Political Science, Scientific Press.

**KENYON J.B.** (1960) *Industrial Localization and Metropolitan Growth: the Paterson-Passaic District*. Chicago, The University of Chicago, Department of Geography, Research Paper Nr. 67.

**KENYON J.B.** (1968) *Land Use Admixture in the built-up Urban Waterfront: Extent and Implications*. *Economic Geography* 44, 152-177.

**KENYON J.B.** (1970) *Elements in Inter-port Competition in the United States*. *Economic Geography* 46, 1-24.

**KREUKELS A.M.J., WEVER E.** (1996) *Ports in Western Europe*. *TESG - Tijdschrift voor Economische en Sociale Geografie* 87(4), 291-292.

**KREUKELS A.M.J., WEVER E.** (1996) *Dealing with Competition: the Port of Rotterdam*. *TESG - Tijdschrift voor Economische en Sociale Geografie* 87(4), 293-309.

**KRUGMAN P.R.** (1990) *Rethinking International Trade*. The MIT Massachusetts Institute of Technology Press, Cambridge-Massachusetts-London-England.

**KRUGMAN P.R.** (1991) *Increasing Returns and Economic Geography*. *Journal of Political Economy* 99(3), 483-499.

**KRUGMAN P.R., OBSTFELD M.** (1997) *International Economics: Theory and Policy*. 4<sup>th</sup> Edition, Reading, Mass., Harlow: Addison-Wesley.

**KUBY M., REID N.** (1992) *Technological Change and the Concentration of the U.S. General Cargo Port System: 1970-1988*. *Economic Geography* 68, 272-289.

**LIPSEY R.G.** (1989) *Introduzione all'economia (An Introduction to Positive Economics)*. Sonzogno, Gruppo Editoriale Fabbri.

- LÖSCH A.** (1940) *Die räumliche Ordnung der Wirtschaft. Eine Untersuchung über Standort, Wirtschaftsgebiete und internationale Handel.* Jena, Fisher.
- LÖSCH D., PLÖTZ P., POLKOWSKI A.** (2000) *Wirtschaftslage und Reformprozesse in Estland, Lettland und Litauen im Frühjahr 2000.* Hamburgisches Welt-Wirtschafts-Archiv HWWA, Hamburg.
- MARCHESE U.** (1996) *Lineamenti e Problemi di Economia dei Trasporti (Elements and Problems of Transport Economics),* Genua, Ed. Culturali Italiane.
- MARTIN P., ROGERS C.A.** (1995) *Industrial Location and Public Infrastructure.* Journal of International Economics 39, 335-351.
- MAYER H.M.** (1957) *The Port of Chicago and the St. Lawrence Seaway.* University of Chicago, Department of Geography, Research Paper Nr. 49, Chicago.
- MAYER H.M.** (1973) *Some Geographic Aspects of Technological Changes in Maritime Transportation.* Economic Geography 49, 145-155.
- MAYER H.M.** (1978) *Current Trends in Great Lakes Shipping.* GeoJournal 2, 117-122.
- MAYER H.M.** (1988) *The Physical Harbour: New Demands on a Scarce Resource.* In: *Urban Ports and Harbour Management: Responding to Change in U.S. Waterfronts.* Ed. by M.J. Hershman. Taylor & Francis – New York, 77-98.
- MAYERES I., OCHELEN S., PROOST S.** (1996) *The Marginal External Costs of Urban Transport.* Transportation Research D 1(2), 111-130.
- MASHUR J.** (1996) *Auseinandersetzung mit den Projekten und Anforderung an die See- und Hinterlandverbindungen aus der Sicht der Raumordnung.* In: *Landesentwicklung in Norddeutschland-Funktionen und Hinterlandanbindung der Häfen an Nord- und Ostsee,* Hannover, Akademie für Raumforschung und Landesplanung, 119-131.
- McCALLA R.J.** (1983) *Separation and Specialization of Land Uses in Cityport Waterfronts. The Cases of St. John and Halifax.* The Canadian Geographer 27, 49-61.

- McKINNON A.C., WOODBURN A.** (1996) *Logistical Restructuring and Road Freight Traffic Growth. An Empirical Assessment.* *Transportation* 23, 141-161.
- MECKING L.** (1928) *Die Seehäfen Japans in vergleichender Betrachtung.* Verhandlungen und Wissenschaftliche Abhandlungen des 22. Deutschen Geographentages zu Karlsruhe, Breslau, 130-140.
- MECKING L.** (1930) *Die Seehäfen in der Geographischen Forschung.* Petermanns Mitteilungen, Gotha, Ergänzungsheft 209, 326-345.
- MIKOLAJSKI J.** (1964) *Polish Sea Ports, their Hinterlands and Forelands.* *Geographia Polonica* 2, 221-229.
- MORGAN F.W.** (1948) *The Pre-War Hinterlands of the German North Sea Ports.* *Transactions of the Institute of British Geographers* 14, 47-55.
- MORGAN F.W.** (1952) *Ports and Harbours.* London, Hutchinson University Library.
- MORGAN F.W.** (1970) *Observations on the Study of the Hinterlands in Europe.* *The Professional Geographer* 22(6), 366-373.
- MORRILL R.L.** (1979) *On the Spatial Organization of the Landscape.* Lund, The Royal University of Lund, Department of Geography, Gleerup.
- MORRILL R.L.** (1981) *Political Redistricting and Geographic Theory.* Washington D.C., Association of American Geographers VI, Resource Publications in Geography.
- MUSSO E.** (1996) *Citta' Portuali: l'Economia e il Territorio (Port Cities: the Economy and the Territory).* Collana Trasporti Franco Angeli, Milano.
- MYRDAL G.** (1957) *Economic Theory and Under-developed Regions.* London, Duckworth.
- NORCLIFFE G.B.** (1981) *Industrial Change in Old Port Areas.* *Cahiers de geographie du Quebec* 25, 237-254.
- NIJKAMP P., MARTELLATO D., REGGIANI A.** (1998) *Measurement and Measures of Network Accessibility: Economic Perspectives.* In: *Transport Networks in Europe*, Ed. by K. Button, P. Nijkamp and H. Premius, Cheltenham UK-Northampton MA,USA, 161-180.

- NUHN H.** (1985) *Industriestruktuelle Wandel und Regionalpolitik-Dargestellt am Beispiel der Hansestadt Hamburg*. GR Geographische Rundschau 37(12), 592-600.
- NUHN H.** (1985) *Der Hamburger Hafen-Strukturwandel und Perspektiven für die Zukunft*. GR Geographische Rundschau 41(11), 646-654.
- NUHN H.** (1986) *Struktur, Entwicklung und Planungsprobleme des Verkehrs im Untereelberaum*. Hamburg.
- NUHN H.** (1994) *Gateway to Europe: the Port City of Hamburg*. In: Gateways to European Market: Case Studies from The Netherlands and Germany, Münster-Hamburg, LIT Verlag, 49-66.
- NUHN H.** (1994) *Verkehrsgeographie-Neuere Entwicklungen und Perspektiven für die Zukunft*. TEGS- Tijdschrift voor Economische en Sociale Geografie 46(5), 260-265.
- NUHN H.** (1994) *Strukturwandlungen im Seeverkehr und ihre Auswirkungen auf die europäischen Häfen*. TEGS- Tijdschrift voor Economische en Sociale Geografie 46(5), 282-289.
- NUHN H.** (1996) *Die Häfen zwischen Hamburg und Le Havre*. Geographische Rundschau 48, 420-428.
- NUHN H.** (1998) *Maritime Wirtschaft in Norddeutschland*. In: Wirtschaftsgeographie Deutschlands, Gotha and Stuttgart, Klett-Perthes, 309-343.
- NUHN H.** (1998) *Verkehr und Kommunikation*. In: Wirtschaftsgeographie Deutschlands, Gotha and Stuttgart, Klett-Perthes, 199-266.
- NUHN H., OßENBRÜGGE J., SÖKER E.** (1983) *Expansion des Hamburger Hafens und Konsequenzen für den Süderelberaum-Durchführung der Umsiedlung Altenwerders und Reaktion der Betroffenen*. Wirtschaftsgeographische Abteilung des Instituts für Geographie und Wirtschaftsgeographie der Universität Hamburg, Hamburg.
- OKUN A.M.** (1975) *Equality and Efficiency. The Big Trade-off*, The Brookings Institution, Washington DC.
- OPPEL A.** (1912) *Die deutschen Seestädte*. Frankfurt am Main.

- OPPENHEIM N.** (1995) *Urban Travel Demand Modelling. From Individual Choices to General Equilibrium*. J. Wiley & Sons Eds., New York.
- PAGNINI M.P.** (1974) *Un ripensamento sui concetti di ecologia umana e di geografia (Rethinking the concepts of human ecology and geography)*. In: *Temi di ecologia*, M.P. Pagnini & P. Nodari, Triest-Italy, Cluet, 101-118.
- PARSONS T.** (1961) *An Outline of the Social System*. In: *Theories of Society*, New York, Free Press.
- PATTI S.** (1994) *Codice Civile (The Civil Code)*. Torino, Giappichelli Editore.
- PATTON D.J.** (1958) *General Cargo Hinterlands of New York, Philadelphia, Baltimore and New Orleans*. *Annals of the Association of American Geographers* 48, 436-455.
- PATTON D.J.** (1960) *Port Hinterlands: the Case of New Orleans*. University of Maryland.
- PEARCE D.W.** (1996) *Measuring Sustainable Development*. London, Blueprint 3, Earthscan.
- PEARCE D.W., TURNER R.K.** (1990) *Economic of Natural Resources and the Environment*. London, Harvester Wheatsheaf.
- PERROUX F.** (1950) *Economic Space: Theory and Application*, *Quarterly Journal of Economics*, 89-104.
- PERROUX F.** (1983) *A New Concept of Development*, Paris-UNESCO, London-Croom Helm.
- POLKOWSKI A.** (2000) *Mare Balticum. Economic Situation, Trading Relations and Direct Investment in the Baltic Sea Region*. Hamburgisches Welt-Wirtschafts-Archiv HWWA, Handelskammer Hamburg, Hamburg.
- POLKOWSKI A.** (2001) *Die mittel- und osteuropäischen Länder auf dem Weg in die EU*. Wirtschaftsdienst 2001/II, HWWA-Forum, Hamburgisches Welt-Wirtschafts-Archiv HWWA, Hamburg.
- PRIEBS A.** (1998) *Hafen und Stadt*. *Geographische Zeitschrift* 86(1), 16-30.
- REINHARD R.** (1901) *Die wichtigsten deutschen Seehandelsstädte*. Stuttgart.

- RICHERT R.** (1996) *Bestandsaufnahme ausgewählter Seehäfen and der deutschen Nord- und Ostseeküste*. In: Landesentwicklung in Norddeutschland-Funktionen und Hinterlandanbindung der Häfen an Nord- und Ostsee, Hannover, Akademie für Raumforschung und Landesplanung, 4-38.
- RIMMER P.J.** (1967) *Inferred Hinterlands: The Example of New Zealand Seaports*. *Geography* 52(4), 384-392.
- RIMMER P.J.** (1967) *The Changing Status of New Zealand Seaports 1853-1960*. *Annals of the Association of American Geographers* 57, 88-100.
- ROBINSON R.** (1970) *The Hinterland-Foreland Continuum: Concept and Methodology*. *The Professional Geographer* 22(6), 307-310.
- ROBINSON R.** (1976) *Modelling the Port as an Operational System: a Perspective for Research*. *Economic Geography* 52, 71-84.
- RÜHL A.** (1920) *Die Nord und Ostseehäfen im deutschen Außenhandel*. Veröffentlichungen des Instituts für Meereskunde NF, Berlin, B. Historischvolkswirtschaftliche Reihe, Heft 3.
- SAMUELSON P.** (1954) *The Transfer Problem and Transport Costs-Analysis of Effects of Trade Impediments*. *Economic Journal* 64, 264-289.
- SARGENT J.R.** (1938) *Seaports and Hinterlands*. London, A. & C. Black.
- SARGENT J.R.** (1958) *British Transport Policy*. Oxford, Clarendon Press.
- SCHÄFER G.C.** (1988) *Round-The-World Services. Entwicklung und Auswirkungen auf Häfen und Hinterlandverkehre der Hamburg-Antwerpen Range*. Europäische Studienprogramm für Betriebswirtschaft, London-Madrid-Reims-Reutlingen, Reutlingen, Institut für Europäische Wirtschaftsstudien.
- SCHÖLLER P.** (1953) *Aufgaben und Probleme der Stadtgeographie*. *Erkunde* 7, 161-184.
- SCHULTZE J.H.** (1930) *Die Häfen Englands*. Leipzig.
- SCHUMPETER J.A.** (1939) *Business Cycles: a Theoretical, Historical and Statistical Analysis of the Capitalist Process*. New York, McGraw-Hill.

- SLACK B.** (1985) *Containerisation, Inter-port Competition and Port Selection*. Maritime Policy and Management 12, 293-303.
- SLACK B.** (1990) *Inter-modal Transportation in North America and the Development of Inland Load Centres*. The Professional Geographer 42, 72-83.
- SLACK B.** (1994b) *Domestic Containerisation and the Load Centre Concept*. Maritime Policy and Management 21, 229-236.
- STATISTISCHES LANDESAMT DER FREIE UND HANSESTADT HAMBURG** (1970-1999) *Statistische Berichten*, Hamburg.
- STENNING A., BRADSHAW M.J.** (1999) *Globalisation and Transformation: the Changing Geography of the Post-Socialist World*. In: The Economic Geography Reader, Ed. by J. Bryson, N. Henry, D. Keeble, R. Martin-Wiley & Sons, Ltd.-Chichester, England, 97-107.
- STORPER M.** (1997) *The Regional World. Territorial Development in a Global Economy*, The Guilford Press, New York.
- TAAFFE E.J.** et al. (1963) *Transport Expansion in Underdeveloped Countries: a Comparative Analysis*. Geographical Review 53, 502-529.
- TAAFFE E.J.** et al. (1996) *Geography of Transportation*. Ohio State University, Ed. Prentice Hall.
- TANIGUCHI E., NORITAKE M., YAMADA T., IZUMITANI T.** (1999) *Optimal Size and Location Planning of Public Logistics Terminals*. Transportation Research E 35, 207-222.
- TANIGUCHI E., THOMPSON R.G.** Eds. (1999a) *City Logistics*. Institute for City Logistics, Kyoto-Japan.
- TANIGUCHI E., van der HEIJDEN R.E.C.M.** (2000) *An Evaluation Methodology for City Logistics*. Transport Reviews 20(1), 65-90.
- TSAMBOULAS D.A., DIMITROPOULUS I.** (1999) *Appraisal of Investments in European Nodal Centres for Goods*. Transportation 26(4), 381-398.
- ULLMANN E.L.** (1941) *A Theory of Location of Cities*. American Journal of Sociology 46(6).

- U.S. BUREAU OF CENSUS** (1970a, 1988b) *U.S. Waterborne Exports and General Imports*. Washington D.C., U.S. Department of Commerce.
- U.S. HYDROGRAPHICAL OFFICE** (1953) *World Port Index*. Nr. 950, Washington D.C.
- U.S. MARITIME ADMINISTRATION** (1980) *U.S. Imports Via Mini Land Bridge*. Washington D.C., U.S. Department of Commerce.
- UV HH UNTERNEHMENSVERBAND HAFEN HAMBURG** (2001) *Hafen Hamburg 2001-Jahresbericht*. Hamburg.
- VALLI V.** (1993) *Politica Economica. Teoria e Politica dello Sviluppo. (Economic Policy. Development Theory and Policy)*. La Nuova Italia Scientifica NIS, Roma.
- VASAB 2010 Vision and Strategies around the Baltic Sea 2010** (1994) *Report on the Third Conference of Ministers for Spatial Planning and Development*, Tallinn, December 7-8, 1994.
- VASAB 2010 Vision and Strategies around the Baltic Sea 2010** (1996) *Report on the Fourth Conference of Ministers for Spatial Planning and Development*, Stockholm, October 22, 1996.
- VAN IERLAND E., GRAVELAND C., HUIBERTS R.** (2000) *An Environmental Economic Analysis of the New Rail Link to European Marin Port Rotterdam*. *Transportation Research D* 5(3), 197-209.
- VAN KLINK H.A.** (1995) *Towards the Borderless Mainport Rotterdam- An Analysis of Functional, Spatial and Administrative Dynamics in Port Systems*. Ph.D. Thesis, Erasmus University Rotterdam, Amsterdam-Rotterdam, Tinbergen Institute Research Series.
- VAN KLINK H.A.** (1998) *The Port Network as a New Stage in Port Development: the Case of Rotterdam*. *Environment and Planning A* 30, 143-160.
- VICKERMAN R.** (1999) *The Transport Sector, New Economic Geography and Economic Development in Peripheral Regions*. In: *New Contributions to Transportation Analysis in Europe*, Ed. by P. Beuthe & P. Nijkamp, Aldershot, England, 45-66.

- VON BERTALANFFY L.** (1972) *Teoria Generale dei Sistemi (General Systems Theory)*. Milano, I.L.I.
- VON ROHR G.** (1996) *Die Arbeitsteilung zwischen den Häfen der Nord Range-Konsequenzen für die Verkehrsinfrastrukturanbindung des Hinterlands*. In: Landesentwicklung in Norddeutschland-Funktionen und Hinterlandanbindung der Häfen an Nord- und Ostsee, Hannover, Akademie für Raumforschung und Landesplanung, 65-77.
- VON THÜNEN J.H.** (1826) *Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie*. Hamburg.
- WALLACE W.H.** (1958) *Railroad Traffic Densities and Patterns*. Annals of the Association of American Geographers 48, 352-374.
- WEIGEND G.G.** (1956) *The Functional Development of the Port of Hamburg*. TESSG- Tijdschrift voor Economische en Sociale Geografie 47(5), 113-120.
- WEIGEND G.G.** (1958) *Some Elements in the Study of Port Geography*. The Geographical Review 48, 185-200.
- WEIGEND G.G.** (1956) *The Problem of Hinterland and Foreland as illustrated by the Port of Hamburg*. Economic Geography 32(1), 1-16.
- WESTLUND H.** (1999) *An Interaction-cost Perspective on Networks and Territory*. The Annals of Regional Science 33, 93-121.
- WIRTSCHAFTSBEHÖRDE DER FREIE UND HASESTADT HAMBURG, AMT STROM- UND HAFENBAU** (1992) *Hafenerweiterung Altenwerder. Zukunft für Hafen und Stadt*. Hamburg.
- WIRTSCHAFTSBEHÖRDE DER FREIE UND HASESTADT HAMBURG, AMT STROM- UND HAFENBAU, AMT HÄFEN; DIENSTLEISTUNGEN UND WIRTSCHAFTSINFRASTRUKTUR** (1997) *Logistisches Dienstleistungszentrum Hafen Hamburg-Chancen einer Neuen Ära*. Hamburg.
- ZATTI P., COLUSSI V.** (1995) *Lineamenti di Diritto Privato (Main Features of Private Law)*. Padova, Cedam.

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