ITMMA
INSTITUTE OF TRANSPORT AND MARITIME MANAGEMENT ANTWERP
Universiteit Antwerpen

ESPO

# Economic analysis of the European seaport system

## Report serving as input for the discussion on the TEN-T policy


**Report prepared by**
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## Disclaimer

The views and opinions expressed by the writer of this report do not necessarily state or reflect those of the European Sea Ports Organization (ESPO) or any member of ESPO.

**Report commissioned by**

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# 1. Introduction

European ports find themselves embedded in ever-changing economic and logistics systems. It is important that policy initiatives are based on a sound knowledge of market processes. This is also relevant in the context of ongoing developments in the European transport infrastructure network.

This report aims at providing a deeper understanding of the market dynamics behind freight distribution patterns in the European port system. The report aims for a balanced approach covering all port regions in Europe and large as well as mid-sized and small ports. The findings of the report serve as input for the ongoing discussion on the revision of the TEN-T program of the European Commission. The report will demonstrate that the routing of maritime freight through European ports to the hinterland is guided by complex interactions between a large set of factors and actors. The first part discusses cargo dynamics in the European port system by analyzing the geographical spread of freight volumes in the European port system and the associated cargo concentration patterns at the local, regional and European scale. Next, the report zooms in on the market dynamics behind the routing of good flows via the European port system. The discussion includes an analysis of the underlying factors that lie at the heart of port and modal choice and of observed patterns in distribution networks, liner services, rail services and barge services. The last section of the report is aimed at providing a deeper insight in the actual routing of hinterland flows between the seaport system and the hinterland.

This report has been realized within the framework of the existing service agreement between the European Sea Ports Organisation and the Institute of Transport and Maritime Management Antwerp (ITMMA), an institute of the University of Antwerp. The views and opinions expressed in this report do not necessarily state or reflect those of the European Sea Ports Organization (ESPO) or any member of ESPO. The report complements earlier studies, in particular the report on market developments in European seaports which was included in the ESPO annual report 2006-2007. ITMMA is determined to continue developing activities fostering the European seaport industry and to further improve our shared understanding and knowledge on European ports.

# 2. Cargo throughput dynamics in the European port system

To accommodate maritime extra-EU and intra-EU trade flows, Europe is blessed with a long coastline reaching from the Baltic all the way to the Med and the Black Sea. The European port system cannot be considered as a homogenous set of ports. It features established large ports as well as a whole series of medium-sized to smaller ports each with specific characteristics in terms of hinterland markets served, commodities handled and location qualities. This unique blend of different port types and sizes combined with a vast economic hinterland shapes port competition in the region.

This part of the report presents an overview of the distribution of cargo flows in the European seaport system. The following sections focus on the following five markets: the container market (section 2.1), the RoRo market (section 2.2), the market for conventional general cargo (section 2.3), the liquid bulk market (section 2.4) and the dry bulk market (section 2.5). The statistics cover both Northern European and Southern European seaports and different port sizes ranging from large mainports to mid-sized and small ports. The discussion on container volumes is the most elaborate with a port throughput analysis for figures from 1985 to 2008. For the four remaining markets, the report includes Eurostat figures for 2005 and 2006, and where available also 2007.

For each of the five markets, the following sections provide a detailed analysis of the geographical spread of cargo volumes in the European port system and the associated cargo concentration patterns at the local, regional and European scale.

## 2.1. Container traffic in the European port system

### 2.1.1. Container throughput dynamics in Europe: general discussion

The analysis on container throughput dynamics is based on container throughput figures in TEU for the period 1985-2008. The relationship between the TEU throughput and the traffic of containerized freight expressed in gross tons is quite straightforward: one TEU on average represents about 10 tons and the differences among ports are fairly small (see table 2.1).

*Table 2.1: Average gross tons per TEU for a sample of European container ports*

| | Antwerp | Zeebrugge | Rotterdam | Amsterdam | Hamburg | Bremerhaven | Le Havre | Dunkirk | Lisbon | Bilbao | Algeciras | Tarragona | Barcelona | Valencia | Marseille | Genoa | Venice | Sample |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 11.5 | | | 10.7 | 10.1 | 10.1 | 9.9 | 8.4 | 10.1 | 10.8 | 12.1 | 8.9 | 9.7 | 10.8 | 9.8 | 10.0 | 10.6 | **10.6** |
| 2007 | 11.6 | 10.1 | 9.7 | 9.2 | 9.7 | 10.0 | 10.0 | 8.0 | 10.3 | 10.7 | 12.4 | 8.7 | 9.7 | 10.7 | 10.0 | 10.1 | 10.2 | **10.3** |
| 2008 | 11.7 | 9.6 | 9.9 | | 9.8 | 10.1 | 9.7 | 7.8 | | 11.0 | 12.9 | 9.1 | 9.8 | 11.4 | 9.9 | 10.1 | 9.9 | **10.5** |

Source: based on data respective port authorities

With a total maritime container throughput of an estimated 90.7 million TEU in 2008, the European container port system ranks among the busiest container port systems in the world. Europe counts many ports. For example, there are about 130 seaports handling containers of which around 40 accommodate intercontinental container services (ESPO/ITMMA, 2007). In the US/Canada there are only 35 seaports involved in containerization and only 17 of them are involved in the deepsea container trades. Growth has been particularly strong in the last few years with an average annual growth rate of 10.5% in the period 2005-2007, compared to 6.8% in the period 1985-1995, 8.9% in 1995-2000 and 7.7% in 2000-2005. The economic crisis which started to have its full effect in late 2008 has made an end to the steep growth curve. Figures for 2008 based on 78 European container ports show that total container throughput increased from 82.5 million TEU in 2007 to 83.2 million TEU in 2008 or a growth of 'only' 0.8% (figure 2.1).

The container ports in the Hamburg-Le Havre range handle about half of the total European container throughput. The market share of the Mediterranean ports grew significantly between the late 1980s and the late 1990s at the expense of the ports in the Hamburg-Le Havre range. In the new millennium, the position of the northern range has gradually improved while the Med ports and the UK port system lost market share. The Baltic and the Black Sea have strengthened their traffic position (figure 2.2). The growth path of each of the port groups is also depicted in figure 2.3. The significant improvement of the market share of the Med is mainly the result of the insertion of transhipment hubs in the region since the mid 1990s.

It is useful to examine the volume of container shifts among port groups in order to get a more detailed insight in throughput dynamics. The net shift analysis provides a good tool for measuring container shifts. A net shift of zero would mean that the port or port group would have the same growth rate as the total seaport system. Figure 2.4 represents the results of the net shift analysis applied to the European port system for eight consecutive periods. The average annual net shift figures for the port groups indicate a gain (positive sign) or a loss (negative sign) of 'potential' container traffic i.e. compared to the situation under which the considered port group would have grown at the same average growth rate as the total European port system. Figure 2.4 confirms earlier findings: growth in the Med ports and the UK ports is lagging behind in the last three periods of observation, while the Hamburg-Le Havre range and the Baltic show significant positive net shifts.

*Table 2.2: The top 15 European container ports (1985-2008, in 1000 TEU)*

*in 1000 TEU*

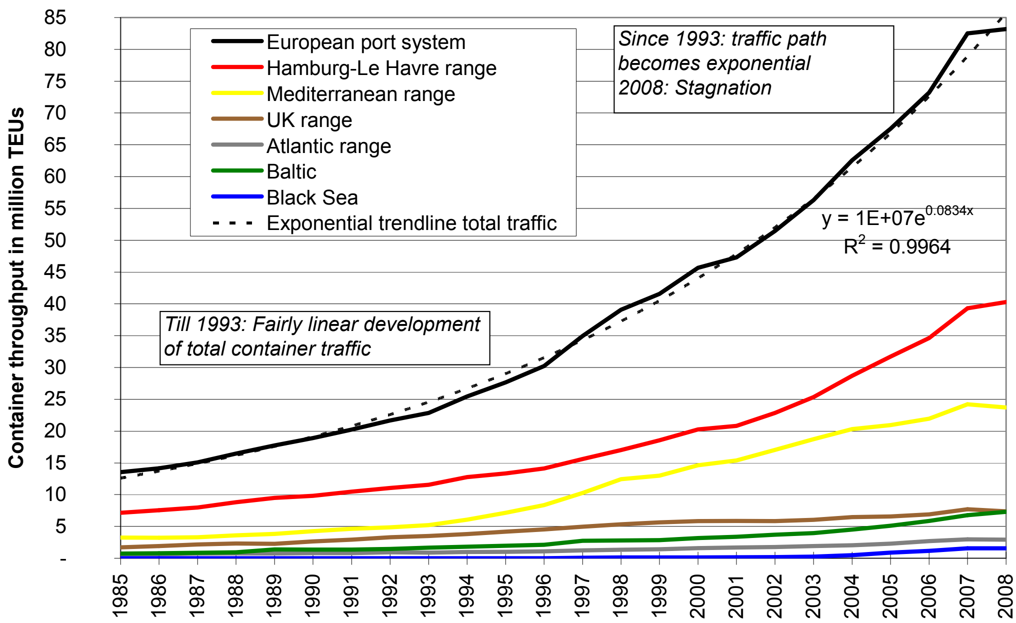
| *R* | | 1985 | | 1995 | | 2000 | | 2005 | | 2006 | | 2007 | | 2008 | *R* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *1* | Rotterdam | 2655 | Rotterdam | 4787 | Rotterdam | 6275 | Rotterdam | 9287 | Rotterdam | 9690 | Rotterdam | 10791 | Rotterdam | 10784 | *1* |
| *2* | Antwerp | 1243 | Hamburg | 2890 | Hamburg | 4248 | Hamburg | 8088 | Hamburg | 8862 | Hamburg | 9890 | Hamburg | 9737 | *2* |
| *3* | Hamburg | 1159 | Antwerp | 2329 | Antwerpen | 4082 | Antwerpen | 6488 | Antwerpen | 7019 | Antwerpen | 8177 | Antwerpen | 8664 | *3* |
| *4* | Bremen | 986 | Felixstowe | 1924 | Felixstowe | 2793 | Bremen | 3736 | Bremen | 4450 | Bremen | 4892 | Bremen | 5448 | *4* |
| *5* | Felixstowe | 726 | Bremen | 1518 | Bremen | 2752 | Gioia Tauro | 3161 | Algeciras | 3245 | Gioia Tauro | 3445 | Valencia | 3597 | *5* |
| *6* | Le Havre | 566 | Algeciras | 1155 | Gioia Tauro | 2653 | Algeciras | 2937 | Felixstowe | 3080 | Algeciras | 3420 | Gioia Tauro | 3468 | *6* |
| *7* | Marseille | 488 | Le Havre | 970 | Algeciras | 2009 | Felixstowe | 2700 | Gioia Tauro | 2938 | Felixstowe | 3343 | Algeciras | 3324 | *7* |
| *8* | Leghorn | 475 | La spezia | 965 | Genoa | 1501 | Le Havre | 2287 | Valencia | 2612 | Valencia | 3043 | Felixstowe (*) | 3200 | *8* |
| *9* | Tilbury | 387 | Barcelona | 689 | Le Havre | 1465 | Valencia | 2100 | Barcelona | 2317 | Le Havre | 2638 | Barcelona | 2569 | *9* |
| *10* | Barcelona | 353 | Southampton | 683 | Barcelona | 1388 | Barcelona | 2096 | Le Havre | 2310 | Barcelona | 2610 | Le Havre | 2500 | *10* |
| *11* | Algeciras | 351 | Valencia | 672 | Valencia | 1310 | Genoa | 1625 | Genoa | 1657 | Zeebrugge | 2021 | Marsaxlokk | 2337 | *11* |
| *12* | Genoa | 324 | Genoa | 615 | Piraeus | 1161 | Piraeus | 1450 | Zeebrugge | 1653 | Marsaxlokk | 1900 | Zeebrugge | 2210 | *12* |
| *13* | Valencia | 305 | Piraeus | 600 | Southampton | 1064 | Marsaxlokk | 1408 | Southampton | 1500 | Southampton | 1869 | Genoa | 1767 | *13* |
| *14* | Zeebrugge | 218 | Zeebrugge | 528 | Marsaxlokk | 1033 | Southampton | 1395 | Marsaxlokk | 1485 | Genoa | 1855 | Southampton (*) | 1710 | *14* |
| *15* | Southhampton | 214 | Marsaxlokk | 515 | Zeebrugge | 965 | Zeebrugge | 1309 | Piraeus | 1399 | Constanza | 1411 | Constanza | 1380 | *15* |
| | TOP 15 | 10450 | TOP 15 | 20841 | TOP 15 | 34698 | TOP 15 | 50067 | TOP 15 | 54217 | TOP 15 | 61305 | TOP 15 | 62695 | |
| | TOTAL Europe | 17172 | TOTAL Europe | 33280 | TOTAL Europe | 51000 | TOTAL Europe | 73729 | TOTAL Europe | 79840 | TOTAL Europe | 89990 | TOTAL Europe | 90710 | |
| | *Share R'dam* | *15%* | *Share R'dam* | *14%* | *Share R'dam* | *12%* | *Share R'dam* | *13%* | *Share R'dam* | *12%* | *Share R'dam* | *12%* | *Share R'dam* | *12%* | |
| | *Share top 3* | *29%* | *Share top 3* | *30%* | *Share top 3* | *29%* | *Share top 3* | *32%* | *Share top 3* | *32%* | *Share top 3* | *32%* | *Share top 3* | *32%* | |
| | *Share top 10* | *53%* | *Share top 10* | *54%* | *Share top 10* | *57%* | *Share top 10* | *58%* | *Share top 10* | *58%* | *Share top 10* | *58%* | *Share top 10* | *59%* | |
| | *Share top 15* | *61%* | *Share top 15* | *63%* | *Share top 15* | *68%* | *Share top 15* | *68%* | *Share top 15* | *68%* | *Share top 15* | *68%* | *Share top 15* | *69%* | |

(*) Estimate

Source: based on traffic data respective port authorities

Table 2.2 provides an overview of the fifteen largest container load centres in Europe. A number of these ports act as almost pure transhipment hubs with a transhipment incidence of 75% or more (i.e. Gioia Tauro, Marsaxlokk, Algeciras) while other load centres can be considered as almost pure gateways (e.g. Genoa and Barcelona to name but a few) or a combination of a dominant gateway function with sea-sea transhipment activities (e.g. Hamburg, Rotterdam, Le Havre, Antwerp). About 69% of the total container throughput in the European port system passes through the top fifteen load centres, compared to 61% in 1985. One third of all containers is handled by the top three ports, whereas this figure was 29% in 1985. These figures suggest an increasing concentration of cargo in only a dozen large container ports. Later in this report, this conclusion will be put in a better perspective. Worth mentioning is that the dominance of market leader Rotterdam has somewhat weakened.

*Figure 2.1: Container throughput in the European container port system (78 ports)*




Notes:
(a) The UK range mainly includes container ports on the Southeast and East coast
(b) The Black Sea only includes the ports at the west coast (Romania and Bulgaria)
(c) The Mediterranean only includes ports in member states of the European Union

*Source: compilation based on traffic data respective port authorities*

*Figure 2.2: Market shares in the European container port system*

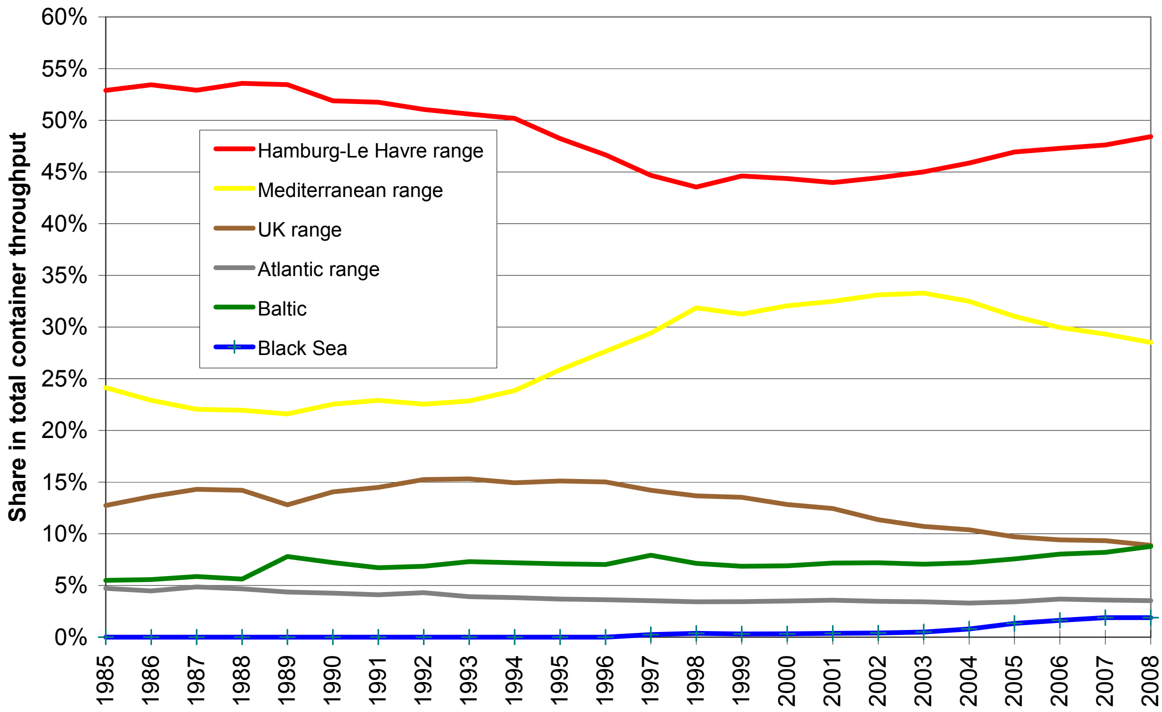



*Figure 2.3: Evolution in container growth and market share (moving averages for three year periods)*

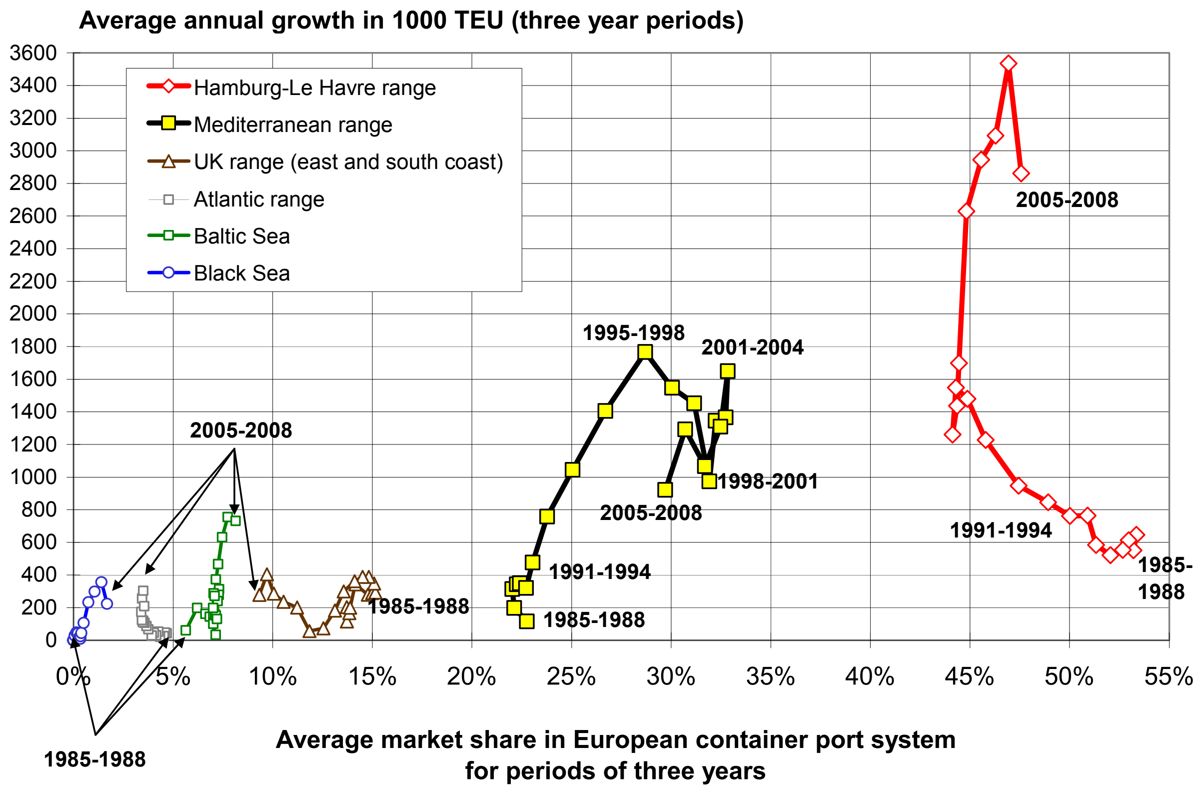
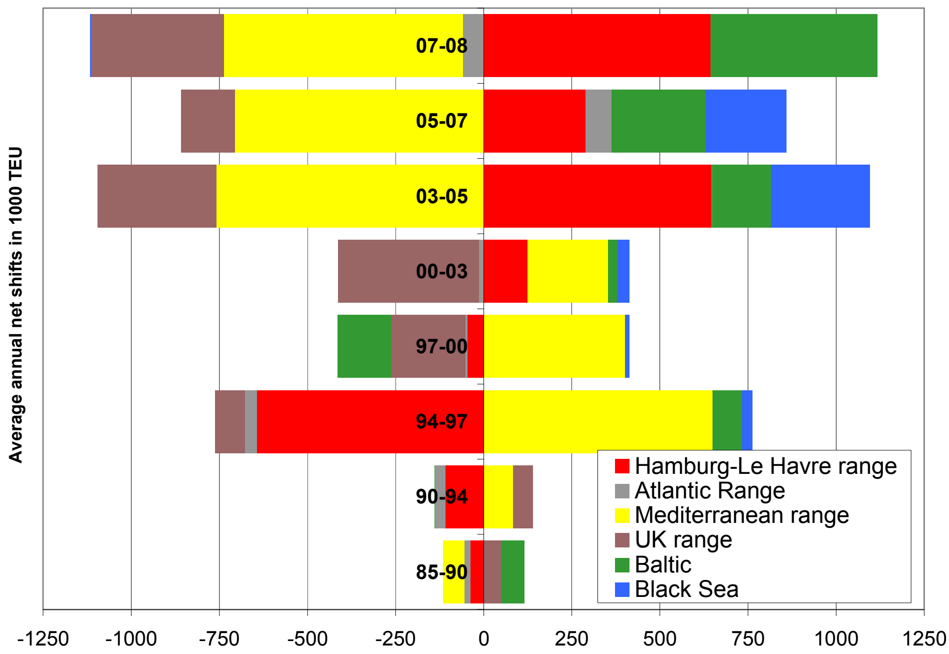


*Figure 2.4: Average annual net shifts in the European port system*




## 2.1.2. Container throughput dynamics for port regions in Europe

Comparisons of container throughput figures are typically based on individual ports. This might be misleading when analyzing the gateway function of specific port regions in Europe. An alternative approach consists in grouping seaports within the same gateway region together to form multi-port gateway regions. The locational relationship to nearby identical traffic hinterlands is one of the criteria that can be used to cluster adjacent seaports. In cases there is no coordination between the ports concerned, the hinterland is highly contestable as several neighboring gateways are vying for the same cargo flows.

It is argued that container throughput dynamics in Europe can best be analyzed by using multi-port gateway regions as units of analysis, and not the broader port groupings as presented in the previous section. The relevance of the multi-port gateway level is supported by the liner shipping networks as developed by shipping lines and the communality in hinterland connectivity issues among ports of the same multi-port gateway region. A further elaboration on these two issues will follow in the market based approach of liner services and hinterland networks further in this report.

Figure 2.5 provides an overview of the main multi-port gateway regions in Europe as well as transhipment hubs and stand-alone gateways. Stand-alone gateways are somewhat isolated in the broader port system, as they have less strong functional interactions with adjacent ports than ports of the same multi-port gateway regions. The following conclusions can be drawn on the basis of figures 2.6 to 2.9 and table 2.3:

- The extended Rhine-Scheldt Delta and the Helgoland Bay ports, both part of the Le Havre-Hamburg range, together represent 44.3% of the total European container throughput in 2008. The market share of the Rhine-Scheldt Delta is quite stable in the last 10 years (about 25-26%) with Rotterdam slightly losing market share in favour of Antwerp, Zeebrugge and newcomer Amsterdam. The North-German ports have gained market share from 14% in the late 1990s to 18.3% in 2008. Bremerhaven's recent volume surge and Hamburg's pivotal role in feeder flows to the Baltic and land-based flows to the developing economies in East and Central Europe are the main causes.

- The Seine Estuary, the third region in the Le Havre-Hamburg range, suffers from a gradual decline in its market share from 5.5% in 1989 to 3.2% in 2008. The 'Port 2000' terminals in Le Havre, a new hinterland strategy and the ongoing port reform process should support a 'renaissance' of Le Havre. Le Havre's strategy goes hand and hand with the ambition of the port to stretch its hinterland reach beyond the Seine basin (its core hinterland) and even across the French border, mainly supported by rail services.

- Among the major winners, we find the Spanish Med ports (from 4% in 1993 to 7.5% in 2008) and the Black Sea ports (from virtually no traffic to a market share of 1.9% in 2008). These ports have particularly benefited from the extension of the Blue Banana (see later in this report for a more detailed analysis).

- In the last couple of years, the ports in the Bay of Gdansk are witnessing a healthy growth and an increasing market share (now 1% compared to 0.5% five years ago). The Polish load centres are still bound by their feeder port status, competing with main port Hamburg for the Polish hinterland.

- The ports at the entrance of the Baltic and Portuguese port system have a more modest growth path. Portuguese ports Lisbon, Leixoes and Sines are trying very hard to expand business by developing a transhipment role (e.g. MSC in Sines) as well as tapping into the Spanish market (particularly the Madrid area) through rail corridor formation and dry port development. After a long period of declining market shares, the Portugese port system has succeeded to stabilize its share at around 1.5%. Similarly, the ports alongside the Kattegat and The Sound show a stable market share of 2.2% since five years after a period of a declining market share.

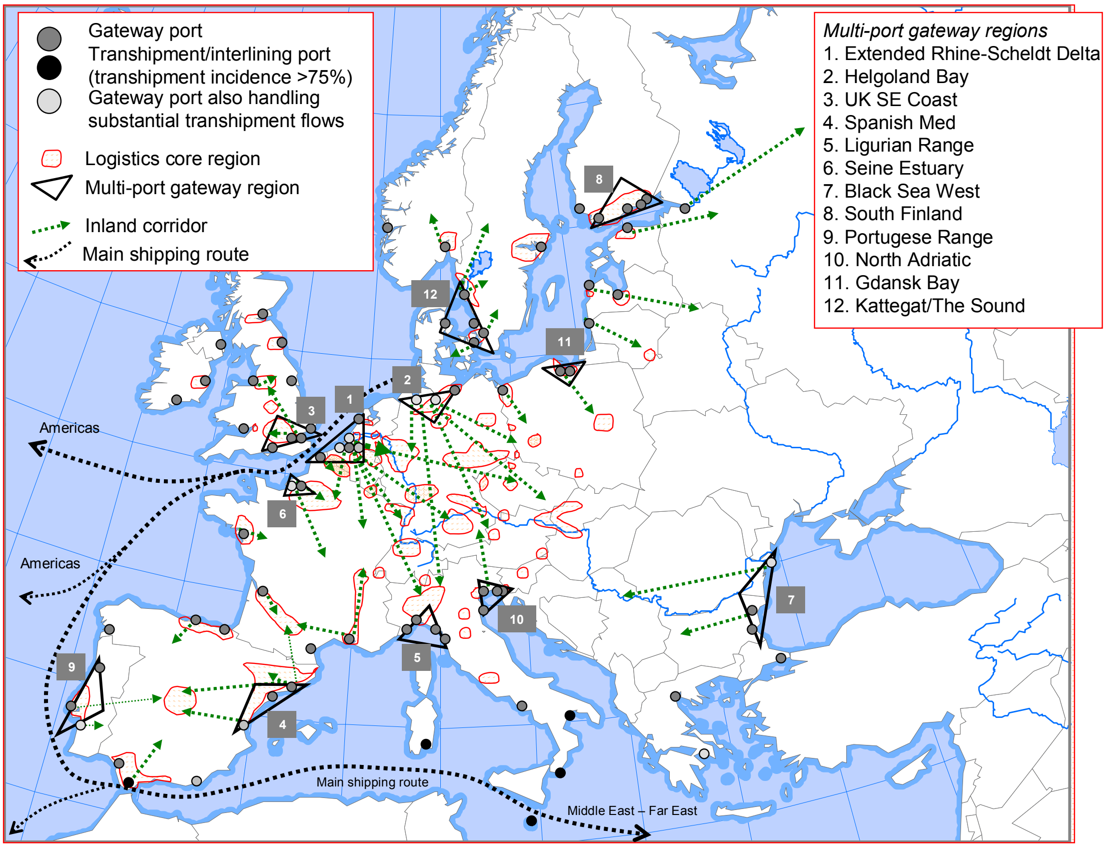
- The Ligurian ports have difficulties in keeping up with other regions in Europe. The ports jointly represent some 4.9% of the total European port volume, a decline compared to 6-7% throughout the 1980s and 1990s. The Ligurian ports rely heavily on the economic centres in northern Italy and also aim at attracting business from the Alpine region, the southeast of France and southern Germany.

- Just like the Ligurian ports, the North-Adriatic ports have been facing lower than average growth rates. However, in the last couple of years the tide seems to have turned. The recent cooperation agreement among the ports of Koper, Venice, Trieste and Ravenna underlines the ambition of the region to develop a gateway function to Eastern and Central Europe and the Alpine region. The strategy should also enable the region to develop larger scale container operations. With nearly 1.3 million TEU in 2008 the Adriatic ports only handle a fraction of the volumes of the two leading multi-port gateway regions of the Hamburg-Le Havre range.

- The UK ports witnessed a rather significant decrease in market share. Many of the load centres along the southeast coast of the United Kingdom faced capacity shortages in recent years. Quite a number of shipping lines opted for the transhipment of UK flows in mainland European ports (mainly Rhine-Scheldt delta and Le Havre) instead of calling at UK ports directly. With the prospect of new capacity getting on stream (e.g. London Gateway, Great Yarmouth and Teesport) there is hope for more direct calls and potentially a (slight) increase in market share. Much will depend on whether the UK and Irish economies regain their strength.

- In the Mediterranean, extensive hub-feeder container systems and shortsea shipping networks emerged since the mid 1990s to cope with the increasing volumes and to connect to other European port regions. The transhipment hubs in the Mediterranean have substantially increased their role in the container market. After a steep increase of the market share from 4.9% in 1993 to 14.3% in 2004, the last few years have brought a small decline to 12.2%. This decline came as volume growth in mainland Med ports allowed shipping lines to shift to more direct calls.

*Figure 2.5: The European container port system and logistics core regions in the hinterland*




*Source: ITMMA*

*Figure 2.6: Container throughput evolution, 1985-2008, in million TEU*

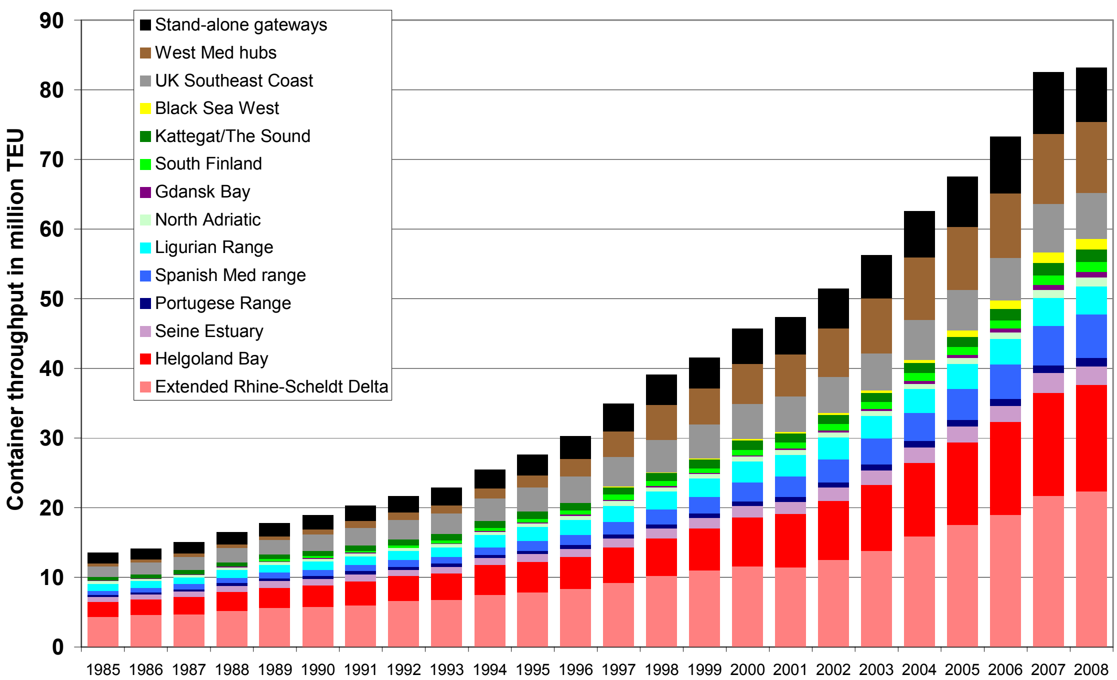


*Table 2.3: Container throughput figures (1985-2008, in 1000 TEU)*

| R | | 1985 | | 1995 | | 2000 | | 2005 | | 2006 | | 2007 | | 2008 | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Main multi-port gateway regions in Europe*** | | | | | | | | | | | | | | | |
| *1* | Extended RS Delta | 4312 | Extended RS Delta | 7818 | Extended RS Delta | 11536 | Extended RS Delta | 17532 | Extended RS Delta | 18954 | Extended RS Delta | 21660 | Extended RS Delta | 22379 | *1* |
| *2* | Helgoland Bay | 2145 | Helgoland Bay | 4430 | Helgoland Bay | 7110 | Helgoland Bay | 11879 | Helgoland Bay | 13373 | Helgoland Bay | 14848 | Helgoland Bay | 15250 | *2* |
| *3* | UK Southeast Coast | 1508 | UK Southeast Coast | 3543 | UK Southeast Coast | 5080 | UK Southeast Coast | 5807 | UK Southeast Coast | 6146 | UK Southeast Coast | 6879 | UK Southeast Coast | 6568 | *3* |
| *4* | Ligurian Range | 986 | Ligurian Range | 2051 | Ligurian Range | 2949 | Spanish Med range | 4490 | Spanish Med range | 4942 | Spanish Med range | 5700 | Spanish Med range | 6214 | *4* |
| *5* | Seine Estuary | 701 | Spanish Med range | 1398 | Spanish Med range | 2742 | Ligurian Range | 3528 | Ligurian Range | 3683 | Ligurian Range | 4030 | Ligurian Range | 4045 | *5* |
| *6* | Spanish Med range | 676 | Seine Estuary | 1090 | Seine Estuary | 1610 | Seine Estuary | 2280 | Seine Estuary | 2303 | Seine Estuary | 2797 | Seine Estuary | 2642 | *6* |
| *7* | Kattegat/The Sound | 529 | Kattegat/The Sound | 986 | Kattegat/The Sound | 1389 | Kattegat/The Sound | 1666 | Kattegat/The Sound | 1778 | Kattegat/The Sound | 1969 | Kattegat/The Sound | 1796 | *7* |
| *8* | North Adriatic | 376 | South Finland | 562 | South Finland | 773 | South Finland | 1120 | South Finland | 1221 | Black Sea West | 1561 | Black Sea West | 1573 | *8* |
| *9* | Portugese Range | 266 | Portugese Range | 470 | North Adriatic | 692 | Portugese Range | 916 | Black Sea West | 1181 | South Finland | 1395 | South Finland | 1419 | *9* |
| *10* | Gdansk Bay | 83 | North Adriatic | 468 | Portugese Range | 670 | Black Sea West | 902 | Portugese Range | 1013 | Portugese Range | 1138 | North Adriatic | 1273 | *10* |
| *11* | Black Sea West | n.a. | Gdansk Bay | 142 | Gdansk Bay | 206 | North Adriatic | 842 | North Adriatic | 907 | North Adriatic | 1095 | Portugese Range | 1239 | *11* |
| *12* | South Finland | n.a. | Black Sea West | n.a. | Black Sea West | 150 | Gdansk Bay | 470 | Gdansk Bay | 540 | Gdansk Bay | 711 | Gdansk Bay | 796 | *12* |
| ***Transhipment/interlining hubs in West and Central Med*** | | | | | | | | | | | | | | | |
| | Med Hubs | 393 | Med Hubs | 1711 | Med Hubs | 5732 | Med Hubs | 9017 | Med Hubs | 9251 | Med Hubs | 10069 | Med Hubs | 10172 | |
| ***Some important stand-alone gateways ranking based on figures of 2008)*** | | | | | | | | | | | | | | | |
| | Marseille | 488 | Marseille | 498 | Marseille | 722 | Marseille | 906 | Marseille | 946 | Marseille | 1003 | Marseille | 848 | |
| | Liverpool | 133 | Liverpool | 406 | Liverpool | 540 | Liverpool | 612 | Liverpool | 613 | Liverpool | 675 | Liverpool | n.a. | |
| | Bilbao | 149 | Bilbao | 297 | Bilbao | 434 | Bilbao | 504 | Bilbao | 523 | Bilbao | 555 | Bilbao | 557 | |
| | Naples | 108 | Naples | 207 | Naples | 397 | Naples | 395 | Naples | 445 | Naples | 461 | Naples | 482 | |
| | Piraeus | 197 | Piraeus | 600 | Piraeus | 1161 | Piraeus | 1395 | Piraeus | 1403 | Piraeus | 1373 | Piraeus | 431 | |
| | Malaga | 5 | Malaga | 4 | Malaga | 4 | Malaga | 247 | Malaga | 465 | Malaga | 542 | Malaga | 429 | |
| | Klaipeda | 0 | Klaipeda | 30 | Klaipeda | 40 | Klaipeda | 214 | Klaipeda | 232 | Klaipeda | 321 | Klaipeda | 373 | |
| | Thessaloniki | 11 | Thessaloniki | 211 | Thessaloniki | 230 | Thessaloniki | 366 | Thessaloniki | 344 | Thessaloniki | 447 | Thessaloniki | 239 | |

(*) Estimate

**Notes:**
Extended Rhine-Scheldt Delta: Rotterdam, Antwerp, Zeebrugge, Amsterdam, Ghent, Zeeland Seaports, Ostend, Dunkirk
Helgoland Bay: Hamburg, Bremen/Bremerhaven, Cuxhaven, Emden, Wilhelmshaven
UK South East Coast: Felixstowe, Southampton, Thamesport, Tilbury, Hull
Spanish Med: Barcelona, Valencia, Tarragona
Ligurian range: Genoa, Savona, Leghorn, La Spezia
Seine Estuary: Le Havre, Rouen
Black Sea West: Constanza, Burgas, Varna
South Finland: Helsinki, Kotka, Rauma, Hamina, Turku
Portugese range: Lisbon, Leixoes, Sines
North Adriatic: Venice, Trieste, Ravenna, Koper
Gdansk Bay: Gdynia, Gdansk
Kattegat/The Sound: Goteborg, Malmo/Copenhagen, Helsingborg, Aarhus

*Figure 2.7: Average annual net shifts between container port regions in Europe*

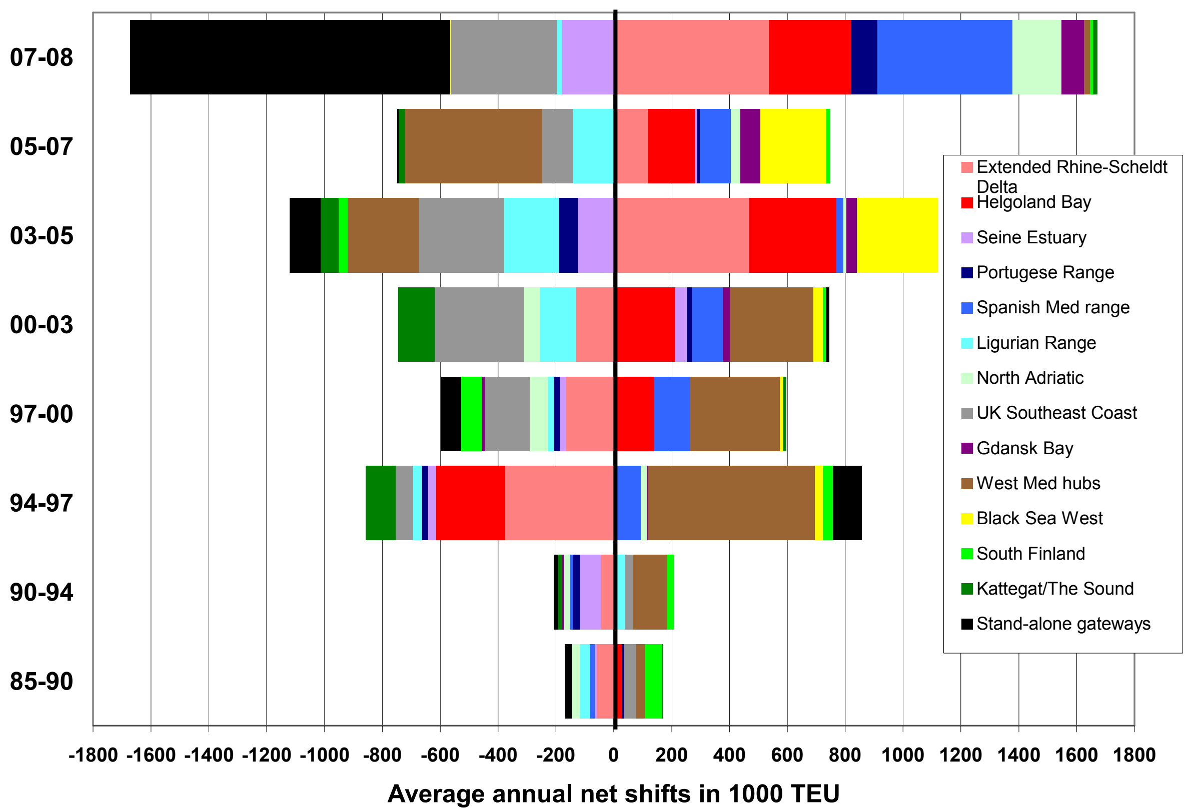


*Figure 2.8: Evolution in container growth and market share (moving averages for three year periods)*

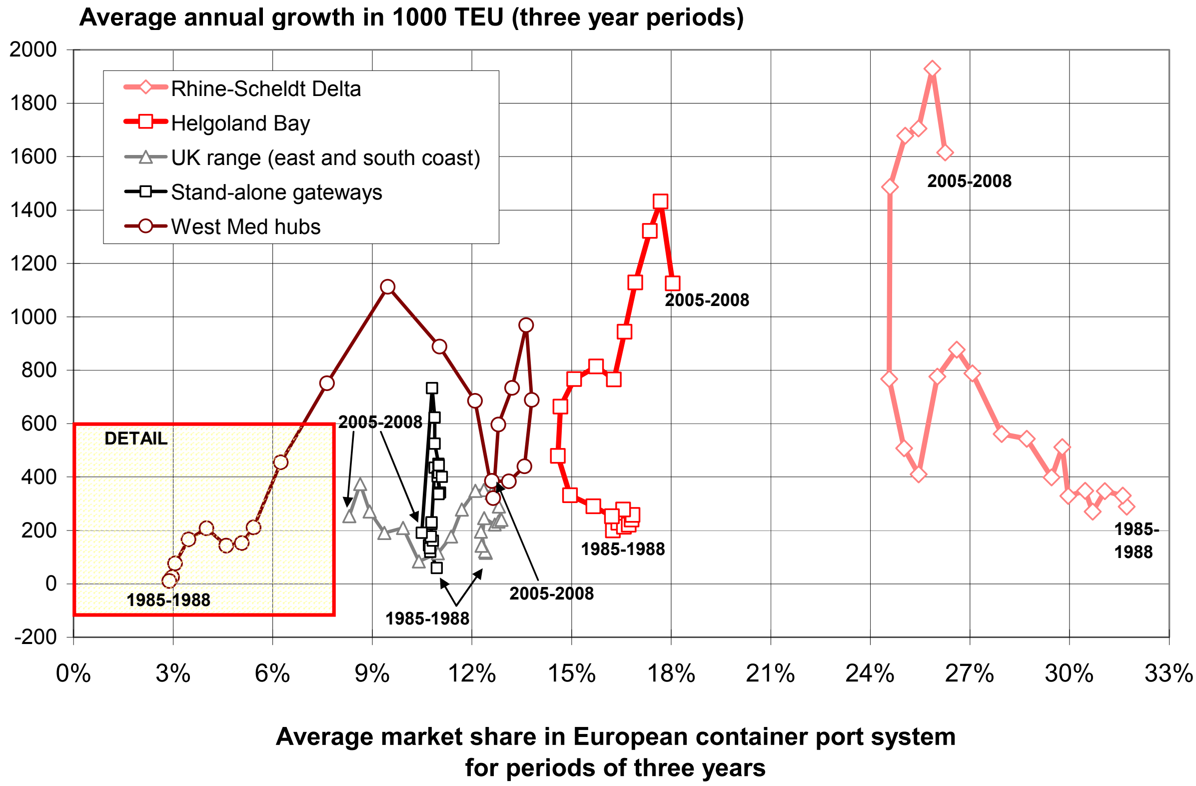
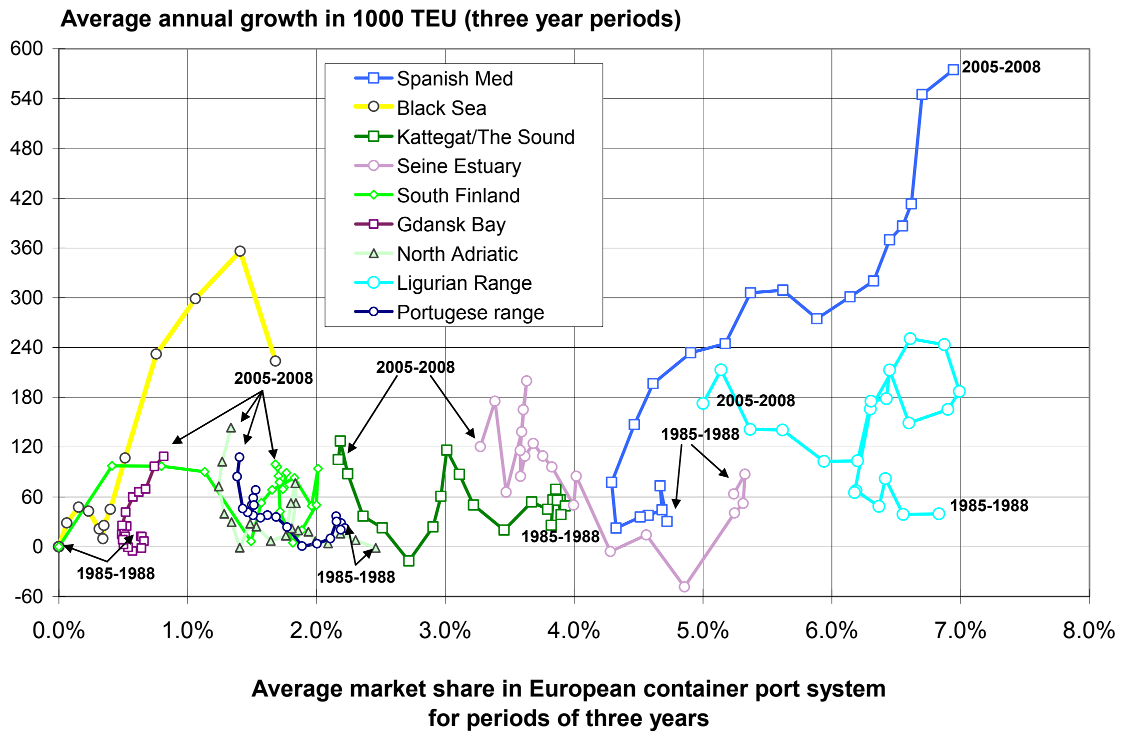


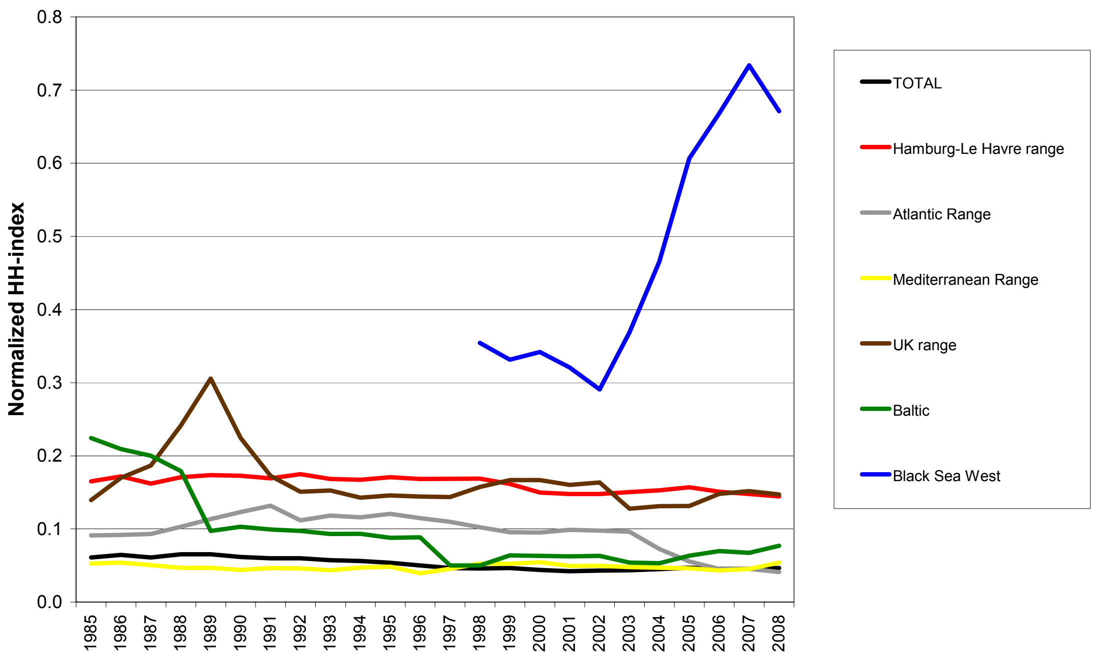

*Figure 2.9: Evolution in container growth and market share (moving averages for three year periods) - detail*



## 2.1.3. Cargo concentration patterns in the European container port system

In this section cargo concentration in the European container port system is analyzed at different levels: Europe as a whole, the ranges and the multi-port gateway systems. At the level of Europe as a whole, table 2.2 demonstrated that the top fifteen container ports handle about 69% of the total container throughput in the European port system (61% in 1985). One third of all containers is handled by the top three ports. These figures suggest an increasing concentration of cargo in only a dozen large container ports. However, this does not imply Europe counts fewer container ports than before. The European port scene is becoming more diverse in terms of the number of ports involved, leading to more routing options to shippers and to a lower concentration index (see the evolution in the 'normalized Hirschman-Herfindahl index'[1] for Europe as a whole in figure 2.10). It is however right to state that the largest ports have benefited slightly more from recent traffic growth. At the level of the ranges, it can be observed that most ranges are evolving towards a more evenly distributed system (lower normalized HH-index in figure 2.10). Only the Black Sea port system (western part) shows an elevated HH-index as a result of the difference in scale and growth path between Constanza and the neighbouring Bulgarian container ports.

*Figure 2.10: The evolution of the normalized Hirschman-Herfindahl index for the European port system as a whole and individual port ranges (1985-2008)*

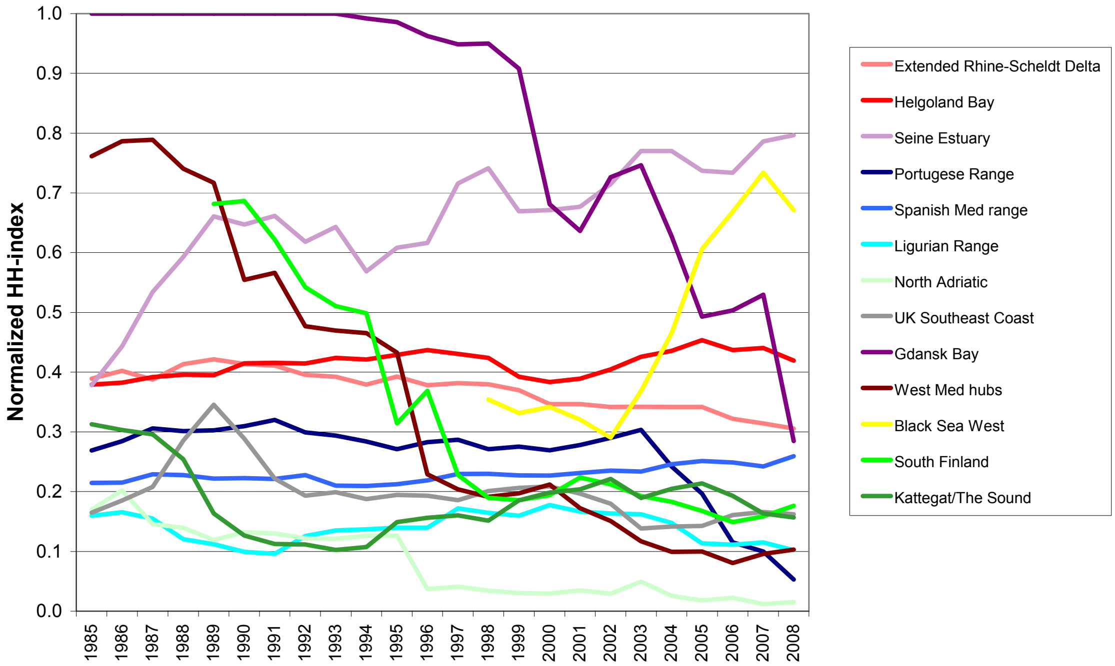



The dominance of ports in the Le Havre – Hamburg range (particularly the Rhine-Scheldt Delta and the Helgoland Bay) in Europe is very apparent when looking at throughput statistics (see earlier). This observation fuels a decades-old debate on what some observers call the traffic imbalance between North and South. After a period of strong Med growth, the throughput gap between the Le Havre—Hamburg range and the Med ports has been widening since five years, as demonstrated earlier in figure 2.2 and via the net shifts in figure 2.4. The increasing participation degree of mainland Mediterranean ports in international shipping networks has not resulted in significant traffic shifts from North to South. The joint market share of the Le Havre-Hamburg range ports in liner services between the Far East and Europe is estimated at 76%, compared to 24% for West Med ports. In the 1980s the Europe–Far East trade was still totally concentrated on Northern range ports.

[1] The Hirschman-Herfindahl index is a measure of concentration. We use the normalized HH-index. Whereas the HH-index ranges from 1/N to one (N being the number of ports), the normalized HH-index ranges from 0 to 1. A normalized HH-index below 0.1 indicates an unconcentrated port system. A normalized HH-index between 0.1 to 0.18 indicates moderate concentration. A normalized HH-index above 0.18 indicates high concentration. Figure 2.11 shows that only the Black Sea area is witnessing a high concentration.

The more local gateway function of mainland Med ports versus a sometimes European wide gateway position (including transhipment flows and land-based intermodal corridors) of ports such as Hamburg, Rotterdam and Antwerp is a major cause for the observed development. Later in this report, we will demonstrate that there are market-based drivers behind the observed patterns.

*Figure 2.11: The evolution of the normalized Hirschman-Herfindahl index for European port regions (1985-2008)*




However, the 'North versus South' discussion does not capture the existing divergence in the development of multi-port gateway regions in both parts of Europe. Hence, not all port regions in the Med are lagging behind the growth path of the Le Havre-Hamburg range (i.e. the Spanish ports are the major winners, while the Ligurian ports and some stand-alone gateways such as Marseille lose market share), and not all port regions in the Le Havre-Hamburg range show a very strong growth path (i.e. the Seine Estuary is losing market share). The geographical level of multi-port gateway regions provides a better basis for analyzing concentration dynamics in the European port system. Figure 2.11 depicts the evolution of the normalized HH-index for the 12 multi-port gateway regions as well as the Med transhipment hubs. The Black Sea region and the Seine Estuary are the only multi-port gateway regions showing a rather significant increase in cargo concentration level. The Spanish Med and the Helgoland Bay see a moderate rise in the HH-index. All other regions are getting more deconcentrated.

Many gateway regions in Europe have witnessed a recent multiplication of container ports or will witness a multiplication in the future. The main challengers in each gateway region are listed in the last column of table 2.4. Centripetal forces that support the entry of newcomers include (a) the new requirements related to deep-sea services (e.g. good maritime and inland accessibility, availability of terminal and back-up land and short vessel turnaround times), (b) the past strong growth in the container market and (c) potential diseconomies of scale in the existing seaports in the form of lack of space for further expansion or congestion. The markets also exert a range of centrifugal forces favouring a sustained strong position of established large load centers vis-à-vis medium-sized and new terminals. First, the planned additional terminal supply in small and medium-sized ports is typically overshadowed by massive expansion plans in established larger seaports. Second, new entrants in the terminal market often have to overcome major issues such as securing hinterland services and a weaker cargo-generating and cargo-binding potential (typically as a result of a lack of associated forwarders' and agents' networks). New transhipment hubs generally face less of these problems given their remote locations, their weak reliance on hinterland connectivity and their strong link with one or few shipping line(s) that will use the facilities as turntables in their liner networks (operational push instead of market pull).

Table 2.4: Market share of the leader port in each multi-port gateway region (in %)

| | 1985 | 1995 | 2005 | 2008 | Trend for market share of leader | Main challengers in the periphery |
|---|---|---|---|---|---|---|
| Extended RS Delta | 61.6 | 61.2 | 53.0 | 48.2 | Decreasing, leader unchanged (Rotterdam) | Zeebrugge (+), Amsterdam (-) Flushing (°/?), Dunkirk (-) |
| Helgoland Bay | 54.0 | 65.2 | 68.1 | 63.8 | Fluctuation, leader unchanged (Hamburg) | Wilhelmshaven (°), Cuxhaven (x) |
| UK SE Coast | 48.1 | 54.3 | 47.5 | 48.7 | Fluctuation, leader unchanged (Felixstowe) | London Gateway (°), Bathside Bay-Harwich (°) Dibden Bay (X), Teesport (?), Great Yarmouth (°) |
| Spanish Med | 52.2 | 49.3 | 53.7 | 57.9 | Recent increase, change in leader (Valencia overtook Barc.) | - |
| Ligurian Range | 48.2 | 47.1 | 46.1 | 43.7 | Decreasing, change in leader (Genoa overtook La Spezia) | - |
| Seine Estuary | 80.8 | 89.0 | 92.9 | 94.6 | Increasing, leader unchanged (Le Havre) | - |
| Black Sea West | n.a. | 68.6 | 85.2 | 87.8 | Increasing, leader unchanged (Constanza) | - |
| Kattegat/The Sound | 59.9 | 46.8 | 53.2 | 48.0 | Fluctuation, leader unchanged (Gotheborg) | - |
| South Finland | n.a. | 60.3 | 41.0 | 44.2 | Fluctuation, change in leader (Kotka overtook Helsinki) | Kotka (+) |
| Portugese Range | 57.9 | 58.4 | 56.0 | 44.9 | Recent decrease, leader unchanged (Lisbon) | Sines (+) |
| North Adriatic | 50.5 | 41.3 | 34.8 | 29.8 | Decreasing, change in leader (Venice overtook Ravenna) | Trieste (+), Koper (+) |
| Gdansk Bay | 100.0 | 99.6 | 85.1 | 76.7 | Decreasing, leader unchanged (Gdynia) | - |
| Med transhipment hubs | 89.3 | 67.5 | 35.3 | 34.1 | Decreasing, change in leader (Gioia Tauro overtook Algeciras) | |

(+) (some) terminal(s) already in operation; strong results
(-) (some) terminal(s) already in operation; moderate results
(°) Terminal under construction
(?) No container terminal yet, planning phase
(x) Container terminal was planned, but plans abandonned or rejected

Source: based on data respective port authorities and specialized press

## 2.2. Roro traffic in the European port system

Broadly speaking, the RoRo market encompasses four main sub-markets. Firstly, there is the deepsea segment which can be divided into car carrying trades and regular liner trades with RoRo-facilities. Secondly, we have the shortsea segment which can be divided into ferry transport for both passengers (with cars) and rolling freight on the one hand, and freight-only RoRo transport (including containers on mafis) on the other.

Many ferry operators have felt the need to substitute passenger space for freight space onboard their vessels. Hence, the general tendency in today's ferry market is clear – an increasing focus on freight (which has indeed now become the main revenue for most ferry operators in Europe) rather than passengers. Having said this, however, passenger transport still remains a very important business for certain ferry operators on certain markets. A prime example of this is the Sweden-Finland link. Another exception to the increasing focus on freight is formed by the so-called "cruise ferries" which only carry about 1300-1500 lanemetre of freight. In addition to the big markets on the English Channel and the Baltic also the Mediterranean is an important market, which has witnessed a tonnage rejuvenation in recent years. The traffic is very much "North-South" oriented rather than "East-West", with large ferries being deployed on services linking e.g. Northern Italy with Sicily, Italy with Greece, and France with Corsica or North Africa.

The market for unaccompanied freight transport is of crucial importance to many ports in Scandinavia, through which substantial volumes of paper and forest products from local manufacturers (such as Stora Enso, UPM Kymmene, SCA or Norske Skog) are exported. Many of these export cargoes are loaded on mafis and then transported via RoRo vessels to destinations all across Europe. Another major market for unaccompanied RoRo freight transport is the North Sea, for example from Benelux ports (Rotterdam (Europoort and Hoek van Holland), Flushing, Zeebrugge and Ostend) to ports along the Humber and Thames (Hull, Killingholme, Dartford, Purfleet, Dagenham and Immingham). Other important UK ports are the so-called "Haven Ports" of Felixstowe (Norfolkline), Harwich (Stena Line) and Ipswich (Ferryways). On the North Sea market, containerized cargo is playing an increasingly important role. Without a doubt, the container will increase its penetration on other trade routes than the North Sea as well. The market between North Europe and the Mediterranean remains a difficult market for unaccompanied RoRo transport, due to the fierce competition from road transport. Finally we have the intra-Mediterranean market, but this market is nowadays more focused towards RoPax vessels, while trailer transport is only of secondary importance.

Figure 2.12 and tables 2.5 and 2.6 present the main roro port groups and main roro ports in Europe. The tables were drawn from a large Eurostat database containing about 260 ports handling RoRo traffic, for a total throughput of 447 million tons in 2006. The total figures for 2007 are not available as Eurostat has not received statistics for all ports yet. As can be seen from table 2.6, ports in the United Kingdom/Ireland handled 114 million tons of RoRo traffic in 2006, i.e. about one quarter of the total RoRo traffic handled in European seaports. With a total traffic of more 125 million tons, the Baltic is the main import/export region for RoRo cargo in Europe, with most of the volumes concentrated on the entrance of the Baltic (i.e. Kattegat and The Sound as well as the German ports in the Baltic). Other important players on the European RoRo handling scene are the English Channel and the western part of Italy.

*Figure 2.12: Roro port groups in the European port system*

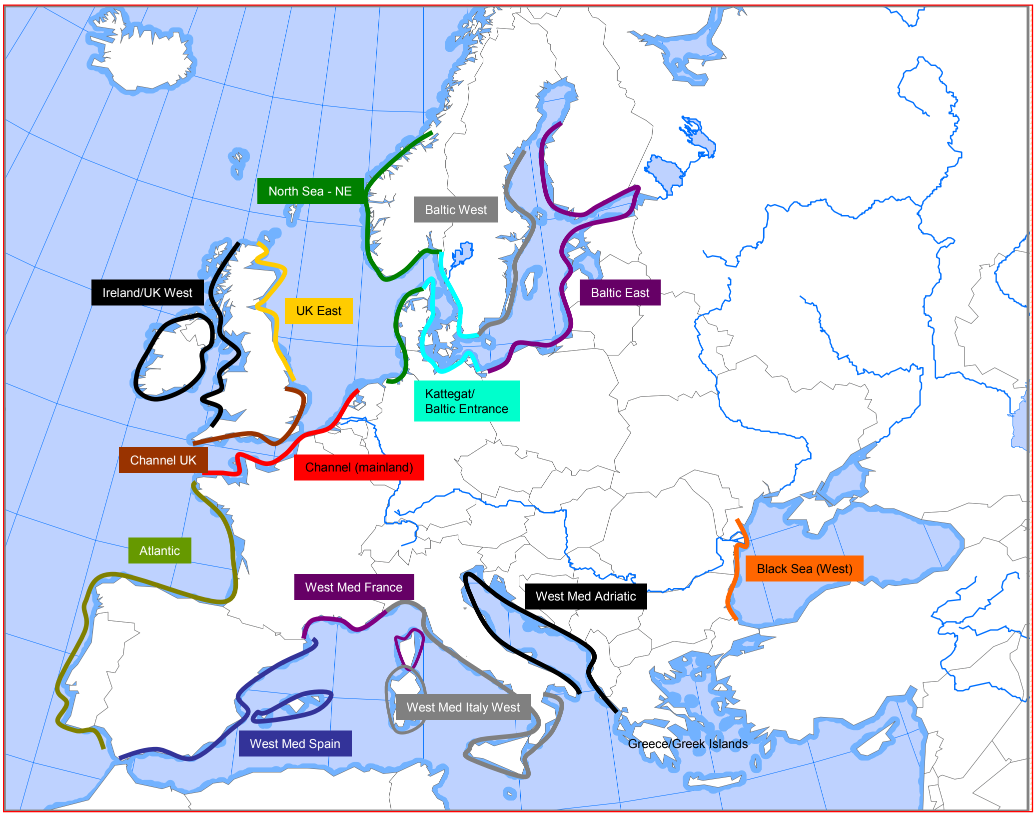



*Table 2.5: Top 20 Roro ports in Europe*

*in tons*

| R | Port | Region | 2005 | 2006 | 2007 | Market share 06 |
|---|---|---|---|---|---|---|
| 1 | Dover | Channel (UK) | 20,665,170 | 23,354,523 | 24,598,350 | 5.2% |
| 2 | Calais | Channel (mainland) | 16,555,458 | 18,489,151 | 18,310,024 | 4.1% |
| 3 | Lübeck | Kattegat/Baltic Entrance | 15,712,290 | 16,968,292 | 17,659,433 | 3.8% |
| 4 | Zeebrugge | Channel (mainland) | 16,006,410 | 16,873,582 | 18,167,938 | 3.8% |
| 5 | Immingham | UK East | 12,680,109 | 14,048,374 | 14,288,712 | 3.1% |
| 6 | Göteborg | Kattegat/Baltic Entrance | 10,197,301 | 12,017,356 | 12,925,595 | 2.7% |
| 7 | Trelleborg | Kattegat/Baltic Entrance | 10,557,588 | 11,205,119 | 12,580,060 | 2.5% |
| 8 | Dunkerque | Channel (mainland) | 8,853,000 | 11,091,142 | | 2.5% |
| 9 | Rotterdam | Channel (mainland) | 10,980,792 | 10,837,161 | 9,704,315 | 2.4% |
| 10 | London | Channel (UK) | 8,990,373 | 9,035,415 | 8,909,156 | 2.0% |
| 11 | Dublin | Ireland/West UK | 8,363,531 | 8,943,694 | 9,442,471 | 2.0% |
| 12 | Rostock | Kattegat/Baltic Entrance | 7,181,284 | 7,880,188 | 8,361,050 | 1.8% |
| 13 | Genova | West-Med-Italy West | 7,336,492 | 7,796,509 | | 1.7% |
| 14 | Palma Mallorca | West Med-Spain | 7,204,997 | 7,504,345 | 3,928,176 | 1.7% |
| 15 | Liverpool | Ireland/West UK | 6,223,535 | 6,734,603 | 6,636,723 | 1.5% |
| 16 | Oostende | Channel (mainland) | 6,187,768 | 6,289,604 | 6,770,298 | 1.4% |
| 17 | Livorno | West-Med-Italy West | 6,767,221 | 6,144,820 | | 1.4% |
| 18 | Rødby (Færgehavn) | Kattegat/Baltic Entrance | 5,240,900 | 5,755,100 | 6,437,500 | 1.3% |
| 19 | Helsinki | Baltic East | 5,034,684 | 5,616,599 | 7,297,318 | 1.3% |
| 20 | Antwerp | Channel (mainland) | 5,378,064 | 5,497,731 | 6,334,871 | 1.2% |
| | TOP 20 | | 196,116,967 | 212,083,308 | | |
| | TOTAL EUROPE | | 425,244,250 | 447,648,070 | | |
| | *Share Dover* | | *4.9%* | *5.2%* | | |
| | *Share top 3* | | *12.4%* | *13.1%* | | |
| | *Share top 10* | | *26.0%* | *26.9%* | | |
| | *Share top 20* | | *46.1%* | *47.4%* | | |

*Table 2.6: Roro traffic and market share per port group*

| Region | 2005 | 2006 | Market share 06 |
|---|---|---|---|
| Atlantic | 3,971,774 | 3,346,750 | 0.7% |
| Baltic East | 23,737,563 | 24,798,721 | 5.5% |
| Baltic West | 8,326,016 | 9,045,236 | 2.0% |
| Kattegat/Baltic Entrance | 84,348,193 | 91,648,773 | 20.5% |
| Channel (mainland) | 77,056,445 | 83,268,203 | 18.6% |
| North Sea Northeast | 15,388,291 | 16,912,087 | 3.8% |
| West Med-France | 4,261,587 | 4,648,627 | 1.0% |
| West Med-Spain | 15,088,892 | 15,890,908 | 3.5% |
| West-Med-Adriatic | 9,877,516 | 9,721,164 | 2.2% |
| West-Med-Italy West | 39,987,469 | 42,234,544 | 9.4% |
| Greece/Greek Islands | 22,848,056 | 23,640,384 | 5.3% |
| East Med | 223,565 | 276,006 | 0.1% |
| Channel (UK) | 47,225,324 | 49,492,822 | 11.1% |
| Ireland/West UK | 44,622,677 | 43,447,295 | 9.7% |
| UK East | 19,479,623 | 21,264,193 | 4.8% |
| Black Sea | 752,745 | 596,423 | 0.1% |
| **Subtotal** | **417,195,736** | **440,232,136** | **98.3%** |
| Non-specified | 8,048,514 | 7,415,934 | 1.7% |
| **Total** | **425,244,250** | **447,648,070** | **100.0%** |

| Region | 2005 | 2006 | Market share 06 |
|---|---|---|---|
| Atlantic | 3,971,774 | 3,346,750 | 0.8% |
| Baltic | 116,411,772 | 125,492,730 | 28.5% |
| North Sea/Channel | 92,444,736 | 100,180,290 | 22.8% |
| Med | 92,287,085 | 96,411,633 | 21.9% |
| UK/Ireland | 111,327,624 | 114,204,310 | 25.9% |
| Black Sea | 752,745 | 596,423 | 0.1% |
| **Subtotal** | **417,195,736** | **440,232,136** | **98.3%** |
| Non-specified | 8,048,514 | 7,415,934 | 1.7% |
| **Total** | **425,244,250** | **447,648,070** | **100.0%** |

Source: based on data Eurostat

*Table 2.7: Normalized HH-index for roro port groups*

| Region | 2005 | 2006 |
|---|---|---|
| Atlantic | 0.10 | 0.05 |
| Baltic East | 0.07 | 0.07 |
| Baltic West | 0.09 | 0.08 |
| Kattegat/Baltic Entrance | 0.05 | 0.05 |
| Channel (mainland) | 0.08 | 0.08 |
| North Sea Northeast | 0.03 | 0.03 |
| West Med-France | 0.59 | 0.59 |
| West Med-Spain | 0.22 | 0.24 |
| West-Med-Adriatic | 0.10 | 0.13 |
| West-Med-Italy West | 0.04 | 0.04 |
| Greece/Greek Islands | 0.04 | 0.05 |
| East Med | 0.78 | 0.85 |
| Channel (UK) | 0.18 | 0.21 |
| Ireland/West UK | 0.04 | 0.05 |
| UK East | 0.31 | 0.32 |
| Black Sea | 0.19 | 0.21 |

On an individual port basis, the biggest RoRo port in Europe is Dover, with a total traffic of 24.5 million tons in 2007 (table 2.5). This represents about 5% of the combined RoRo throughput of the 260 ports in the Eurostat database. Other major RoRo ports, handling more than 10 million tons per year, include Calais (France), Zeebrugge (Belgium), Lübeck (Germany), Immingham (UK), Rotterdam (the Netherlands), Dunkirk (France), Trelleborg and Göteborg (Sweden). At the other end of the spectrum, more than 160 European seaports handled less than 1 million tons of RoRo traffic in 2006. Compared to the container business, the roro volumes are much more dispersed over the European port system. The top 10 roro ports represent 26.9% of the total European roro volumes (table 2.5). In containerized trades, the share of the top 10 ports amounts to an elevated 59%. The normalized HH-index in table 2.7 demonstrates that the cargo concentration levels are typically very low. The only port groups with a high concentration level include the east coast of the UK (dominated by Immingham), the Spanish ports in the Med (dominance of Palma de Mallorca and Barcelona), the ports in southern France (dominance of Marseille) and the East Med (this only includes EU member Cyprus).

## 2.3. Conventional general cargo traffic in the European port system

The conventional general cargo, also known as breakbulk, refers to cargo that is normally packed, bundled or unitized but which is not stowed in containers. Examples of breakbulk packaging techniques include (big)bags, bales, cardboard boxes, cases, casks, crates, drums or barrels which can be stowed on pallets or skids. The term "bundled", for its part, is sometimes used to refer to unpacked goods (usually iron and steel items or sawn timber) which are strapped together. Finally, the term "neobulk cargo" is often used for specific kinds of general cargo that is mostly shipped in larger parcels. As such, conventional general cargo encompasses a myriad of different commodities:

- Project cargo: e.g. power generation plants, steel mills, wood pulp factories, gas power plants, roadbuilding equipment, …
- Powerplant equipment: e.g. gas turbines, power generators, transformers, turbines, heavy machinery, industrial equipment, …
- Iron and steel products: e.g. bars, coils, plates, wires, …
- Forest products: i.e. all kinds of wood and paper products
- Parcels: e.g. malt, fertilizer, sugar, rice, …
- Breakbulk shipments of smaller lots

*Table 2.8: Conventional general cargo traffic and market share per country*

| Port | 2005 | 2006 | Market share 06 |
|---|---|---|---|
| Belgium | 23,386,166 | 22,033,936 | 6.9% |
| Netherlands | 22,617,808 | 25,340,308 | 7.9% |
| Germany | 18,355,942 | 19,577,965 | 6.1% |
| Denmark | 3,850,497 | 4,072,111 | 1.3% |
| Norway | 16,640,077 | 15,974,562 | 5.0% |
| Sweden | 21,536,619 | 15,518,843 | 4.9% |
| Finland | 15,107,294 | 15,672,191 | 4.9% |
| Latvia | 6,745,251 | 5,170,898 | 1.6% |
| Lithuania | 2,262,325 | 1,996,321 | 0.6% |
| Estonia | 4,035,009 | 7,478,925 | 2.3% |
| Poland | 5,304,647 | 4,350,962 | 1.4% |
| Ireland | 1,437,662 | 1,612,862 | 0.5% |
| United Kingdom | 27,506,320 | 26,997,587 | 8.5% |
| France | 7,611,278 | 7,797,102 | 2.4% |
| Portugal | 4,962,999 | 4,787,433 | 1.5% |
| Spain | 88,753,158 | 92,840,590 | 29.1% |
| Italy | 28,496,456 | 30,464,142 | 9.5% |
| Malta | 175,232 | 146,509 | 0.0% |
| Croatia | 1,369,692 | 1,421,697 | 0.4% |
| Slovenia | 992,883 | 1,110,894 | 0.3% |
| Romania | 6,149,531 | 4,798,495 | 1.5% |
| Bulgaria | 2,883,079 | 3,119,335 | 1.0% |
| Greece | 6,559,471 | 6,071,890 | 1.9% |
| Cyprus | 686,494 | 718,215 | 0.2% |
| Total | 317,425,890 | 319,073,773 | 100% |

Source: based on data Eurostat

Although the general cargo market has witnessed an increased container penetration rate in recent years, the volume of breakbulk cargo shipped overseas is still very significant. Tables 2.8 and 2.9 provide an overview of conventional general cargo traffic handled in Europe. The table was drawn from a large Eurostat database containing about 340 ports, handling a total throughput of 319 million tons of conventional general cargo in 2006. Although the total throughput implies that conventional general cargo is by far the smallest (in tonnage terms) of the five traffic categories discussed in this report, its importance for the port sector should not be underestimated. Compared to the handling of, say, crude oil or the major dry bulks, conventional general cargo is much more labour-intensive and generates a substantially higher value-added per ton. Generally speaking, the handling of conventional general cargo is confronted with ever-tighter handling space in many seaports in Europe (as more and more square metres are consumed by containers) and, given the strong labour intensity, it is also very sensitive to labour-related issues.

The lion's share of conventional general cargo was handled in ports in Italy, the United Kingdom, Spain, Belgium, the Netherlands, Sweden, Germany, Norway, Finland and France (table 2.8). On an individual port basis, Antwerp is by far the market leader with a volume of 18.2 million tons in 2006. This represents about 5.7% of the combined throughput of the 340 ports in the Eurostat database. Other major conventional general cargo ports, handling more than 5 million tons per year, include Rotterdam, Taranto, Dunkirk and Valencia (table 2.9). The general cargo volumes show a very high level of dispersion over the European port system. The top 10 ports represent 'only' 21% of the total European volumes. More than 200 ports handled less than half a million ton of general cargo traffic.

*Table 2.9: Top 20 general cargo ports in Europe*

| R | Port | 2005 | 2006 | Market share 06 |
|---|---|---|---|---|
| *1* | Antwerp | 17,384,429 | 18,182,316 | 5.7% |
| *2* | Rotterdam | 8,275,914 | 9,979,648 | 3.1% |
| *3* | Valencia | 5,664,944 | 6,319,185 | 2.0% |
| *4* | Taranto | 7,230,846 | 6,032,329 | 1.9% |
| *5* | Tallinn | 1,637,419 | 5,318,008 | 1.7% |
| *6* | Ravenna | 3,741,117 | 4,872,332 | 1.5% |
| *7* | Bremen, Blumenthal | 4,508,065 | 4,855,066 | 1.5% |
| *8* | Vlissingen | 4,140,100 | 4,705,080 | 1.5% |
| *9* | Constanza | 5,012,843 | 3,879,331 | 1.2% |
| *10* | London | 3,308,409 | 3,719,173 | 1.2% |
| *11* | Bilbao | 3,779,335 | 3,718,617 | 1.2% |
| *12* | Rauma | 2,982,065 | 3,211,630 | 1.0% |
| *13* | Velsen/Ijmuiden | 2,827,924 | 3,104,714 | 1.0% |
| *14* | Venezia | 2,377,480 | 3,047,190 | 1.0% |
| *15* | Riga | 4,373,132 | 2,981,565 | 0.9% |
| *16* | Marseille | 2,904,948 | 2,967,500 | 0.9% |
| *17* | Monfalcone | 2,293,394 | 2,749,368 | 0.9% |
| *18* | Medway | 2,493,405 | 2,528,001 | 0.8% |
| *19* | Brake | 2,645,544 | 2,493,658 | 0.8% |
| *20* | Livorno | 2,326,550 | 2,427,539 | 0.8% |
| | TOTAL EUROPE | 317,425,890 | 319,073,773 | 100.0% |
| | *Share Antwerp* | *5.5%* | *5.7%* | |
| | *Share top 3* | *9.9%* | *10.8%* | |
| | *Share top 10* | *19.2%* | *21.3%* | |
| | *Share top 20* | *28.3%* | *30.4%* | |

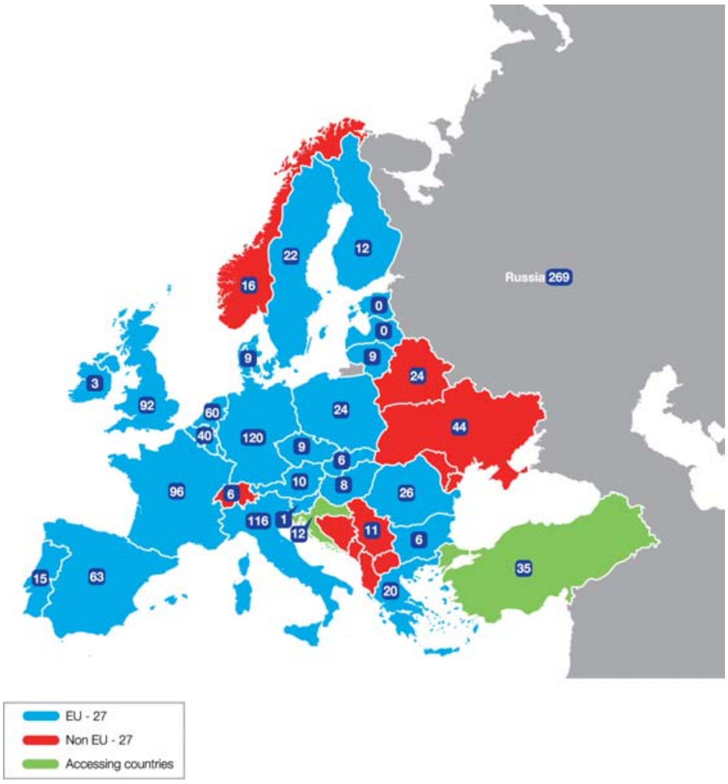
Source: based on data Eurostat

## 2.4. Liquid bulk cargo traffic in the European port system

The liquid bulk market is the largest cargo handling segment in the European port system, at least when expressed in metric tons handled. Crude oil is by far the largest subcategory in the liquid bulk market, but other significant flows include oil products such as LNG, LPG, naphta, gasoline, jet fuel, kerosene, light oil, heavy oil, lubricants, etc.. . There are around 116 refineries in the European Union (figures 2007 of European Petroleum Industry Association), many of which are located in seaports. Together they account for around 767 million tons of refining capacity per year, 18% of total global refining capacity. Figure 2.13 gives an overview of the refining capacity at country level.

Tables 2.10 and 2.11 provide an overview of liquid bulk traffic handled in Europe. The table was drawn from a large Eurostat database containing about 330 ports, handling a total throughput of 1.59 billion tons of liquid bulk traffic in 2006. The lion's share of this volume was handled in ports in the United Kingdom, Italy, the Netherlands, France and Spain. On an individual port basis, by far the biggest liquid bulk port in Europe is Rotterdam, handling 173 million tons in 2006. This represents nearly 11% of the combined liquid bulk throughput of the 330 ports in the Eurostat database. One of the main reasons for Rotterdam's strong market position is its favourable nautical accessibility for VLCC and ULCC vessels, coupled with its good connections with the major petrochemical clusters in Rotterdam (four world-scale oil refineries and more than 40 chemical and petrochemical companies) and Antwerp (via the Rotterdam-Antwerp pipeline to supply the five refineries – two large and three smaller units - in Antwerp) and the German Ruhr area. Other major liquid bulk ports include Bergen Ports in Norway, Marseilles and Le Havre (France), Wilhelmshaven (Germany), Tees & Hartlepool, Milford Haven, Forth and Southampton (UK), Antwerp (Belgium, mainly oil products) and Trieste and Augusta (Italy).

*Figure 2.13: Refining capacity at country level (in million tons per year)*




Source: www.europia.com

*Table 2.10: Liquid bulk cargo traffic and market share per country*

| Port | 2005 | 2006 | Market share 06 |
|---|---|---|---|
| Belgium | 44,413,642 | 46,546,967 | 2.9% |
| Netherlands | 201,881,215 | 212,598,120 | 13.4% |
| Germany | 71,602,984 | 69,208,256 | 4.3% |
| Denmark | 30,402,220 | 29,906,438 | 1.9% |
| Norway | 103,561,162 | 99,396,480 | 6.2% |
| Sweden | 60,488,071 | 62,715,457 | 3.9% |
| Finland | 29,868,111 | 32,163,616 | 2.0% |
| Latvia | 21,839,782 | 23,235,448 | 1.5% |
| Lithuania | 13,341,442 | 14,046,581 | 0.9% |
| Estonia | 27,583,168 | 27,475,211 | 1.7% |
| Poland | 13,909,318 | 15,962,502 | 1.0% |
| Ireland | 13,780,004 | 14,258,893 | 0.9% |
| United Kingdom | 262,759,022 | 250,164,266 | 15.7% |
| France | 180,851,298 | 182,931,076 | 11.5% |
| Portugal | 30,832,544 | 30,792,493 | 1.9% |
| Spain | 146,746,182 | 150,847,914 | 9.5% |
| Italy | 241,679,801 | 240,740,149 | 15.1% |
| Malta | 1,755,673 | 1,903,061 | 0.1% |
| Croatia | 10,448,711 | 9,106,927 | 0.6% |
| Slovenia | 2,039,003 | 2,078,241 | 0.1% |
| Romania | 15,322,097 | 14,514,340 | 0.9% |
| Bulgaria | 9,701,769 | 11,825,696 | 0.7% |
| Greece | 42,039,027 | 46,436,809 | 2.9% |
| Cyprus | 2,768,625 | 2,612,059 | 0.2% |
| Total | 1,579,614,871 | 1,591,467,000 | 100.0% |

Source: based on data Eurostat

Table 2.11: Top 20 liquid bulk ports in Europe

| R | Port | 2005 | 2006 | Market share 06 |
|---|---|---|---|---|
| 1 | Rotterdam | 167,869,712 | 173,369,956 | 10.9% |
| 2 | Marseille | 65,688,272 | 67,487,700 | 4.2% |
| 3 | Bergen Ports | 68,981,252 | 62,889,874 | 4.0% |
| 4 | Le Havre | 46,824,700 | 47,507,337 | 3.0% |
| 5 | Wilhelmshaven | 43,644,543 | 40,866,072 | 2.6% |
| 6 | Antwerp | 36,840,786 | 37,740,159 | 2.4% |
| 7 | Trieste | 35,818,499 | 36,094,547 | 2.3% |
| 8 | Tees & Hartlepool | 36,894,324 | 34,752,350 | 2.2% |
| 9 | Milford Haven | 36,384,369 | 33,078,967 | 2.1% |
| 10 | Augusta | 31,994,840 | 29,800,568 | 1.9% |
| 11 | Southampton | 28,170,916 | 28,240,766 | 1.8% |
| 12 | Porto Foxi | 22,727,718 | 27,092,774 | 1.7% |
| 13 | Forth | 29,100,329 | 26,207,856 | 1.6% |
| 14 | Amsterdam | 18,846,791 | 24,471,055 | 1.5% |
| 15 | Tallinn | 24,413,634 | 23,978,685 | 1.5% |
| 16 | Immingham | 24,291,746 | 23,779,934 | 1.5% |
| 17 | Nantes Saint-Nazaire | 23,643,323 | 23,400,265 | 1.5% |
| 18 | Algeciras | 21,447,343 | 22,591,001 | 1.4% |
| 19 | Bilbao | 19,717,492 | 22,289,781 | 1.4% |
| 20 | Göteborg | 19,673,855 | 20,942,331 | 1.3% |
| | TOTAL EUROPE | 1,579,614,871 | 1,591,467,000 | 100.0% |
| | *Share Rotterdam* | *10.6%* | *10.9%* | |
| | *Share top 3* | *19.2%* | *19.1%* | |
| | *Share top 10* | *36.1%* | *35.4%* | |
| | *Share top 20* | *50.8%* | *50.7%* | |

Source: based on data Eurostat

The top 20 ports handled about half of the total European liquid bulk volumes. With this figure the concentration level in liquid bulk handling is much higher than in the roro or conventional general cargo markets, but still lower than in the container business. About 185 ports handled less than 1 million tons of liquid bulk cargo. The high level of concentration is explained by local cargo flows generated by large petrochemical and chemical clusters in major ports (cf. Rotterdam, Antwerp, Marseille, etc..) or in the vicinity of ports. There are also some major bulk ports which handle large volumes of North Sea oil (cf. Bergen ports, Milford, etc..).

## *2.5. Dry bulk cargo traffic in the European port system*

The dry bulk volumes in European ports are dominated by coal and iron ore. These volumes are strongly linked with electricity production (coal plants) and steel production. A large part of the volumes is relatively captive to the discharging ports since the customers (power plants and steel plants) are typically located in the port or in the vicinity of the port. A good example is ArcelorMittal, the largest steel group in the world. ArcelorMittal operates several 'maritime' flat carbon steel mills (e.g. Dunkirk, Ghent, Fos, Gijon, Bremen) and most other mills are located less than 100km from major import ports (figure 2.14). Next to coal and iron ore, other important dry bulk flows include grains, bauxite/alumina, minerals and fertilizers.

Table 2.12 and 2.13 provide an overview of dry bulk traffic handled in European seaports. The table was drawn from a large Eurostat database containing about 350 ports, handling a total throughput of about 1 billion tons of dry bulk in 2005. With a volume of about 1 million tons in 2006 the dry bulk handling market is similar in size compared to the container market (i.e. total container volume of an estimated 90.7 million TEU in 2008 or approximately 1 billion tons).

As can be seen from table 2.12, the lion's share of this volume was handled in ports in the Netherlands, the United Kingdom, Spain, Italy and France. On an individual port basis, by far the biggest dry bulk port is Rotterdam, handling nearly 86 million tons of dry bulk traffic in 2006. This represents 8.5% of the combined dry bulk throughput of the 350 ports in the Eurostat database. Just as is the case for the liquid bulk market, Rotterdam owes its strong market position to its excellent nautical accessibility (it can receive dry bulk carriers of 300,000 dwt or more), coupled with good links with major consumption centres in the hinterland (especially the German Ruhr area). Other major dry bulk ports include Hamburg (Germany), Antwerp (Belgium), Dunkirk (France), Taranto (Italy) and Amsterdam (Netherlands). Apart from these ports, 16 other ports handled between 10 and 25 million tons of dry bulk cargo in 2006. The dry bulk market is less spatially concentrated than the liquid bulk market. The top 10 ports have a joint market share of 29.4% compared to 35.4% in the liquid bulk market. More than 185 ports handled less than 1 billion tons of dry bulk cargo.

*Figure 2.14: Location of European flat carbon steel mills of ArcelorMittal*


Source: ArcelorMittal

*Table 2.12: Dry bulk cargo traffic and market share per country*

| Port | 2005 | 2006 | Market share 06 |
|---|---|---|---|
| Belgium | 42,449,820 | 45,299,795 | 4.5% |
| Netherlands | 146,226,478 | 144,012,493 | 14.3% |
| Germany | 54,940,574 | 59,431,681 | 5.9% |
| Denmark | 25,808,461 | 31,651,719 | 3.1% |
| Norway | 51,011,629 | 53,702,622 | 5.3% |
| Sweden | 27,751,195 | 27,582,407 | 2.7% |
| Finland | 23,683,395 | 27,882,352 | 2.8% |
| Latvia | 27,058,323 | 24,003,773 | 2.4% |
| Lithuania | 7,462,926 | 7,488,554 | 0.7% |
| Estonia | 7,636,104 | 11,315,495 | 1.1% |
| Poland | 26,485,226 | 22,377,802 | 2.2% |
| Ireland | 14,703,963 | 15,089,597 | 1.5% |
| United Kingdom | 125,462,037 | 131,619,386 | 13.1% |
| France | 81,536,769 | 83,336,123 | 8.3% |
| Portugal | 18,430,445 | 19,136,751 | 1.9% |
| Spain | 113,651,418 | 113,488,240 | 11.3% |
| Italy | 99,321,792 | 102,294,166 | 10.2% |
| Malta | 679,673 | 567,629 | 0.1% |
| Croatia | 7,849,127 | 7,608,356 | 0.8% |
| Slovenia | 7,731,876 | 10,077,490 | 1.0% |
| Romania | 18,764,458 | 16,775,102 | 1.7% |
| Bulgaria | 10,382,060 | 10,640,950 | 1.1% |
| Greece | 38,107,287 | 38,180,340 | 3.8% |
| Cyprus | 1,443,334 | 1,689,379 | 0.2% |
| Total | 978,578,370 | 1,005,252,202 | 100.0% |

Source: based on data Eurostat

*Table 2.13: Top 20 dry bulk ports in Europe*

| R | Port | 2005 | 2006 | Market share 06 |
|---|---|---|---|---|
| 1 | Rotterdam | 87,694,773 | 85,568,983 | 8.5% |
| 2 | Hamburg | 27,011,709 | 28,718,146 | 2.9% |
| 3 | Dunkerque | 26,314,285 | 27,875,719 | 2.8% |
| 4 | Amsterdam | 25,107,777 | 26,605,916 | 2.6% |
| 5 | Antwerp | 26,684,613 | 25,608,710 | 2.5% |
| 6 | Taranto | 25,453,936 | 25,277,588 | 2.5% |
| 7 | Immingham | 20,735,227 | 23,412,454 | 2.3% |
| 8 | Gijón | 19,663,187 | 18,298,185 | 1.8% |
| 9 | Velsen/Ijmuiden | 18,666,451 | 17,500,572 | 1.7% |
| 10 | Ghent | 13,054,649 | 16,860,362 | 1.7% |
| 11 | Constanta | 18,103,190 | 16,476,220 | 1.6% |
| 12 | Marseille | 15,363,075 | 16,194,000 | 1.6% |
| 13 | Narvik | 15,921,615 | 16,029,207 | 1.6% |
| 14 | Ravenna | 12,962,076 | 14,619,739 | 1.5% |
| 15 | Riga | 14,938,364 | 14,223,045 | 1.4% |
| 16 | London | 15,002,694 | 13,811,456 | 1.4% |
| 17 | Tees & Hartlepool | 12,401,973 | 12,217,022 | 1.2% |
| 18 | Tarragona | 11,915,749 | 11,233,708 | 1.1% |
| 19 | Venezia | 11,224,317 | 11,192,391 | 1.1% |
| 20 | Tallinn | 6,975,427 | 10,528,523 | 1.0% |
| | TOTAL EUROPE | 978,578,370 | 1,005,252,202 | 100.0% |
| | *Share Rotterdam* | *9.0%* | *8.5%* | |
| | *Share top 3* | *14.4%* | *14.1%* | |
| | *Share top 10* | *29.7%* | *29.4%* | |
| | *Share top 20* | *43.5%* | *43.0%* | |

Source: based on data Eurostat

## 2.6. Conclusions on cargo traffic in the European port system

Europe counts many ports along its long coastline. The number of ports active in roro, general cargo, liquid bulk and or dry bulk handling is in excess of 300. There are about 130 seaports handling containers of which around 40 accommodate intercontinental container services[2]. The normalized HH-index for the European container port system is decreasing which means an increasing number of European ports is present on the competitive scene. While the European container port scene becoming more diverse in terms of number of ports involved, a lot of cargo is concentrated in a limited number of ports. Moreover, large differences in growth patterns can be observed among the multi-port gateways regions.

The Le Havre-Hamburg range remains volume-wise a strong port range in Europe. However, its market share in total European volumes differs depending on the market segment considered:

- 48.4% or 40.3 million TEU in the container business
- 26.8% or 269 million tons for dry bulk
- 24.6% or 391 million tons for liquid bulk
- 19.5% or 62 million tons for conventional general cargo
- 18.3% or 82 million tons for roro

The container handling market remains more concentrated than other cargo handling segments in the European port system. This conclusion is supported by the normalized HH-index presented in this section of the report as well as the tables on the market shares of the largest set of seaports. Figure 2.15 compares the five cargo handling segments on the basis of a cumulative market share curve for the 50 largest ports in each of the segments. It can be observed that the concentration is the lowest in the conventional general cargo segment and the highest in the container market.

The observed trends in the cargo distribution in the European port system lead to a few questions that need further elaboration:

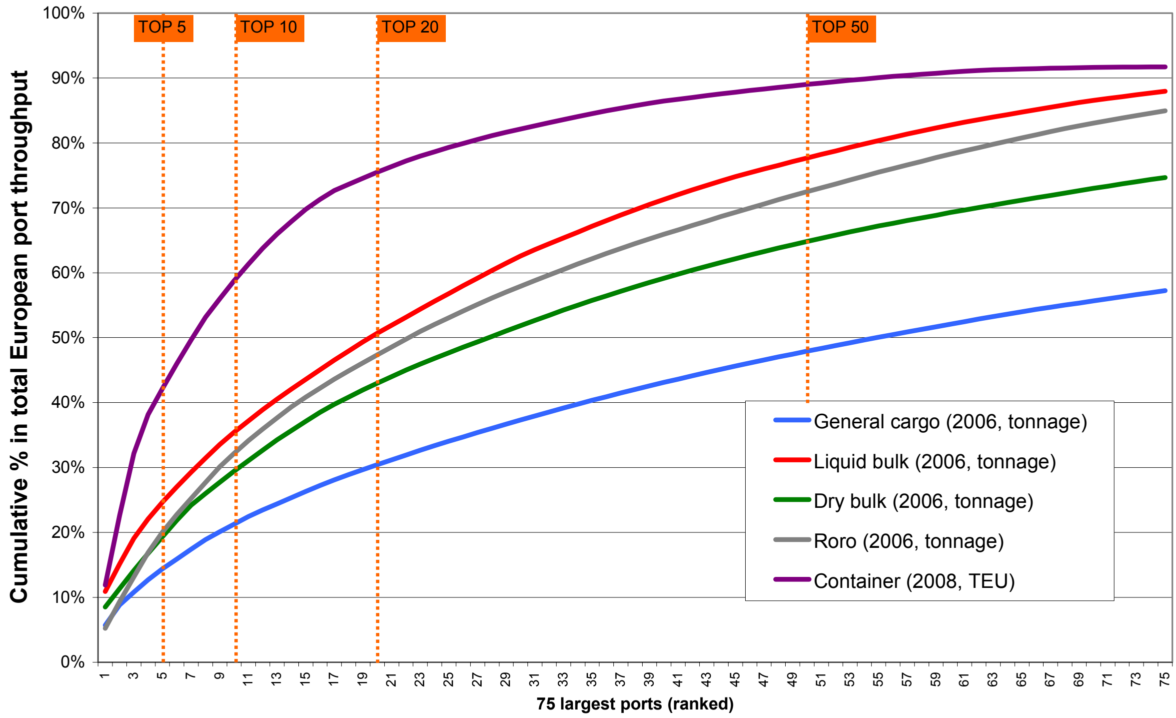
1. Why do we observe differences in concentration levels between the different commodities ?
2. What factors contribute to the distribution of cargo in the European port system ?
3. Is the existing port hierarchy likely to be structurally challenged in the future ?

[2] In the US/Canada there are only 35 seaports involved in containerization and only 17 of them are involved in the deepsea container trades.

4. What is the role of infrastructure in explaining cargo distribution patterns in the European port system ?

To provide answers to these questions, the next sections will analyze the supply and demand factors that shape current and future port-hinterland dynamics in Europe.

*Figure 2.15: Cumulative market share of the top 75 ports in each cargo segment*




Source: own elaboration based on individual port data (containers) and Eurostat data (other cargo segments)

# 3. Global supply chains and the market dynamics behind the routing of goods flows via the European port system

## *3.1. The four layers in the port-hinterland relationship*

Cargo flows in Europe are strongly influenced by port-hinterland dynamics, particularly over four inter-related layers ranging from a spatial to a functional perspective (see figure 3.1):

- The ***locational layer*** relates to the geographical location of a port vis-à-vis the economic space and forms a basic element for the intrinsic accessibility of a seaport. A good intermediate location can imply a location near the main maritime routes and or near production and consumption centers such as gateway ports. For gateway ports, a good location is a necessary condition for attaining a high intrinsic accessibility to a vast hinterland, which often builds upon the centrality of the port region. It becomes a sufficient condition when the favorable geographical location is valorized by means of the provision of efficient infrastructures and transport services;

- The ***infrastructural layer*** involves the provision and exploitation of basic infrastructure for both links and nodes in the transport system. Containerization and intermodal transportation, particularly the transshipment infrastructures they rely on, have contributed to a significant accumulation of infrastructures in a number of ports. This is where the intrinsic accessibility is valorized since a port site has little meaning unless capital investment is provided;

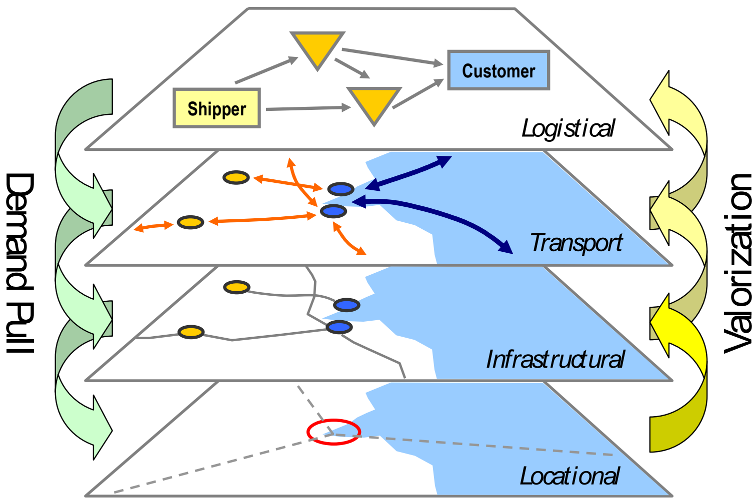
- The ***transport layer*** involves the operation of transport services on links and corridors between the port and other nodes within the multimodal transport system and the transshipment operations in the nodes of the system. It is a matter of volume and capacity;

- The ***logistical layer*** involves the organization of transport chains and their integration in logistical chains. This layer is mostly managerial with a decision making process in terms of the allocation of modes and the booking of transshipment facilities.

The upward arrow in figure 3.1 depicts that each layer valorizes the lower layers. The downward arrow represents the demand pull exerted from the higher levels towards more fundamental layers. In a demand-driven market environment the infrastructural layer serves the transport and logistical layers. The more fundamental the layer is, the lower the adaptability (expressed in time) in facing market changes. For instance, the planning and construction of major port and inland infrastructures (infrastructural level) typically takes many years. The duration of the planning and implementation of shuttle trains on specific railway corridors (transport level) usually varies between a few months up to one year. At the logistical level, freight forwarders and multimodal transport operators (MTOs) are able to respond almost instantly to variations in the market by modifying the commodity chain design, i.e. the routing of the goods through the transport system. As adaptable as they may be, they are still dependant on the existing capacity, but their decisions are often indications of the inefficiencies of the other layers and potential adjustments to be made.

The differences in responsiveness on the proposed levels leads to considerable time lags between proposed structural changes on the logistical and the transport level and the necessary infrastructural adaptations needed to meet these changes adequately. This observation partly explains both the existing undercapacity (congestion) and/or overcapacity situations in hinterland networks and port systems in Europe.

*Figure 3.1: A multi-layer approach to port-hinterland dynamics*




Source: Notteboom & Rodrigue (2008)

It is becoming increasingly common to see transport operators taking control of the valorization process by positioning themselves through the logistical, transport, infrastructure and locational layers. Global port holdings, such as PSA, Hutchison Port Holding, APM Terminals and DP World, are a salient example of this strategy as they select relevant locations (valorizing intermediacy and centrality), invest in the development of infrastructures, including hinterland access, have intricate linkages with – maritime – transport companies and are a crucial element of global commodity chains. As the dynamics in the macro-economic and logistical hinterland is high, long delays in the realization of physical infrastructures could ultimately lead to a misallocation of resources. Hence, the market conditions might change considerably in the time-span between the planning phase and the actual realization of an infrastructure. So, an infrastructure investment which at the time of its conception seemed feasible and market-driven, could end up as an investment in the wrong place, at the wrong time, for the wrong market and using the wrong technology. Such missteps can have serious impacts on markets in terms of rates, user costs and competition levels.

## 3.3. *The logistics layer: distribution networks, port selection and modal choice*

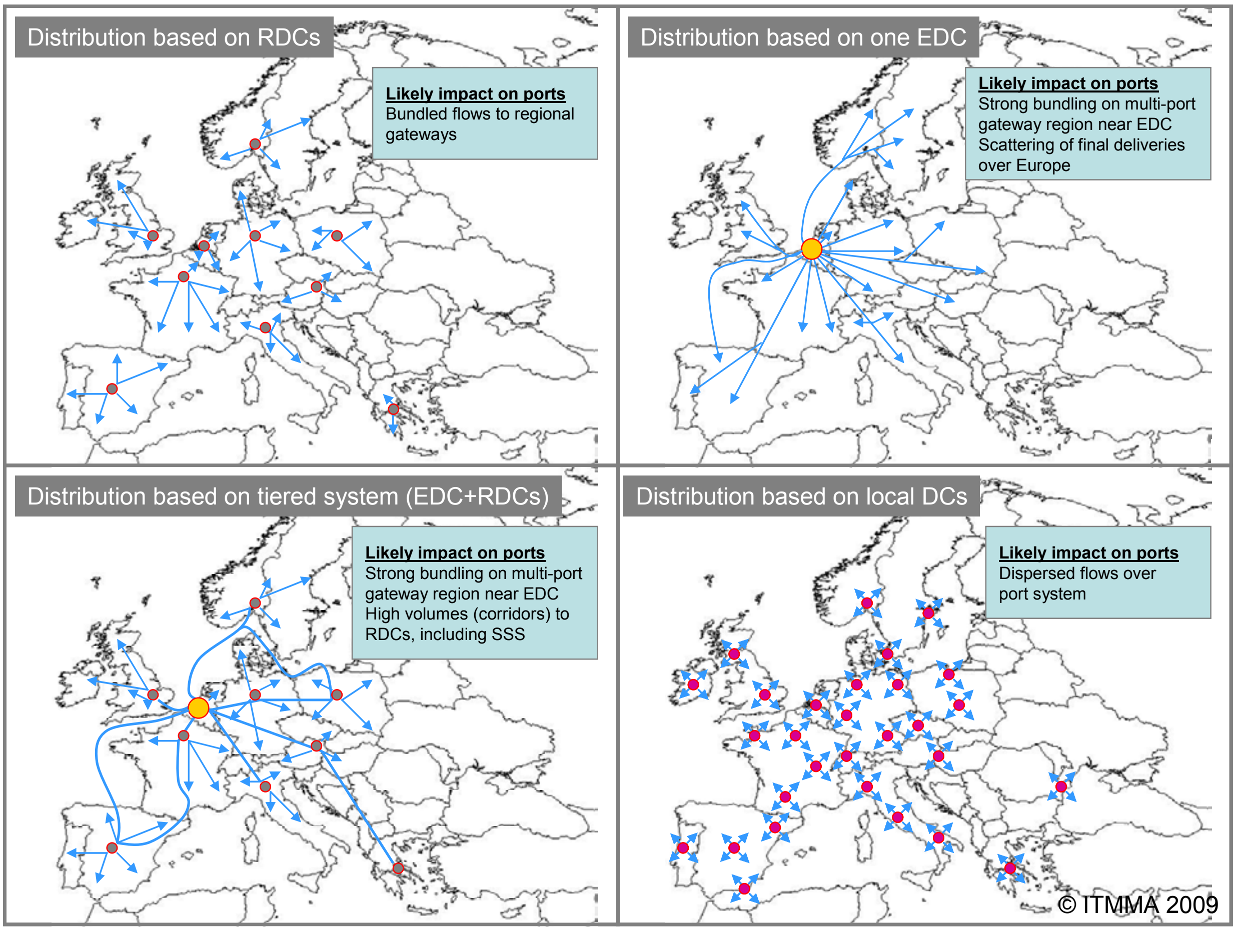
At the logistical layer shippers, freight forwarders, logistics service providers and other market parties design the routing solutions that best fit the requirements of the supply chains they are dealing with. The decision-making at the level of the logistics layers is mainly oriented towards: (a) the design of the distribution network; (b) the choice of the maritime service and the associated ports; (c) the choice and combination of transport modes for the inland section of the transport chain. This section presents the main issues in these routing decisions.

### 3.3.1. Distribution network configuration

***The (re)design of distribution networks***

Supply chains across Europe are being redesigned to respond to varying customer and product service level requirements. The variables which affect site selection of distribution facilities are numerous and quite diverse and can be of a quantitative or qualitative nature: centrality, accessibility (i.e. infrastructure for efficient connections to and from Europe), size of the market, track record regarding reputation/experience, land and its attributes, labour (costs, quality, productivity), capital (investment climate, bank environment), government policy and planning (subsidies, taxes) and personal factors and amenities. Many companies fall back on intuition and rules of thumb in selecting an appropriate site.

*Figure 3.2: Examples of distribution networks (import flows)*




When it comes to European distribution of overseas retail goods and semi-finished products, a general-applicable distribution structure does not exist. Companies can opt for direct delivery without going through a distribution centre, distribution through an EDC (European Distribution Centre), distribution through a group of NDCs (National Distribution Centers) or RDCs (Regional Distribution Centers) or a tiered structure in which one EDC and several NDCs/RDCs are combined to form a European distribution network (figure 3.2). The choice between the various distribution network configurations depends on among other things the type of product and the frequency of deliveries. In the fresh food industry for example, worldwide or European distribution centres are rare because the type of product (mostly perishables) dictates a local distribution structure. In the pharmaceuticals industry, European distribution centres are common but regional or local distribution centres are not present, because the pharmaceutical products are often manufactured in one central plant and delivery times are not very critical (hospitals often have own inventories). However, in the high tech spare parts industry, all of the distribution centre functions can be present because spare parts need to be delivered within a few hours and high tech spare parts are usually very expensive (which would require centralized distribution structures).

Before the creation of the EU, the distribution structure of most companies was based on a network of national distribution centers in the major countries in which they were present. The enlargement of the European Union and the strong economic growth of regions situated somewhat at the periphery of the internal market might have implications on the design of European distribution networks. Over the last fifteen years or so many barriers for cross-border transactions between countries within the EU have decreased. With the emergence of the European Monetary Union and the harmonization of European regulatory standards and the convergence of prices, the advantage of having subsidiary units in multiple national markets has become less advantageous. A growing number of companies have responded by choosing to centralize their manufacturing and distribution operations with significant cost savings to provide high quality and low cost financial, administrative and support services to customers and line management. As a result many companies consolidated their distribution operations into one central EDC covering all European Union countries. The concentration/consolidation of import flows in an EDC has several advantages:

- Reduction of transport costs to Europe due to optimization of inbound transport;
- Improvement in delivery time and higher service level to customer;
- Maintaining one customs clearing center;
- Efficiency improvements in stock management;
- Reduction of inventory and other overhead costs

EDCs have also engaged into product customization for the various national markets which can range from adding manuals and plugs to different packaging activities (so-called Value Added Logistics). EDCs are operated by the company’s own management or entrusted to a third party service provider.

The rise of EDCs meant longer distances to the final consumers and in some market segments local market demand has led companies to opt for RDCs. At present, the tiered structure consisting of one EDC in combination with some smaller local warehouses, ‘merge in transit’ concepts or ‘cross docking’ facilities offers the best results for many companies in terms of high level of service, frequency of delivery and distribution cost control. Companies today often opt for a hybrid distribution structure of centralized and local distribution facilities. For instance, they use an EDC for medium- and slow-moving products and RDCs for fast-moving products. These RDCs typically function as rapid fulfilment centres rather than holding inventories. The classical or multi-country distribution structures are being replaced by merge-in-transit, cross-docking or other fluid logistics structures.

The geographical centre of gravity within the expanded EU has slightly moved eastwards from the Benelux region to Germany and this is causing some companies to reconsider their location behavior of European Distribution Centres (EDCs). The past waves of EU enlargements might further promote a two-tiered European distribution structure consisting of an EDC together with regional distribution centres in Northern Europe, UK/Ireland, Southern Europe, Eastern Europe and Italy/Greece. Favourable regions for locating such a RDC include northern Germany and Finland for northern access, Hungary, Southern Germany and Austria for central access, northern Italy and the north Adriatic region for southern access and the Czech republic and Poland for eastern access.

The new European Union covers a much larger geographical area making it more difficult to deliver all EU countries out of one EDC within two to three working days. Northern ports, in particular Hamburg, are likely to benefit the most from the recent waves of EU enlargement, whereas new development opportunities arise for secondary port systems in the Adriatic and the Baltic Sea.

At the moment, North West Europe still offers the best access to the EU core markets and infrastructure. The majority of EDCs is still opting for a location in the Benelux region or northern France. Next to dedicated transport services companies, companies in the automotive, food, retail, chemicals, electronics and pharmaceuticals industries are the main investors in distribution activities. Flanders, northern France and the Netherlands remain the top locations for EDCs, but more and more regions are vying for a position as attractive location for RDCs and potentially EDCs.

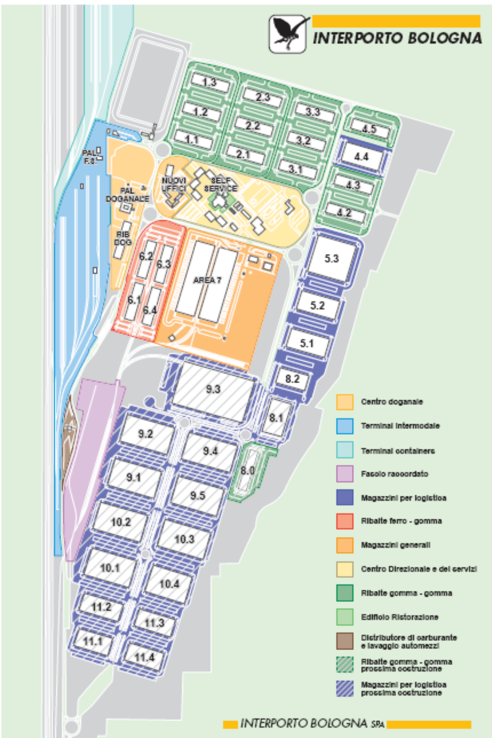
Efficient long-distance corridors can have a downside to well established EDC regions: they make it easier for logistics service providers to move distribution facilities inland closer to the customer base without having to sacrifice a good accessibility to the maritime gateways.

***Ports and inland ports as locations for distribution activities***
The dynamics in logistics networks have created the right conditions for a large-scale development of inland ports. The range of functions of inland logistics centers is wide ranging from simple cargo consolidation to advanced logistics services. Many inland locations with multimodal access have become broader logistics zones. They not only have assumed a significant number of traditional cargo handling functions and services, but also have attracted many related services, among others distribution centers, shipping agents, trucking companies, forwarders, container repair facilities and packing firms. The concept of logistics zones in the hinterland is now well-advanced in Europe: e.g. 'platformes logistiques' in France, the Güterverkehrszentren (GVZ) in Germany, Interporti in Italy, Freight Villages in the UK and the Zonas de Actividades Logisticas (ZAL) in Spain (see figure 3.3 for a few examples).

*Figure 3.3: Two examples of freight villages in Europe*

**Interporto Bologna – Italy**

The Bologna Freight Village is located in Italy at a nodal point for collection and distribution throughout the Peninsula and abroad. The interport has direct rail access via an intermodal rail terminal and a container terminal.




**Güterverkehrszentren (GVZs) in Berlin – Germany**

Berlin counts three freight villages: GVZ Berlin Ost (surface of 130 ha gross with rail connection), GVZ Berlin Süd (260 ha gross surface, no intermodal terminal yet) and GVZ Berlin West (226 ha gross of which 10.7 ha for the port and 3.4 ha for an intermodal terminal). Companies can develop warehousing facilities on the GVZs from 2.000 m² to 150.000 m². Users of the facilities include large players such as DHL Freight, Kieserling Transport+Logistik GmbH, DB Intermodal Services GmbH (operator of the intermodal terminals), Rhenus AG and the German supermarket chains Aldi and Lidl.

**Map of GVZ Berlin West**


Source: based on www.bo.interporto.it and www.gvz-berlin.de

Quite a few of these logistics zones are competing with seaports for what the location of distribution facilities are concerned. The availability of fast, efficient and reliable intermodal connections is one of the most important prerequisites for the further development of inland terminals. The interaction between seaports and inland locations leads to the development of a large logistics pole consisting of several logistics zones. Seaports are the central nodes driving the dynamics in such a large logistics pole. But at the same time seaports rely heavily on inland ports to preserve their attractiveness. The corridors towards the inland terminal network can create the necessary margin for further growth of seaborne container traffic in the ports. Inland terminals as such acquire an important satellite function with respect to ports.

Notwithstanding the rise of inland ports, seaports typically remain key constituents in European distribution networks. Many seaports have responded by creating logistics parks inside the port area or in the immediate vicinity of the port. Logistics activities can take place on the terminal itself, in a logistics park where several logistics activities are concentrated or in case of industrial subcontracting on the site of an industrial company. The concentration of logistics companies in dedicated logistics parks offers more advantages than providing small and separated complexes. As the hinterland becomes a competitive location, the question remains as to which logistics activities are truly port-related. In the new logistic market environment, the following logistics activities typically find a good habitat in ports:

- Logistics activities resulting in a considerable reduction in the transported volume;
- Logistics activities involving big volumes of bulk cargoes, suitable for inland navigation and rail;
- Logistics activities directly related to companies which have a site in the port area;
- Logistics activities related to cargo that needs flexible storage to create a buffer (products subject to season dependent fluctuations or irregular supply);
- Logistics activities with a high dependency on short-sea shipping.

Moreover, port areas typically possess a strong competitiveness for distribution centers in a multiple import structure and as a consolidation centre for export cargo.

## 3.3.2. Port selection and modal choice

The traditional view on port selection primarily considers standalone physical attributes of a port such as (a) the physical and technical infrastructure (nautical accessibility profile, terminal infrastructure and equipment, hinterland accessibility profile), (b) the geographical location (vis-à-vis the immediate and distant hinterlands and vis-à-vis the main shipping lanes), (c) port efficiency, (d) interconnectivity of the port (sailing frequency), (e) quality and costs of auxiliary services such as pilotage, towage, customs, etc.., (f) efficiency and costs of port management and administration (e.g. port dues), (g) availability, quality and costs of logistic value-added activities (e.g. warehousing), (h) availability, quality and costs of port community systems, (i) port security/safety and environmental profile of the port, (j) port reputation and (k) the reliability, capacity, frequency and costs of inland transport services by truck, rail and barge.

The focus on standalone physical attributes of a port when assessing the competitiveness of European ports does not mirror the reality of (global) supply chains. European ports compete not as individual places that handle ships but as crucial links within (global) supply chains. This implies that the routing of goods flows in Europe and the associated port selection can only be understood by following a supply chain oriented approach. Port and route selection criteria are related to the entire network in which the port is just one node. The ports that are being chosen are those that will help to minimize the sum of sea, port and inland costs, including inventory and quality considerations of shippers. Port choice becomes more a function of the overall network cost and performance.

In this setting, the out-of-the-pocket costs of transporting goods between origins and destinations and the port (including cargo handling costs) constitute just one cost component in supply chain routing decisions by shippers or their representatives. The more integrated supply chain decision-making becomes, the more the focus is shifted to the generalized logistics costs. The implications on port and modal choice are far-reaching: shippers or their representatives might opt for more expensive ports or more expensive hinterland solutions in case the additional port-related and modal out-of-the-pocket costs are overcompensated by savings in other logistics costs. These other costs typically consist of:

(a) Time costs of the goods (opportunity costs linked to the capital tied up in the transported goods and costs linked to the economic or technical depreciation of the goods);

(b) Inventory costs linked to the holding of safety stocks;
(c) Indirect logistics costs linked to the aggregated quality within the transport chain and the willingness of the various actors involved to tune operations to the customer's requirements, e.g. in terms of responsiveness to variable flows, information provision and ease of administration.

These three cost categories have gained in significance (particularly for general cargo) as more and more high value products are being shipped worldwide (i.e. impact on time costs). There are some major points to be made in relation to this shift.

First of all, scale increases in vessel size and alliance co-operation have lowered ship system costs (see further in section 3.4.1), but at the same time intermodal costs share an increasing part of the total cost. The portion of inland costs in the total costs of container shipping typically ranges between 40% and 80%. The shift from vessel costs to landside costs is enhanced by transport price evolutions. The price difference per FEU-km between inland transport and long-haul liner shipping ranges from a factor 5 to a factor 30. For example, table 3.1 presents the evolution of the base freight rate and additional charges (including BAF, THC, but excluding CAF and administrative costs and time costs) on a port-to-port basis with a post-panamax vessel between Shanghai and the Rhine-Scheldt Delta. The shipping price ranges between 0.05 and 0.19 euro per FEU-km (0.065 - 0.25 US$). The price for inland haulage per truck from north European ports usually ranges from 1.5 to 4 euro per FEU-km depending on distance and weight. By barge the price ranges between 0.5 and 1.5 euro per FEU-km (excluding handling costs and pre- and endhaul by truck).

*Table 3.1: Base freight rate, BAF and THC in US$ for the maritime transport of one forty foot container (FEU) from Shanghai to Antwerp (excluding CAF and other surcharges)*

| **Distance = 11000 nm** | **Typical freight rate** | **Typical BAF** | **Typical THC (Antwerp+Shanghai)** | **Total** |
|---|---|---|---|---|
| Q1 2007 | 2100 | 235 | 157 | 2492 |
| Q2 2008 | 1400 | 1242 | 157 | 2799 |
| September 2008 | 700 | 1440 | 157 | 2297 |
| February 2009 | 250 (all in) | - | 157 | 407 |
| April 2009 | 550 (all in) | - | 157 | 707 |

BAF = Bunker Adjustment Factor, CAF = Currency Adjustment Factor, THC = Terminal Handling Charges

*Source: based on market data*

The out-of-the pocket costs do however not fully explain routing decisions. Connectivity via liner services and connectivity via rail or barge (where available) remain important factors for route decisions, since they imply higher frequencies and a better connectivity to the foreland and the hinterland. In practice, a port with a high connectivity is typically able to attract more cargo for the distant hinterland, even if there is another port with a much lower connectivity which offers a cheaper solution for the hinterland routing of the goods. This mechanism is one of the reasons why a lot of cargo for Central and Southern Europe is still routed via Northern ports instead of via Adriatic or Ligurian ports. The (small) cost advantage that the latter ports might have for inland routing to parts of Central and Southern Europe is counterbalanced by the high liner service and rail connectivity and associated economies of scale and scope provided by the main ports in the Helgoland Bay and the Rhine-Scheldt Delta.

The second point relates to the capacity situation in ports and inland transport networks. Until recently, there were growing concerns on capacity shortages in ports and inland infrastructures. This situation made supply chain managers base their port and modal choice decisions increasingly on reliability and capacity considerations next to pure cost considerations. While concerns over congestion have eased significantly in recent months due to the economic crisis and the associated drop in volumes, freight transportation still is the most volatile and costly component of many firms' supply chain and logistics operations. Also managers still have to deal with reliability issues in the transport system and face strong fluctuations in oil prices (high peak in the summer of 2008 followed by a dramatic collapse), complex security issues, and labour and equipment imbalances. Each of these problems adds risk to the supply chain. These sorts of problems have not disappeared despite the economic slowdown. Managers in the logistics industry, including the port and maritime industry, are spending more and more of their time handling freight transport missteps and crises.

*Table 3.2: Index comparison among gateway regions in Europe with respect to emissions of $CO_2$ and $NO_x$ and energy consumption levels on specific origin-destination relations*

**Transport of one TEU of 10 tons**

**$CO_2$** — Index (base = total $CO_2$ emissions in kg)

| | Inland mode | RS Delta | Helgoland Bay | Black Sea | Spanish Med | South France | North Adriatic |
|---|---|---|---|---|---|---|---|
| Shanghai - Frankfurt | Truck | 103 | 106 | 132 | 115 | 105 | 100 |
| Shanghai - Frankfurt | Rail | 111 | 114 | 115 | 109 | 104 | 100 |
| Shanghai - Lyon | Truck | 137 | 151 | 168 | 112 | 100 | 119 |
| Shanghai - Lyon | Rail | 125 | 132 | 128 | 106 | 100 | 107 |
| Shanghai - Budapest | Truck | 146 | 141 | 113 | 152 | 136 | 100 |
| Shanghai - Budapest | Rail | 129 | 129 | 104 | 127 | 119 | 100 |
| Shanghai - Munich | Truck | 131 | 131 | 141 | 133 | 121 | 100 |
| Shanghai - Munich | Rail | 124 | 126 | 118 | 117 | 112 | 100 |
| Shanghai - Strasbourg | Truck | 107 | 114 | 135 | 110 | 100 | 100 |
| Shanghai - Strasbourg | Rail | 113 | 117 | 116 | 106 | 101 | 100 |
| Santos - Frankfurt | Truck | 100 | 105 | 193 | 137 | 123 | 132 |
| Santos - Frankfurt | Rail | 100 | 105 | 159 | 116 | 111 | 125 |
| Santos - Lyon | Truck | 138 | 161 | 238 | 116 | 100 | 150 |
| Santos - Lyon | Rail | 117 | 129 | 180 | 106 | 100 | 135 |
| Santos - Budapest | Truck | 129 | 121 | 124 | 150 | 132 | 100 |
| Santos - Budapest | Rail | 102 | 102 | 115 | 116 | 108 | 100 |
| Santos - Munich | Truck | 107 | 107 | 162 | 124 | 112 | 100 |
| Santos - Munich | Rail | 100 | 103 | 141 | 109 | 104 | 106 |
| Santos - Strasbourg | Truck | 100 | 110 | 187 | 120 | 106 | 124 |
| Santos - Strasbourg | Rail | 100 | 107 | 158 | 109 | 103 | 122 |
| New York - Frankfurt | Truck | 100 | 108 | 249 | 170 | 150 | 162 |
| New York - Frankfurt | Rail | 100 | 108 | 213 | 148 | 139 | 161 |
| New York - Lyon | Truck | 129 | 157 | 270 | 120 | 100 | 162 |
| New York - Lyon | Rail | 101 | 116 | 201 | 108 | 100 | 144 |
| Ney York - Budapest | Truck | 120 | 112 | 128 | 158 | 137 | 100 |
| Ney York - Budapest | Rail | 101 | 100 | 135 | 137 | 126 | 115 |
| New York - Munich | Truck | 100 | 100 | 181 | 135 | 120 | 105 |
| New York - Munich | Rail | 100 | 104 | 181 | 133 | 126 | 130 |
| New York - Strasbourg | Truck | 100 | 114 | 237 | 144 | 125 | 149 |
| New York - Strasbourg | Rail | 100 | 110 | 209 | 135 | 127 | 155 |

**Transport of one TEU of 10 tons**

**$NO_x$** — Index (base = total $NO_x$ emissions in kg)

| | Inland mode | RS Delta | Helgoland Bay | Black Sea | Spanish Med | South France | North Adriatic |
|---|---|---|---|---|---|---|---|
| Shanghai - Frankfurt | Truck | 119 | 122 | 103 | 105 | 103 | 100 |
| Shanghai - Frankfurt | Rail | 112 | 115 | 114 | 109 | 104 | 100 |
| Shanghai - Lyon | Truck | 122 | 127 | 105 | 102 | 100 | 101 |
| Shanghai - Lyon | Rail | 125 | 132 | 127 | 105 | 100 | 107 |
| Shanghai - Budapest | Truck | 128 | 130 | 100 | 113 | 110 | 101 |
| Shanghai - Budapest | Rail | 130 | 130 | 104 | 126 | 119 | 100 |
| Shanghai - Munich | Truck | 124 | 127 | 104 | 108 | 106 | 100 |
| Shanghai - Munich | Rail | 124 | 126 | 117 | 117 | 111 | 100 |
| Shanghai - Strasbourg | Truck | 120 | 124 | 104 | 104 | 102 | 100 |
| Shanghai - Strasbourg | Rail | 114 | 118 | 116 | 106 | 101 | 100 |
| Santos - Frankfurt | Truck | 102 | 107 | 133 | 100 | 100 | 117 |
| Santos - Frankfurt | Rail | 100 | 105 | 157 | 115 | 110 | 124 |
| Santos - Lyon | Truck | 113 | 121 | 145 | 100 | 100 | 125 |
| Santos - Lyon | Rail | 118 | 130 | 178 | 106 | 100 | 134 |
| Santos - Budapest | Truck | 105 | 107 | 117 | 101 | 100 | 108 |
| Santos - Budapest | Rail | 104 | 103 | 114 | 115 | 107 | 100 |
| Santos - Munich | Truck | 105 | 109 | 130 | 100 | 100 | 113 |
| Santos - Munich | Rail | 100 | 103 | 139 | 107 | 102 | 105 |
| Santos - Strasbourg | Truck | 105 | 111 | 136 | 100 | 100 | 119 |
| Santos - Strasbourg | Rail | 100 | 107 | 156 | 107 | 102 | 120 |
| New York - Frankfurt | Truck | 100 | 108 | 173 | 122 | 122 | 149 |
| New York - Frankfurt | Rail | 100 | 108 | 209 | 145 | 137 | 159 |
| New York - Lyon | Truck | 100 | 111 | 167 | 106 | 106 | 140 |
| New York - Lyon | Rail | 102 | 117 | 199 | 107 | 100 | 143 |
| Ney York - Budapest | Truck | 100 | 103 | 140 | 117 | 115 | 127 |
| Ney York - Budapest | Rail | 101 | 100 | 133 | 134 | 124 | 114 |
| New York - Munich | Truck | 100 | 106 | 160 | 116 | 117 | 136 |
| New York - Munich | Rail | 100 | 104 | 178 | 131 | 124 | 128 |
| New York - Strasbourg | Truck | 100 | 109 | 171 | 117 | 118 | 146 |
| New York - Strasbourg | Rail | 100 | 111 | 206 | 133 | 125 | 153 |

**Transport of one TEU of 10 tons**

**Energy consumption** — Index (base = total energy consumtion in MJ)

| | Inland mode | RS Delta | Helgoland Bay | Black Sea | Spanish Med | South France | North Adriatic |
|---|---|---|---|---|---|---|---|
| Shanghai - Frankfurt | Truck | 106 | 110 | 126 | 113 | 105 | 100 |
| Shanghai - Frankfurt | Rail | 108 | 111 | 119 | 111 | 104 | 100 |
| Shanghai - Lyon | Truck | 134 | 146 | 153 | 110 | 100 | 115 |
| Shanghai - Lyon | Rail | 127 | 135 | 138 | 107 | 100 | 110 |
| Shanghai - Budapest | Truck | 142 | 138 | 110 | 143 | 131 | 100 |
| Shanghai - Budapest | Rail | 132 | 130 | 107 | 134 | 124 | 100 |
| Shanghai - Munich | Truck | 129 | 130 | 133 | 127 | 118 | 100 |
| Shanghai - Munich | Rail | 124 | 126 | 124 | 121 | 114 | 100 |
| Shanghai - Strasbourg | Truck | 110 | 116 | 129 | 109 | 100 | 100 |
| Shanghai - Strasbourg | Rail | 110 | 115 | 122 | 107 | 101 | 100 |
| Santos - Frankfurt | Truck | 100 | 105 | 180 | 129 | 118 | 128 |
| Santos - Frankfurt | Rail | 100 | 105 | 170 | 123 | 115 | 128 |
| Santos - Lyon | Truck | 133 | 152 | 218 | 113 | 100 | 145 |
| Santos - Lyon | Rail | 120 | 134 | 195 | 109 | 100 | 139 |
| Santos - Budapest | Truck | 122 | 116 | 121 | 138 | 124 | 100 |
| Santos - Budapest | Rail | 107 | 105 | 117 | 125 | 115 | 100 |
| Santos - Munich | Truck | 104 | 105 | 152 | 117 | 107 | 100 |
| Santos - Munich | Rail | 100 | 102 | 147 | 113 | 106 | 104 |
| Santos - Strasbourg | Truck | 100 | 109 | 176 | 115 | 104 | 122 |
| Santos - Strasbourg | Rail | 100 | 108 | 168 | 113 | 105 | 124 |
| New York - Frankfurt | Truck | 100 | 108 | 235 | 161 | 145 | 160 |
| New York - Frankfurt | Rail | 100 | 108 | 227 | 157 | 145 | 164 |
| New York - Lyon | Truck | 122 | 146 | 246 | 116 | 100 | 156 |
| New York - Lyon | Rail | 106 | 123 | 220 | 111 | 100 | 149 |
| Ney York - Budapest | Truck | 112 | 106 | 125 | 145 | 128 | 100 |
| Ney York - Budapest | Rail | 103 | 100 | 133 | 143 | 129 | 110 |
| New York - Munich | Truck | 100 | 101 | 178 | 132 | 119 | 110 |
| New York - Munich | Rail | 100 | 103 | 186 | 138 | 127 | 125 |
| New York - Strasbourg | Truck | 100 | 113 | 225 | 139 | 124 | 149 |
| New York - Strasbourg | Rail | 100 | 111 | 222 | 140 | 129 | 156 |

Source: own elaboration based on simulation results

Thirdly, the logistics actors and transport operators have designed more complex networks that need a high level of reliability. The current development and expansion of global supply chains and the associated intermodal transport systems relies on the synchronization of different geographical scales. The efficiency of transport systems can be seriously hampered if shipments would significantly be delayed, although having low transport costs. But when the synchronization level increases, the sea-land network as a whole becomes more instable. This leads to extra costs to find alternative routes. In view of reducing the risk of major disruptions, logistics players tend to opt for a flexible network design offering various routing alternatives. This 'not all eggs in one basket' approach implies a specific port-corridor combination rarely finds itself in a position where the market will forgive major flaws in system performance.

To add to the complexity, it is worth mentioning that the competitive position of a port vis-à-vis a specific hinterland region can not always be narrowed down to cost and quality factors only. Historical (the so-called 'memory' effect), psychological, political and personal factors can result in the routing of flows that diverges from a perfect market-based division. Bounded rationality, inertia and opportunistic behavior are among the behavioral factors that could lead to a deviation from the optimal solution[3].

A last cost dimension concerns the external costs (congestion, traffic safety and environmental damage) generated by port and inland transport activities. When major differences exist in external costs between modes or when these external costs are not internalized in a balanced way, the resulting market imperfections might enhance port and modal choices that deviate from a situation in which external costs are more balanced and equally internalized in the generalized logistics costs. Table 3.2 depicts the results of a simulation exercise with respect to three externalities namely emissions of $CO_2$ and $NO_x$ and energy consumption. The case study considers fifteen origin-destination relations transiting via six gateway regions in Europe. All inland destinations are major economic centres in mainland Europe: Frankfurt, Lyon, Budapest, Strasbourg and Munich. Both the rail and truck options are included in the analysis. An index of 100 indicates the gateway region that has the lowest emission level or energy consumption on the specific origin-destination relation. Nautical distances are based on the Dataloy distance tables. Nautical distances take into account intermediate ports of call along the route. The inland distances by truck and rail were obtained from routeplanning software and information from rail infrastructure managers in Europe. The emission and energy consumption levels per FEU-km are based on various academic studies and information obtained from market players (for instance, vessel emission data were obtained from Maersk Line).

The results show that, for the given inland destinations, the North Adriatic has the most favourable results on most relations with the Far East. The Rhine-Scheldt Delta, closely followed by the Helgoland Bay, shows the most favourable outcomes on most links with North-America. The outcome for South-America is quite mixed, with south France and the Spanish Med showing a strong profile for quite a number of inland destinations. A limitation of the simulation exercise relates to the assumption that the vessel size deployed on the routes is the same for all gateway ports. In reality, the average vessel size on the international maritime trunk routes is larger for the Rhine-Scheldt Delta, the Helgoland Bay and the Spanish Med compared to the Black Sea or the North Adriatic. Including vessel size differences in the analysis would make the position of the Black Sea and the North Adriatic less favourable. Another limitation is that the analysis excludes other externalities such as congestion, traffic safety, noise and visual intrusion. It needs to be stressed that the analysis is purely focused on emission levels and energy consumption and does not include market-based factors such as the pricing of the sea and land leg, cargo bundling possibilities and quality and connectivity considerations.

[3] Incorrect and incomplete market information on the possible alternative routes available to chain managers and shippers results in 'bounded rationality' in the transport chain design, leading to sub-optimal decisions. Shippers sometimes impose bounded rational behaviour on freight forwarders and shipping lines, e.g. in case the shipper asks to call at a specific port or to use a specific land transport mode. Opportunistic behaviour of economic actors or informal commitments to individuals or companies might lead to non-cost minimizing decisions. Also, some customers might not consider to use other ports or other transport modes because they assume that the mental efforts (inertia) and transactions costs linked to transferring activities to other ports or modes do not outweigh the direct and indirect logistics costs connected to the current non-optimal solution.

## 3.4. The transport layer: maritime and inland service networks

At the transport layer, transport operators such as shipping lines, rail operators, barge operators and trucking companies, and cargo handling companies aim at providing transport and handling services that meet the requirements of the customers at the logistical layer. At the same time they have to take into account the possibilities and limitations linked to the infrastructural capacities at nodes and links in the transport networks (infrastructural layer). This section of the report discusses current issues in the design and operation of maritime services, cargo handling activities and land transport services. By doing so, this section aims to provide a deeper understanding of the network structures through which maritime flows are channeled.

### 3.4.1. Maritime service networks

The organization of maritime services by shipping lines varies with the commodities carried.

The maritime transport of ***major bulks*** such as iron ore and coal typically relies on end-to-end services between a port of loading (connected by rail to mines) and a European port of discharge. Economies of scale in vessel size are significant in dry bulk shipping, so operators will try to maximize vessel size on the end-to-end tramp service. The nautical accessibility in the port of loading and port of discharge, the charter price level and the availability of vessel types play a decisive role in the choice of vessel size. Inland transport costs per tonkilometer are typically a factor 20 to 30 higher than sea transport costs per tonkilometer. Consequently, market players make a trade-off between, on the hand, the minimization of inland transport costs by routing the bulk flows via the ports that are closest to the final destination, and on the other hand maximizing the scale economies in vessel size by calling at the ports that offer the best nautical accessibility. This exercise in some cases leads to multiple calls whereby a large Capesize vessel will first call at a deepwater port to discharge part of the cargo and then proceed to a second port of call with a less favourable nautical access to discharge the remainder (e.g. a call sequence starting in Dunkirk and ending in Antwerp). Another practice consists of lightening deepsea vessels on stream, whereby floating cranes discharge part of the load to barges in view of decreasing vessel draft (e.g. lightening operations on River Scheldt to access the Canal Ghent-Terneuzen).

The vessels deployed in the ***minor bulk segments*** (grain, fertilizers, minerals) are generally much smaller so that vessel operators have a much wider range of potential ports of call at their disposal. The eventual call patterns will be determined by factors such as the proximity to the market, the specificities of the distribution network (centralized or decentralized in Europe), the number of cargo batches on the vessel and the need for dedicated terminal facilities (e.g. grain silos).

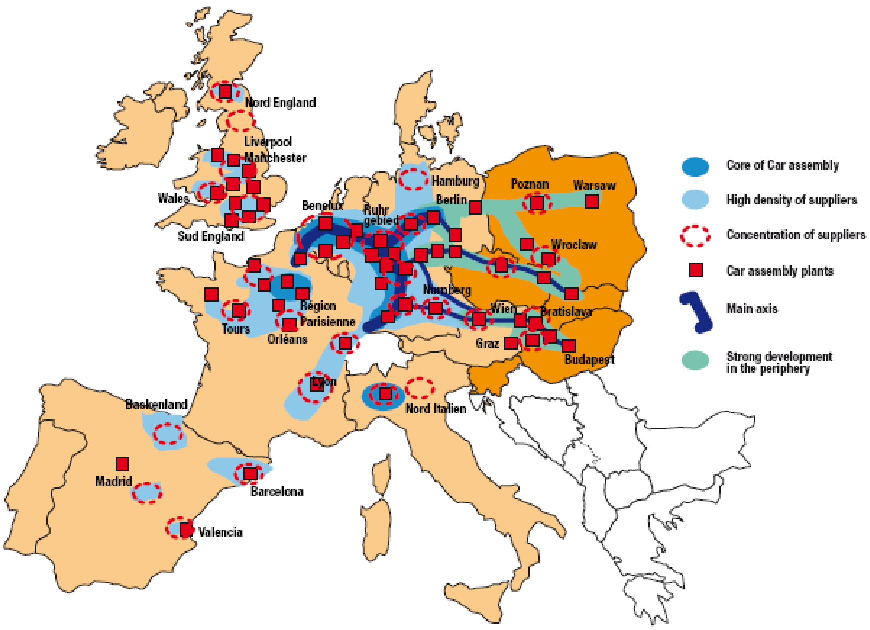
The operational characteristics of maritime services in the ***roro*** segment depend on the submarkets considered:

- Intra-European ***roro and ropax services*** are typically of the end-to-end type with a port of call at either side of the route. The shipping services follow a fixed schedule with medium to high frequencies (sometimes several times a day). The ferry capacities tend to vary greatly with the cargo density on route and the one-way distance. Large units are deployed on the English Channel and parts of the Baltic (e.g. 120 trucks per voyage on link Dover-Calais, 4200 lanemeter and several hundreds of passengers between Travemünde and Finland), whereas vessel capacities on services in smaller markets (e.g. the Irish isles) tend to be much smaller. The trucks that are using ferry services can have a long pre- and endhaul by road (for instance a truck driving from Dortmund to Zeebrugge to catch a ferry to Hull and onward by highway to final destination Manchester).

- The market for ***unaccompanied roro transport***, which is of crucial importance to many ports in Scandinavia (cf. paper and forest products trade) and the North Sea region, is based on end-to-end services with dedicated roro freight vessels which often have reserve space for containers. The market for unaccompanied roro transport between North Europe and the Mediterranean faces fierce competition from road transport. The North Europe – Atlantic market (e.g. between Zeebrugge and Bilbao) is developing well.

- The ***deepsea and shortsea car carrying trade*** is another submarket in the roro market. On intercontinental routes, the operators deploy Pure Car and Truck Carriers (PCTC) with capacities of up to 8000 CEU, resulting in significant costs savings on the sea leg (economies of scale). The number of port of calls is kept to a strict minimum as shipping lines aim for low port time and as they face a shortfall in the number of ports that have the infrastructure to accommodate large quantities of new cars. As a result, a significant part of the market is concentrated in a dozen of very large European car ports lead by Zeebrugge (2.13 million units in 2008) and Bremerhaven (2.08 million). The position of the main ports is strongly entwined with their proximity to the main buyer markets in Europe and the spatial concentration of car assembly plants (figure 3.4). A number of large car ports, such as Zeebrugge, has successfully combined deepsea services with intra-European shortsea services. The resulting hub-and-spoke network configuration combined with growing local clusters of automotive logistics companies have reinforced the concentration of the new car trade in a few European turntable ports. While road haulage is by far the dominant mode in land transport to/from car terminals, rail (all over Europe) and barge (particularly in the Rhine-Scheldt Delta) are playing an ever more important role in securing the inland access of the larger car ports.

*Figure 3.4: The European automotive network*



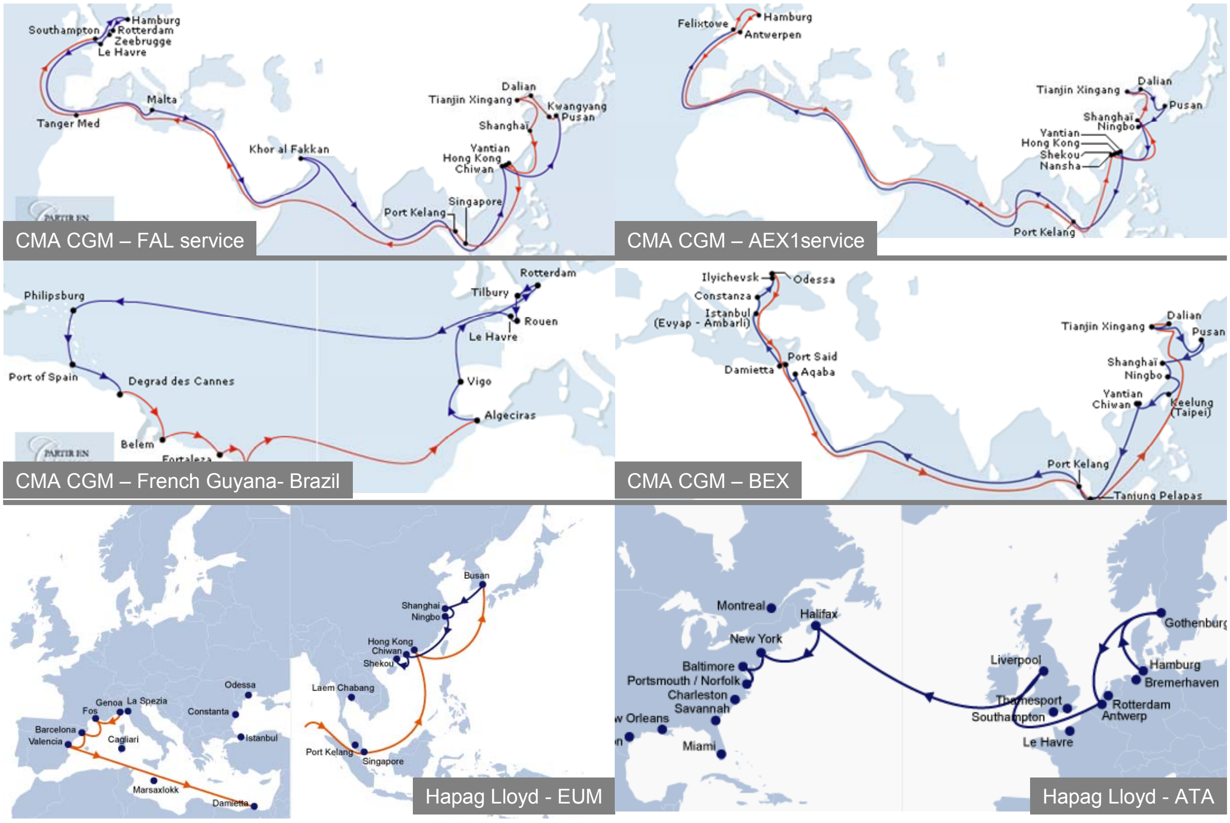

Source: based on ESPO/ITMMA Market Report on the European port industry

The diversity in maritime service configurations is probably the highest in the market of ***conventional general cargo***. In contrast to the bulk cargo market, where parcel sizes are usually big enough to fill an entire ship, the general cargo market deals with the shipment of consignments which are smaller than a ship or hold size. Given the enormous variety of different cargoes involved, there exist several ways in which breakbulk cargoes can be shipped. The most common are the conventional liner-type concepts. The concept of "weekly fixed-day services", which characterizes today's liner shipping industry, is something the deepsea trade of conventional cargo has never really been able to achieve. Instead, the following service/schedule options can be distinguished in the case of breakbulk shipping: (a) Services of a certain frequency operated with dedicated ships, (b) Services offering sailings within a certain period, deploying trip charters, (c) Services operated on inducement, but still within a more or less defined trade lane, (d) A mixture of two or three of the above options; (e) "Parcelling", i.e. tramping whereby a vessel is chartered (usually on a trip-out basis) once a specific cargo volume is available (Dynamar, 2006).

The conventional general cargo market counts a lot of specialized ships, designed to carry specific cargo loads. For example, heavy-lift vessels do not operate on fixed routes, but they are attracted to those areas where large investments in the oil and gas industry are made. Conventional reeferships mainly carry high-value foodstuffs that require refrigeration and/or atmosphere control on an end-to-end service (e.g. bananas from a port of loading in Latin America to a specialized terminal in Antwerp). Examples of reefer cargoes include fresh and frozen fruit (e.g. bananas, deciduous and other citrus fruits), vegetables, fish, meat, poultry and dairy products. Reefer shipping is a prime example of a one-way (and for some products seasonal) business, i.e. cargoes are mainly exported from the Southern Hemisphere to industrialized countries in the Northern Hemisphere. The reefer shipping sector is increasingly being put under pressure from container shipping. It is estimated that about 50-60% of all reefer trade is nowadays being carried in containers. Apart from the 'classic' vessel types, other vessels used to transport of breakbulk cargo include small Handysize (up to 32,000 dwt) or Handymax (up to 47,000 dwt) bulk ships.

The most advanced structures in maritime services are to be found in ***container shipping***. Shipping lines design the networks they find convenient to offer, but at the same time they are bound to provide the services their customers want in terms of frequency, direct accessibility and transit times. In the last two decades increased cargo availability has made carriers and alliances to reshape their liner shipping networks through the introduction of new types of liner services on the main east-west trade lanes. Alliances and consolidation have created multi-string networks on the major trade routes and both shippers and liners are used to it. The largest ships operate on multi-port itineraries calling at a limited number of ports. Maersk Line, MSC and CMA-CGM are among the truly global liner operators, with a strong presence also in secondary routes. The networks are based on traffic circulation through a network of specific hubs.

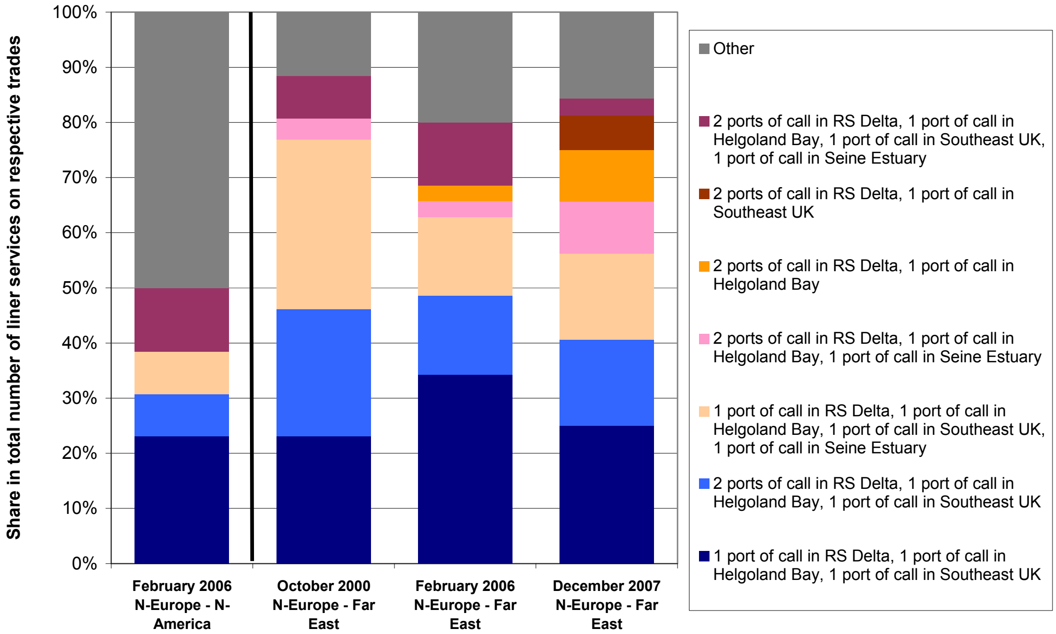
*Figure 3.5: Typical examples of liner services on trade routes in relation to Europe*




Source: shipping lines' websites

When observing recent developments in liner shipping, the productivity has been improved by using larger ships and the devising of new operational patterns and co-operation between shipping lines. Since the 1990s a great deal of attention is devoted to larger, more fuel-economic vessels and this indeed produced a substantial reduction in the cost per TEU of capacity provided. Adding post-panamax capacity gave a short-term competitive edge to the early mover, putting pressure on the followers in the market to upgrade their container fleet and to avert a serious unit cost disadvantage. Shipping lines also rely on organizational scale increases. Horizontal integration in liner shipping comes in various forms ranging from operating agreements (e.g. vessel sharing agreements, slot chartering agreements, consortia and strategic alliances) to mergers and acquisitions. The economic rationality for mergers and acquisitions is rooted in the objective to size, growth, economies of scale, market share and market power. Co-operation between carriers serves as a means to secure economies of scale, to achieve critical mass in the scale of operation and to spread the high level of risk associated with investments in ships. Alliance structures (cf. Grand Alliance, New World Alliance and CYKH) provide its members easy access to more loops or services with relative low cost implications and allow them to share terminals, to co-operate in many areas at sea and ashore, thereby achieving costs savings in the end.

*Figure 3.6: Relative importance of port calling patterns on the North Europe - Far East trade and North Europe – North America trade (in %)*




Note: RS Delta = extended Rhine-Scheldt Delta (see section 2 for location of the multi-port gateway regions)

Source: based on liner service schedules of shipping lines

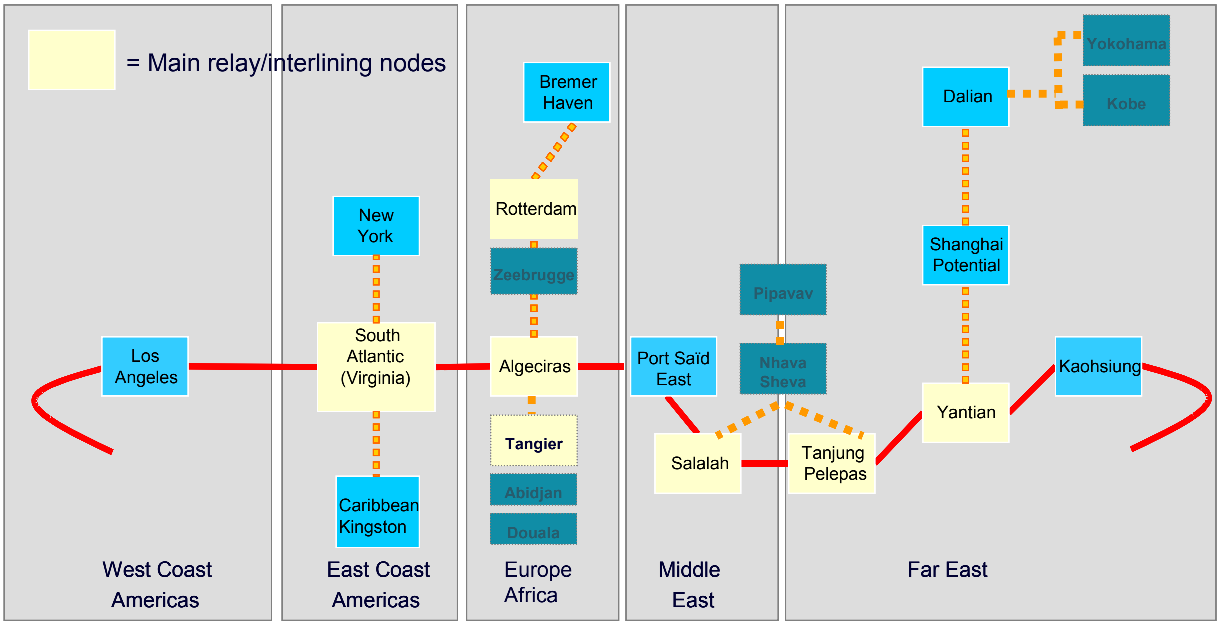
Scale increases in vessels are an important driver of a rationalization in the number of port calls per loop. Given the high operational costs of post-panamax vessels, shipping lines aim for a reduction of the total round voyage time. Limiting the number of calls to a few highly productive seaport terminals contributes to this objective. The Far East trade provides a good example. Most mainline operators and alliances running services from the Far East to North Europe stick to line bundling itineraries with direct calls scheduled in each of the main markets. Notwithstanding diversity in calling patterns on the observed routes, carriers select three up to five regional ports of call per loop (figure 3.6). Shipping lines have significantly increased average vessel sizes deployed on the route from around 4500 TEU in 2000 to over 7000 TEU in early 2009. These scale increases in vessel size have put a downward pressure on the number of port calls per loop on the Far East – North Europe trade: 4.9 ports of call in 1989, 3.84 in 1998, 3.77 in October 2000, 3.68 in February 2006 and 3.66 in December 2007. As vessel sizes are also increasing on other trade routes (table 3.3), shipping lines put a pressure on the number of ports of call for the bulk of liner services in relation to Europe.

*Table 3.3: Typical past and expected vessel sizes on the main trades*

| | 2000 | 2005 | 2010 | 2015 | 2010 vs 2000 | 2015 vs 2000 |
|---|---|---|---|---|---|---|
| **Deepsea east/west** | | | | | | |
| Far East - Europe | 4500-5500 | 5500-7000 | 8000-9000 | 10500 | +70% | +110% |
| Transpacific | 4500-5000 | 5500-6500 | 7000 | 8500 | +47% | +79% |
| Transatlantic | 3500 | 4000 | 5000 | 6500 | +43% | +86% |
| **Deepsea north/south** | 2500 | 3000 | 3000 | 3500 | +20% | +40% |
| **Feeder** | 550 | 650 | 700 | 850 | +27% | +55% |

One of the results of the rationalization in port calls is that not all port regions have the same direct connectivity to the international maritime trade routes. Both in the Baltic and the Mediterranean, extensive hub-feeder container systems and shortsea shipping networks came into existence in the last decade or so to cope with the increasing volumes and to connect to other European port ranges (the Hamburg-Le Havre range in particular). While a number of ports along the Southeast Coast of the UK receive quite some calls of mainline vessels, a significant share of the intercontinental flows in relation to the UK is passing via ports in the Hamburg-Le Havre range, particularly the Rhine-Scheldt Delta ports and Le Havre.

*Figure 3.7: The main strategic ports in the liner service network of Maersk Line*




Note: Relay/Interlining involves trade route based transhipment at key network ports between deep-sea vessel strings. The aim is to transfer containers between mainline services, thereby adding new service options.

*Source: based on liner service data of Maersk Line*

Consequently, the liner service networks of shipping lines are revolving around a set of strategic hubs with each hub having a high connectivity (in terms of frequency and range of ports served) to secondary ports in the network and major inland markets. Figure 3.7 gives an overview of the strategic ports within the worldwide liner network of Maersk Line. A few important points need to be made in this respect:

- Container shipping lines have been very active in securing (semi-)dedicated terminal capacity in the strategic locations within their liner service networks. A substantial number of container terminals in North and South Europe feature a shipping line among their shareholders (in most cases as a minority shareholder). In particular MSC and CMA CGM, the world's second and third biggest container shipping lines, are very active in this field, with involvements in 15 and 10 container terminals, respectively. Maersk Line's parent company, AP Moller-Maersk, operates a large number of container terminals in Europe (and abroad) through its subsidiary APM Terminals;
- Shipping lines do not necessarily opt for the same hubs. For example, the strategic ports in the network of MSC are quite different from the ones Maersk Line is using. MSC uses Antwerp as its main North-European hub (next to Bremerhaven and Le Havre), while Valencia is functioning as one of the main MSC connectivity points in the Med;
- There is an upper limit to the concentration of flows in only a few hubs. For instance, Maersk Line did not opt for one European turntable, but several major hubs. The optimal number of hub ports in the network depends on various factors. One of the main operational factors relates to the cost trade-off between the hub-feeder option versus direct call option. Also, shipping lines can have commercial reasons for not bundling all their cargo in one port (i.e. not all eggs in one basket). The optimal liner service design is not only a function of carrier-specific operational factors (lower costs), but also of shippers' needs (for transit time and other service elements) and of shippers' willingness to pay for a better service. This implies liner service network design is aimed at finding the best trade-off between a cost-driven exercise (cutting

operational costs by deploying larger vessels and reducing the number of calls per round voyage) and a customer-oriented differentiation exercise (e.g. serve local markets with direct calls of mainline vessels).

Next to the number of port calls, the calling order is of importance. If the port of loading is the last port of call on the maritime line-bundling service and the port of discharge the first port of call then transit time is minimized[4]. A port regularly acting as last port of loading or first port of discharge in a liner service schedule in principle has more chance of achieving a higher deepsea call efficiency ratio (i.e. the ratio between the total TEU discharged and loaded in the port and the two-way vessel capacity) compared to rival ports which are stuck in the middle of the loop.

In practice, shipping lines' decisions on the number and order of ports of call is influenced by many commercial and operational determinants, including the cargo generating effect of the port (i.e. the availability of export cargo), the distribution of container origins and destinations over the hinterland, the berth allocation profile of a port, the nautical access, the time constraints of the round voyages and so on. The selection of the ports of call by a shipping line can also be influenced by market structures and behaviour of market players. Some examples:

- Important shippers or logistics service providers might impose a certain port of call on a shipping line leading to bounded rationality in port choice.
- If a shipping line is part of a strategic alliance, port choice is subject to negotiations among the alliance members and can deviate from the choice of one particular member.
- A shipping line might possess a dedicated terminal facility in a port of a multi-port gateway region and might be urged to send more ships to that facility in view of optimal terminal use.
- Carriers might stick to a specific port as they assume that the mental efforts and costs linked to changes in the network design will not outweigh the costs associated with the current non-optimal solution.

Container lines have to a certain extent adjusted their liner service networks to cope with the significant drop in volumes since October 2008 caused by the economic crisis:

- First of all, shipping lines adjusted their capacity deployment strategies. In mid April 2009, the worldwide laid-up fleet totaled about 1.3 million TEU or 10.4% of the world container fleet (Journal of Commerce, 2009). Total capacity on the Far East- Europe trade fell by 21% between October 2008 and March 2009. This corresponds to a net withdrawal of 19 liner services on the trade, leaving only 45 services between Europe/Med and the Far East in March 2009 (table 3.4). The capacity decreases led to a modest rate restoration. Not all shipping lines make the same decisions. While many ocean carriers have been idling their owned ships and returning charter vessels when they come off hire, MSC has been adding capacity by chartering ships at bargain rates. As such, some shipping lines see the crisis as an opportunity to gain market share;
- Many vessels continue to slow steam at around 19 knots, despite the cheaper bunker prices, as the longer roundtrip time helps to absorb surplus capacity in the market (more vessels needed per liner service). Maersk Line and the Grand Alliance are examples of shipping lines even opting to route some of the liner services around the Cape instead of following the Suez Canal route (mainly on the Eastbound leg of the roundtrip). The Cape route became an alternative due to a combination of a poor market situation (low vessel utilization), piracy near Somalia and high Suez Canal transit fees;
- The crisis has urged shipping lines to rationalize services and to cascade larger vessels downstream to secondary trade routes. Shipping companies may face a more comprehensive review of their port calls and network configuration. Port pricing would play an important role in this reconfiguration with the larger ports and their more developed hinterland transport systems in better position than small and medium-sized ports. There are signs that the current drop in volumes might also lead to an increased geographical specialization of gateway ports vis-à-vis specific overseas maritime regions. For example, shipping lines have started to consolidate most of their vessel calls on the Far-East – North Europe trade in Rotterdam and Hamburg, which historically have a strong orientation on Asian cargo.

[4] An example makes this clearer. A more detailed analysis of the position of the Rhine-Scheldt Delta ports in loops on the transatlantic and Europe - Far East trades reveals that Antwerp often appears as first port of call on the transatlantic trade, but seldom on the Far East trade. Shipping lines hardly ever position Rotterdam as last port of call for Asian cargoes. This confirms the general market perception on the Asian trade: Rotterdam has a strong inbound cargo profile, whereas Antwerp possesses a rather strong cargo-generating effect for export flows. The resulting imbalance in the accommodation of inbound and outbound flows points to some degree of complementarity among the large load centres, notwithstanding the existence of fierce inter-port competition.

*Table 3.4: Far East – Europe capacity situation*

| | March 2009 | October 2008 | % change |
|---|---|---|---|
| Total no. of weekly services (North Europe/Med) | 45 (26/19) | 64 (36/28) | -30% |
| Total ships deployed | 406 | 549 | -26% |
| Average vessel size (TEU) | 7310 | 6517 | 12% |
| Total capacity (TEU) | 2.97 million | 3.58 million | -17% |
| Average weekly capacity (TEU) - March 2009 vs. October 2008 | 319,301 | 405,901 | -21% |
| Average weekly capacity (TEU) - 1Q 2009 vs. 4Q 2008 | 335,793 | 397,350 | -15% |

Source: based on data Alphaliner

In the future, shipping lines will continue to mix liner services to create a network best fitting a carriers' requirements. Increasing volumes would lead to an increasing segmentation in liner service networks and a hierarchy in hubs. Hub-and-spoke systems are just a part of the overall scene. There remains no 'one size fits all' approach to the future design of liner service networks. The port hierarchy is determined by the decisions of individual container shipping lines (operating as independent carriers or in groupings) thereby guided by strategic, commercial and operational considerations. The decisions of these lines regarding the hierarchy of the ports of call are rarely identical. Hence, a port may function as a regional hub for one liner operator and as a feeder port for another.

A major threat to the future of complex liner service networks lies in increased schedule unreliability. Low schedule integrities can have many causes, ranging from weather conditions, delays in the access to ports (pilotage, towage, locks, tides) to port terminal congestion or even security considerations. Given the nature of many liner services (more than one port of call, weekly service, hub-and-spoke configurations, etc..) which are closely integrated, delays in one port cascade throughout the whole liner service and therefore also affect other ports of call (even those ports which initially had no delays). The issue of schedule unreliability remains important even as the economic downturn has made capacity problems in ports less severe. Vessel delays compound to delays in inland freight distribution.

## 3.4.2. Rail services

The ***organization of European rail transport*** has undergone a major change characterized by liberalization of the freight market. The opening of the European network was the culmination of a process instigated by the European Commission in the early 1990s with EC Directive 91/440 and Regulation 1896/91. The introduction of competition modified the terms of operation of rail services. The rail liberalization process should lead to real pan-European rail services on a one-stop shop basis.

The liberalization process not only has led to a division between infrastructure managers and railway undertakings. It also broadened the contractual models and service offerings applicable in the rail industry. The container shuttle market provides a good example (Debrie and Gouvernal, 2005).

Dedicated trains and long-term agreements are common when the rail service is provided by railway undertakings which are independent of the senders. Railway undertakings are eager to sign contracts as they have to increase the turnaround rate of the rolling stock and thereby increase profitability. Contracts for dedicated trains are very common in the United Kingdom. The decision to opt for dedicated trains has been motivated by the problems that affect road transport, in particular the shortage of drivers, as well as the fear that the desired rail capacities would not be available. Obviously, dedicated trains are only a solution for those with a sufficient volume of traffic. Other contract arrangements include a shipping line filling a predefined percentage of the total capacity of the shuttle trains.

Market players can also actively participate in rail services through joint ventures arrangements or via subsidiaries. A good example is provided by European Rail Shuttle (ERS), a subsidiary of the AP Moller Group. ERS was initially centered on the port of Rotterdam, but it has now been extended to the German ports of Hamburg and Bremerhaven, to Belgian ports Zeebrugge and Antwerp and to inland terminals in Hungary, Poland, the Czech Republic and Slovakia. ERS acts as an intermediary between Maersk Line and the rail undertakings in the countries it operates in, managing the contracts for train staff and traction and renting out empty space to third party shipping companies. ERS can also perform traction itself on a few routes via ERS Railways. Similarly, a number of terminal operators are also developing a set of rail services. For example, HHLA[5] and Eurogate[6], two German terminal operators have introduced rail shuttles, mainly from Hamburg and Bremerhaven. Some of these services were put in place with the traditional operator while others took advantage of the opening up of the rail market to work with new operators. The intermodal operators own the inland terminals. There are many examples of participations of this type by which operators become important players in the development of rail services. The taking of participation in the capital of transport operators and the creation of railway subsidiaries from nothing demonstrates the widespread presence of this participative model. While Germany and the UK are some of the countries at the forefront of new rail service models, France only recently started to adopt cooperation models between SNCF subsidiaries and major clients (shipping companies, senders, etc.). The first private traction company entered the French market in 2005. The opening up of the market has been applied differently in different EU countries.

While the institutional modification has major impacts on the organization of rail transport supply, it is also changing the ***configuration of rail service networks***.

There are three key decisions for rail operators to make when setting up a new container service: the service frequency (including the fixed days/hours of the week for departure/arrival), the capacity of the train combination and the number of stops at intermediate terminals (if any). These elements are highly interrelated. Rail service frequencies in hinterland transportation largely depend on the route considered, but typically range between one and six departures per week. The optimal load capacity of a train combination depends on cargo availability, shippers' needs for transit time or other service elements and choices made with respect to the two other key variables. The maximum rail track lengths in inland rail terminals put an upper limit on the unit capacity of a train (i.e. typically 600m to 750m in Europe). Container shuttle trains in Europe have a capacity ranging between 40 and 95 TEU.

Rail operators prefer to operator frequent point-to-point services between a port and an inland destination. Such direct shuttle trains have more chances of survival if a substantial part of the necessary cargo volume is guaranteed by a large customer (e.g. a shipper via merchant haulage or a shipping line via carrier haulage). The backbone of rail services out of the European container ports is formed by direct shuttle trains that offer uninterrupted services between a port and one point of destination at a fixed time schedule and a fixed composition of wagons. Direct shuttles require large base volumes. For example, at an average load factor of 80%, a train capacity of 75 TEU and a frequency of three departures per week, the operator will need an annual demand of 9,000 TEU one-way or 18,000 TEU two-ways (see point A in figure 3.8) and this is only for one destination. The elevated volumes needed to run regular shuttle trains imply that they can only be exploited in a profitable way on a number of high-density traffic corridors. It also implies that the profitability of a lot of individual direct shuttle trains remains insecure. As a result, new direct shuttle services are often terminated within a time span of less than one year, simply because cargo availability is low or highly fluctuating.

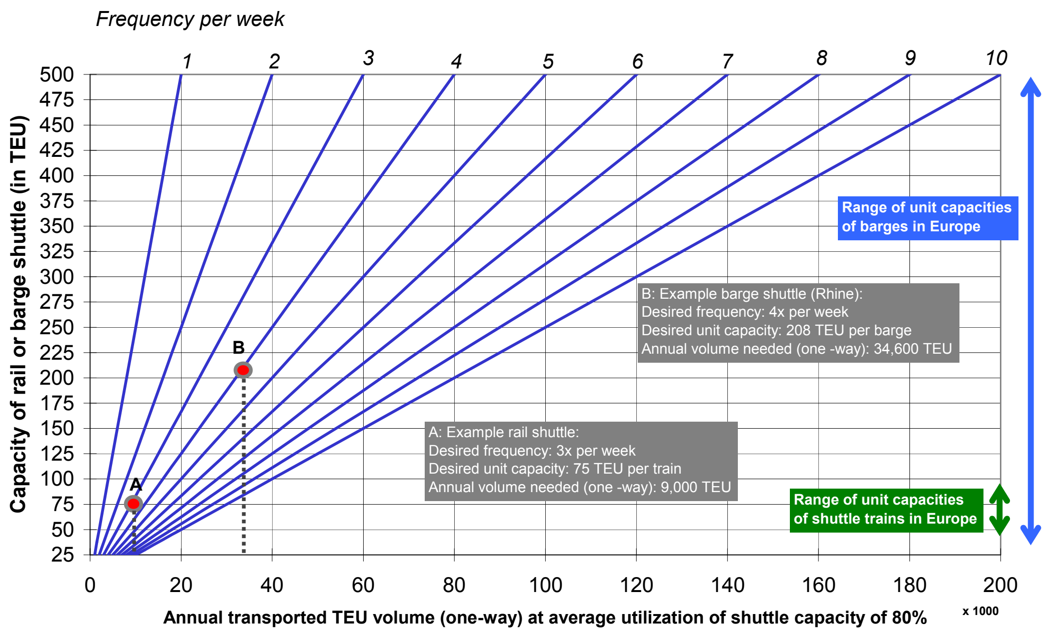
Some carriers and rail operators have resolved the problems related to the fluctuating volumes and the numerous final destinations by bundling container flows in centrally located rail nodes in the hinterland. Shuttle trains from the ports carrying containers for many destinations arrive in the hub on a regular basis. The wagon groups are exchanged between trains at the rail hub and are combined to form new single-destination shuttle trains heading for the distant hinterland. The advantages of bundling are higher load factors and/or the use of larger transport units in terms of TEU capacity and/or higher frequencies and/or more destinations served. The main disadvantages of bundling are the need for extra container handling at intermediate terminals (higher transit time, increased risk of damage), longer transport distances and a higher dependency on service

[5] HHLA, a cargo handler owned by the City of Hamburg, is a stakeholder in three services: one to Poland, a second to the Czech Republic, and a third to Hungary. In each case, an intermodal operator is involved: Polzug in the first case, Metrans for the Czech Republic and Intercontainer-Interfrigo (ICF) for the HHCE service to Hungary.

[6] BoxXpress is a joint venture of which Eurogate Intermodal, a subsidiary entirely owned by Eurogate, owns 38.5% of the capital, European Rail Shuttle (ERS) 46.5% and the logistics provider Netlog 15%. Eurogate is responsible for all operations at the port terminal as well as for rail coordination.

quality. These elements incur additional costs which could counterbalance the cost advantages linked to higher load factors or the use of larger unit capacities.

*Figure 3.8: Relationship between unit capacity, service frequency and annual volume (at a load factor of 80%)*



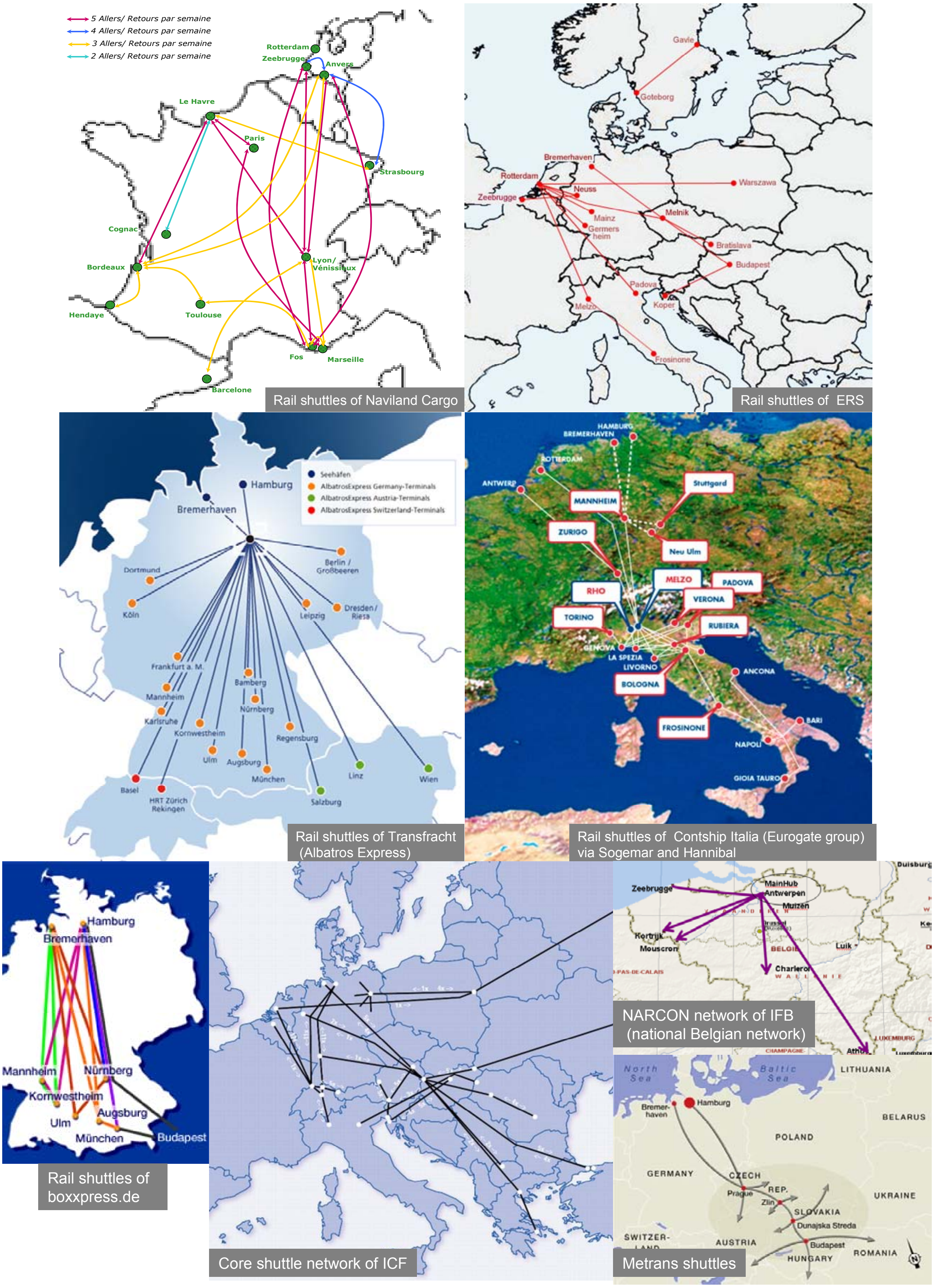

Source: own elaboration

In the new millennium, European rail liberalization has partly contributed to a decline of many of the hub-and-spoke networks. The search for profitability has encouraged massification and concentration on the most highly trafficked routes, and, conversely, withdrawal from the least profitable routes leading to a reduction in the size of networks. In other words, rail operators are relying heavily on a massified system of direct point-to-point links. What is involved is not developing a railway network but increasing the number of major lines. The new networks would be less vulnerable to distortions in the network. As a result, quite a number of hub-and-spoke networks in Western Europe have ceased to exist in the past five years. For example, both ICF's Qualitynet and IFB's North European Network (NEN) stopped operations in 2004. The rail operators involved shifted operations to a system of direct shuttle trains out of the main load centers. Hub-and-spoke networks are however still quite common in the connection to East and Central Europe.

The German rail case is quite unique in Europe. German container terminal operators are directly involved in intermodal rail transport. HHLA has a stake in Metrans, Polzug and HHCE (Hamburg Hungaria Container Express) and formed Hanse Express with DB. TFG Transfracht, a subsidiary of HHLA Intermodal GmbH and DB Mobility Logistics AG, transported 932,000 TEU by rail via its AlbatrosExpress system (figure for year 2007). Eurogate Intermodal formed boXXpress.de together with ERS (European Rail Shuttle) and KEP Logistik. BoXXpress.de organises shuttle trains to and from German ports completely independent of DB Cargo. Furthermore, Eurogate has a controlling interest in the Italian rail operator Sogemar (through Contship Italia). Transfracht DB Intermodal is also present in the UK by providing daily services through the Channel Tunnel to countries across Europe. French sister company, Euro Cargo Rail, is able to provide rail services in France.

A number of shipping lines, such as Maersk Line, have gone rather far in providing rail services. Maersk Line wants to push containers into the hinterland supported by its terminal branch APM Terminals and its rail branch ERS. ERS operates a vast network of shuttle trains mainly out of the port of Rotterdam to inland destinations across Europe. Started at 3 shuttles a week in 1994, ERS now offers 280 shuttles a week and handled a rail volume of 620,000 TEU in 2006. CMA CGM and MSC are moving along the same path. For example, CMA Rail (formerly known as Rail Link), the CMA CGM rail subsidiary, was founded in 2001 and handled 90,200 TEU in 2007 on links from Marseille/Fos, Lyon, Dourges and Le Havre to destinations in France, the Benelux and Germany.

*Figure 3.9: Examples of rail services of a number of European operators*




Rail shuttles of Naviland Cargo

Rail shuttles of ERS

Rail shuttles of Transfracht (Albatros Express)

Rail shuttles of Contship Italia (Eurogate group) via Sogemar and Hannibal

Rail shuttles of boxxpress.de

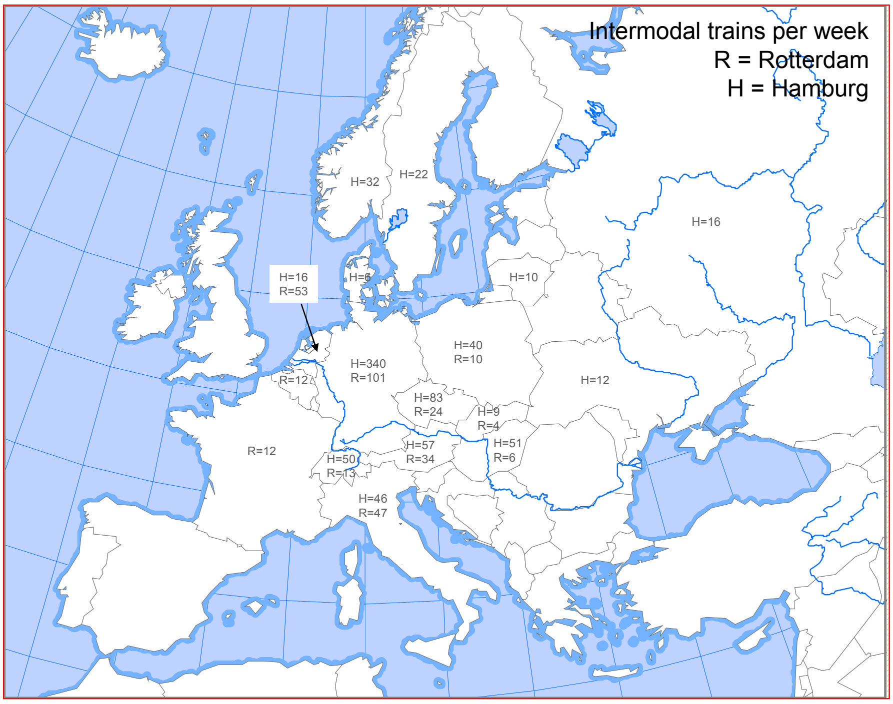
Core shuttle network of ICF

NARCON network of IFB (national Belgian network)

Metrans shuttles

Source: companies' websites

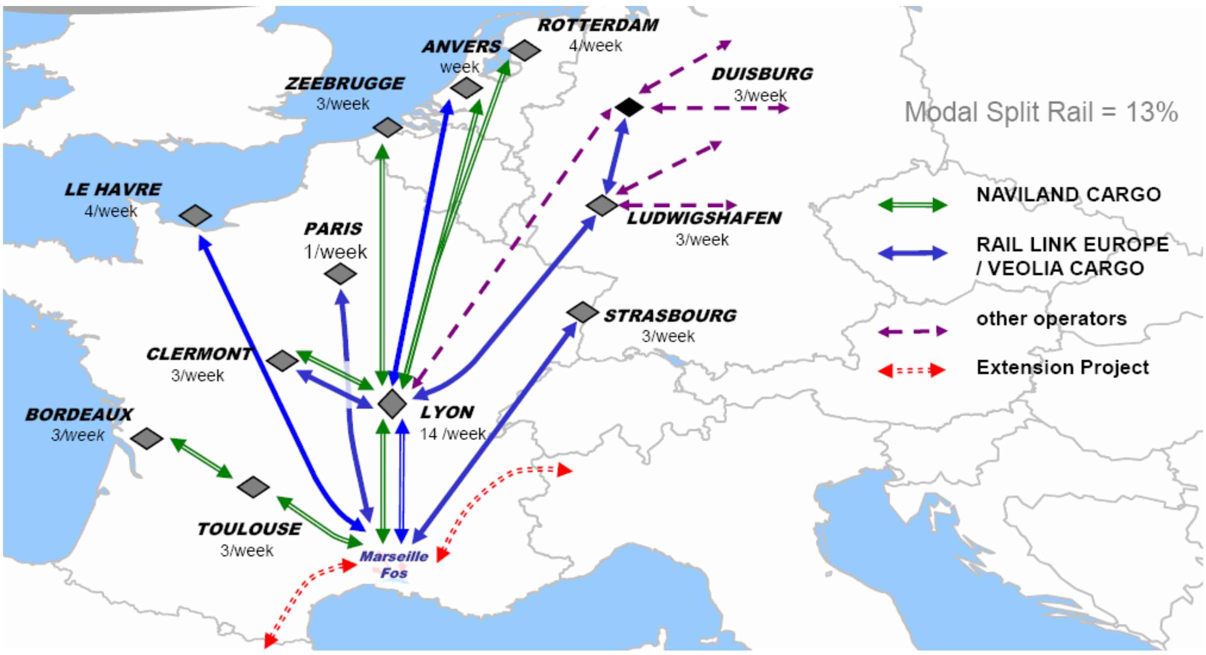
*Figure 3.10: Intermodal rail services out of Rotterdam (R) and Hamburg (H) – departures per week*




Source: based on figures HPA and Rotterdam Port Authority

Major differences can be observed in rail demand in European ports. Among the largest rail ports in Europe we find Hamburg (1.89 million TEU in 2008, 1.8 million TEU in 2007), Rotterdam (905,000 TEU in 2007), Antwerp (700,000 TEU in 2006), Bremerhaven (812,000 TEU in 2007), Zeebrugge (7.3 millions tons of containerized cargo in 2007), Gothenburg (342,000 TEU in 2008 and 322,000 TEU in 2007), Marseille (130,000 TEU in 2007) and Le Havre (98,000 TEU in 2007). As an illustration, figures 3.10 and 3.11 provide an overview of the rail service frequencies out of the ports of Rotterdam, Hamburg and Marseille. Table 3.5 presents the modal split figures in a selection of European container ports.

*Figure 3.11: Intermodal rail services out of Marseille*




Source: Grand Port Maritime de Marseille

*Table 3.5: Modal split for inland transport of containers (selection of container ports)*

| | | Road | Rail | Barge |
|---|---|---|---|---|
| **Amsterdam (Ceres Paragon)** | 2004 | 60 | 5 | 35 |
| | 2005 | 57 | 2 | 41 |
| | 2006 | 54 | 3 | 43 |
| | 2007 | 50 | 7 | 43 |
| **Antwerp** | 1998 | 64.5 | 7.8 | 27.7 |
| | 2000 | 60.6 | 10.1 | 29.3 |
| | 2002 | 59.5 | 9.3 | 31.2 |
| | 2007 | 59.8 | 8.0 | 32.2 |
| **Bremerhaven (Eurogate)** | 2002 | 53.1 | 44.4 | 2.5 |
| | 2005 | 43.0 | 53.0 | 4.0 |
| | 2006 | 39.6 | 56.3 | 4.1 |
| **Constanza** | 2000 | 56.0 | 44.0 | 0.0 |
| | 2002 | 53.0 | 47.0 | 0.0 |
| | 2004 | 61.6 | 38.4 | 0.0 |
| | 2005 | 33.9 | 65.8 | 0.3 |
| | 2006 | 47.6 | 47.3 | 5.1 |
| **Dunkirk** | 2002 | 82 | 14 | 4 |
| | 2002 | 72 | 25 | 3 |
| | 2005 | 88 | 8 | 4 |
| | 2006 | 88 | 8 | 4 |
| **Hamburg** | 1998 | 70.1 | 29.7 | 0.2 |
| | 2000 | 70.0 | 28.7 | 1.3 |
| | 2002 | 69.6 | 28.7 | 1.7 |
| | 2005 | 67.4 | 30.5 | 2.1 |
| | 2006 | 69.0 | 28.7 | 2.3 |
| | 2007 | 68.9 | 29.0 | 2.1 |

| | | Road | Rail | Barge |
|---|---|---|---|---|
| **Le Havre** | 1995 | 82.5 | 16.9 | 0.6 |
| | 1998 | 84.6 | 14.3 | 1.3 |
| | 2000 | 85.1 | 12.2 | 2.7 |
| | 2002 | 85.4 | 11.7 | 2.9 |
| | 2005 | 87.4 | 6.2 | 6.4 |
| | 2006 | 86.8 | 5.1 | 8.1 |
| **Marseilles-Fos** | 2000 | 82.7 | 16.9 | 0.4 |
| | 2002 | 82.1 | 15.6 | 2.4 |
| | 2005 | 82.0 | 12.0 | 5.6 |
| | 2006 | 81.9 | 12.1 | 6.0 |
| **Rotterdam** | 1998 | 51.3 | 14.5 | 34.2 |
| | 2000 | 48.0 | 13.0 | 39.0 |
| | 2002 | 59.0 | 9.0 | 32.0 |
| | 2003 | 59.0 | 10.0 | 31.0 |
| | 2004 | 60.0 | 9.0 | 31.0 |
| | 2005 | 60.0 | 9.0 | 31.0 |
| **Zeebrugge** | 1990 | 70.5 | 26.9 | 2.6 |
| | 2000 | 79.8 | 17.7 | 2.5 |
| | 2002 | 78.3 | 20.5 | 1.2 |
| | 2005 | 62.0 | 36.6 | 1.4 |
| | 2006 | 61.2 | 37.6 | 1.2 |

*Source: Data respective port authorities and Schiffahrt Hafen, Bahn und Technik (2/2007)*

## 3.4.3. Barge services

The spatial distribution of barge services in Europe is strongly linked with the availability and navigability of inland waterways and canals (see figure 3.12). Barge container transport in Europe has its origins in transport between Antwerp, Rotterdam and the Rhine basin, and in the last decade it has also developed greatly along the north-south axis between the Benelux and northern France (Notteboom & Konings, 2004). Antwerp and Rotterdam together handle about 95% of total European container transport by barge. Volumes on the Rhine have increased from 200,000 TEU in 1985 to some 1.8 million TEU in 2006 leading to higher frequencies and bigger vessels (figures Central Commission for Navigation on the Rhine). Both Rotterdam and Antwerp handle more than 2 million TEU (about 2.2 million TEU for Antwerp and 2.445 million TEU in Rotterdam in 2007). Inter-port container exchanges by barge between Antwerp and Rotterdam are estimated at nearly 1 million TEU. The huge scale of barge operations in Rotterdam and Antwerp generates advantages not found in smaller container ports. The organizational advantages are apparent in the clustering of barge operators and related companies (e.g. ship repairs and ship chandlers). Other container seaports are seeking to give inland barging a more prominent place in their inland distribution patterns of maritime containers, but the existing dominance of Antwerp and Rotterdam in barging is unlikely to be challenged.

The barge container market is growing on the Rhône-Saône basin in relation to Marseille (from around 7,700 TEU in 2001 to about 60,000 in 2007) and the Seine (159,000 TEU in 2007 via barge services out of Le Havre operated by Logiseine, River Shuttle Containers, Marfret, MSC and Maersk). Hamburg is developing barge services on the Elbe, with annual volumes in 2008 exceeding 119,000 TEU compared to 92,000 TEU in 2007. Bremen/Bremerhaven has a modest barge volume of 53,502 TEU in 2007 compared to 32,857 TEU in 2003. The barge volumes of Le Havre, Hamburg, Bremerhaven and Marseille together amount to about 365,000 TEU, which remains modest compared to the joint barge traffic of Rotterdam and Antwerp (about 4.65 million TEU). Apart from the ports discussed, also Constanza is developing barge transport solutions to former Yugoslavia, Hungary, Slovakia and Austria[7].

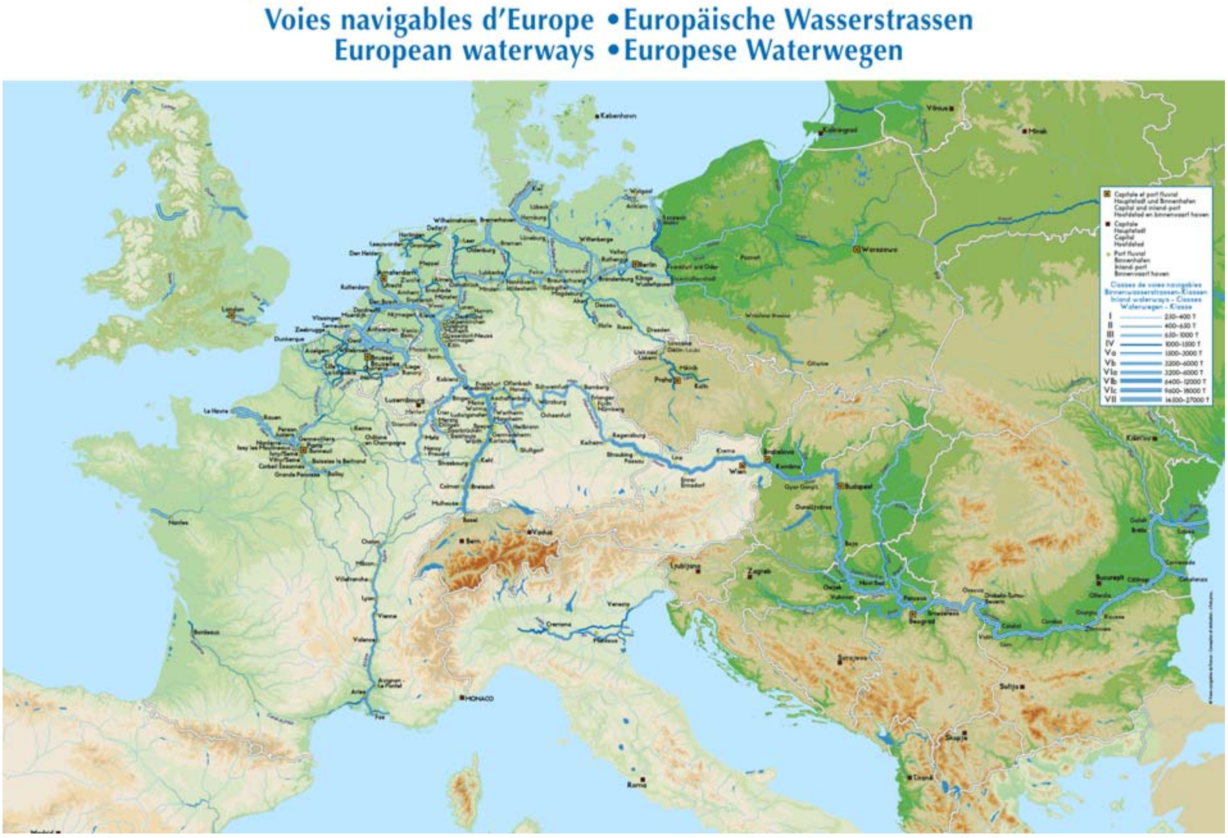
At present the liner service networks offered on the Rhine are mainly of the line bundling type with each rotation calling at 3 to 8 terminals per navigation area (Lower Rhine, Middle Rhine, Upper Rhine). The inland vessels used on the Rhine have capacities ranging from 90 to 208 TEU, although more and more bigger units and push convoys of up to 500 TEU can be spotted. On average, the annual volume needed to operate a frequent barge service is higher than in rail transport (see

[7] In 2004, the EBRD lent € 16 million to the state owned National Company Maritime Ports Administration Constanta S.A. (MPAC), for the construction of a barge terminal that would facilitate the transfer of some 40 million tons of transshipment cargo from the inland river system to the deepsea carriers calling at the port.

point B in figure 3.8 earlier in this report). Rotterdam has a strong position on barge traffic from/to the lower Rhine and middle Rhine, whereas Antwerp and Rotterdam are equally strong on the upper Rhine. The number of terminals in the Rhine basin is steadily increasing. This is the result of new terminal operators arriving on the market and of new terminals appearing along the Rhine and its tributaries.

*Figure 3.12: European inland waterways*




The growing realization of the potential offered by barge container shipping has led to a wave of investment in new terminals over the past ten years, in northern France, the Netherlands and Belgium. The Benelux and northern France now have more than 35 container terminals, about as many as in the Rhine basin. In 1991 there was still no terminal network on the north-south axis (only two terminals). The next step is to establish a network of liner services connecting the various terminals outside the Rhine basin on a line bundling basis.

The bulk of the barge services is controlled by independent barge operators. They have always shown a keen interest in the exploitation of inland terminals. About two thirds of all terminals in the Rhine basin are operated by inland barge operators or the logistics mother company of a barge operator. The remaining terminals are operated/owned by stevedoring companies of seaports, inland port authorities (e.g. Port Autonome de Strasbourg) or logistic service providers.

The new millennium brought rising pressure on the existing co-operation agreements on the Rhine as more and more operators are eager to start services independently from their partners. For instance, CCS withdrew from the Fahrgemeinschaft Niederrhein collective on 1 January 2000. In 2006, the Fahrgemeinschaft Oberrhein (OFG) nearly ceased to exist when Rhinecontainer and Haeger&Schmidt decided to step out of the OFG partnership and to start up the Upper Rhine Container Alliance (URCA). A major restructuring of the barge services within OFG took place once Interfeeder was taken over by Contargo in October 2006. Collaborative agreements are making their appearance in other navigation areas such as shuttle services between Antwerp and Rotterdam. Joint ventures, mergers and takeovers form a relatively new aspect, aimed at increasing the geographical scope of the services offered, and at developing the operators' own barge transport networks. The initiatives being developed in this connection are aimed at increasing the geographical scope of the services offered, and at developing the operators' own barge transport networks[8]. In addition, the leading barge container carriers are increasingly trying to achieve a functional vertical integration of the container transport chain by extending the logistical services package to include complete door-to-door logistical solutions. In the 1990s, three logistics holdings got a strong grip on the barging market: (1) Wincanton, the mother company of Rhenania with subsidiary Rhinecontainer (375,000 TEU in 2004), (2) Rhenus Logistics, mother company of Contargo (including SRN Alpina and CCS) and (3) Imperial Logistics Group, mother company of Alcotrans. Alcotrans transported around 220,000 TEU on the Rhine in 2006. The Contargo network, comprising of 19 inland container terminals in Germany, the Netherlands, France and Switzerland, handled some 840,000 TEU in 2006. The integration of leading barge operating companies in the structures of highly-diversified logistics groups further strengthens the functional integration in the logistics chain. On top of barge operations via Rhinecontainer, the Wincanton group has set up its own railway company Railcontainer that uses main hubs in Neuss and Mannheim and cooperates with ERS, IFB, MSC and others. Rhenus Logistics offers similar services through the RheinRail Service of CCS.

A number of deepsea terminal operators show an increasing interest in the barging option and particularly the inland terminals connected to it. HPH-owned ECT in Rotterdam has followed an active strategy of acquiring key inland terminals acting as extended gates to its deepsea terminals, e.g. DeCeTe terminal in Duisburg (Germany) and TCT Belgium in Willebroek (Belgium). DP World is following a similar strategy. DP World is working in partnership with CMA CGM to streamline intermodal operations on the Seine and Rhône axes, while the large terminals of Antwerp Gateway (open since 2005) and London Gateway (future) are both linked to inland centres in the hinterland. DP World has set up Hintermodal in joint venture with the intermodal transport organizer Shipit to give concrete content to the concept of terminal operator haulage from the Antwerp Gateway terminal to the hinterland. The terminal operator haulage concept is aimed at a more active involvement of the terminal operator in hinterland connections by establishing closer relationships with shipping lines and inland operators. Terminal operators can play an instrumental role in bringing together intermodal volumes of competing lines and as such create a basis for improved or even new intermodal services.

### 3.4.4. The relation between cargo concentration in ports and rail and barge service networks

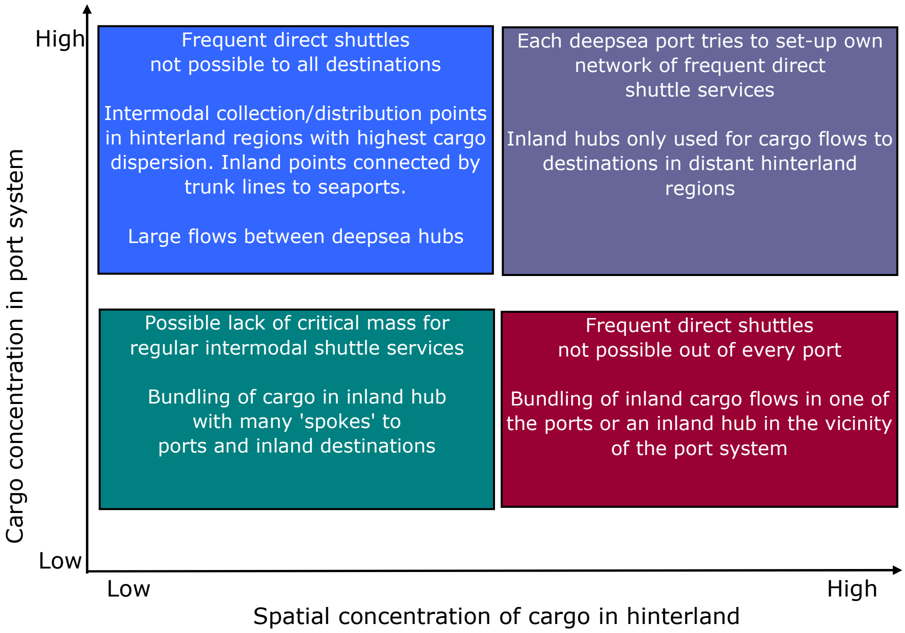
The configuration of barge and rail networks proofs to be a crucial organizational element for the future spatial hierarchy in the European port system. Market players have identified inland logistics as one of the most vital area still left to cut costs. More economical ships and alliance co-operation have lowered ship system costs, but at the same time intermodal costs share an increasing part of the total cost.

The feasibility of bundling in hinterland container traffic partly depends on the level of cargo concentration in the port system and on the dispersion level of maritime cargo volumes in the hinterland (figure 3.13).

A certain level of traffic concentration in a limited number of seaports is required in order to allow a virtuous cycle of modal shifts from road haulage to high-volume transport modes. Most large container ports in Europe are witnessing a virtuous cycle: the availability of cargo makes it possible to build an extensive network of intermodal hinterland services and this in itself attracts even more cargo (partly triggered by economies of scale and density). But even port systems with a low degree of concentration have embraced intermodal transport as maritime container traffic has increased sufficiently in the last decades to allow the operation of frequent inland shuttles to destinations in the immediate hinterland. As such, a low level of cargo concentration in a port system can still be beneficial to the development of intermodal services if it goes hand in hand with substantial cargo volumes per port or if inland hubs are in place where outgoing container flows of the individual seaports can be bundled.

[8] Danser Container Line, for instance, which offers services on the Rhine and Neckar and between Rotterdam and Oss, acquired Eurobarge from Nedlloyd Rijn & Binnenvaart in 1999. Eurobarge mainly operates barges on the Antwerp-Rotterdam route. Since January 2006, Danser Container Line controls the barge services of Natural Van Dam AG, an operator formerly owned by the logistics group Cronat from Basel. In 2000, Rhinecontainer acquired Container Exploitatiemaatschappij (CEM), a main player on the Antwerp-Rotterdam axis. In the same year, CCS and SRN Alpina came under the same ownership, as a result of Rhenus (the parent company of CCS - SRN Alpina) acquiring the Swiss holding company Migros. Since 2004, Rhenus Logistics integrated Combined Container Service (CCS) in its container transport division Contargo.

*Figure 3.13: Inland service configuration as a function of the level of cargo concentration in port systems and in the hinterland*




Source: own elaboration

Figure 3.8 earlier in this report illustrated the volume needed to set-up a frequent barge or rail shuttle can be substantial. However, there is no general rule available to determine the critical mass a port needs to set up a network of direct shuttles to the hinterland. Much will depend on the spatial dispersion of cargo in the service area of the port. A port that only serves a dense local economic cluster typically will have less difficulties in developing a regular inland service than a port handling containers for a large number of final destinations dispersed over a vast hinterland. A seaport with a large local cargo base will sooner or later be tempted to increase the inland penetration of its intermodal hinterland network so as to increase its capture area. From that moment on the existing dense network of direct shuttles to nearby destinations might be complemented by indirect inland services to more distant destinations built around one or more inland hubs. This is a trend that is taking place in quite a number of ports. Some examples:

- Marseille is using Lyon to connect to more Northern destinations. Also Barcelona sees Lyon as an important inland turntable;
- The Benelux ports are using inland hubs in Germany and Hungary (cf. Sopron) to connect to Central and Eastern Europe;
- Hamburg strongly relies on rail services to Prague to connect to further destinations in Central Europe.

Extensive cargo concentration on a few trunk lines opens possibilities to economies of scale in inland shuttles (through the deployment of longer trains or larger inland barges) but even more likely to higher frequencies.

The hinterland connections of smaller ports and new container ports in a start-up phase remain rather precarious. Smaller ports and new terminals find themselves confronted with a vicious circle in the organization of hinterland transportation. The small-scale container volumes do not allow to install frequent block and shuttle trains to the more distant hinterlands. Because of the inability to serve a substantial hinterland, the major shipping lines do not include these ports in their liner services. One way for smaller container ports to escape this vicious circle is by seeking connection to the extensive hinterland networks of the larger ports through the installation of shuttle services either (a) to rail platforms in the big container ports or (b) to master rail hubs in the hinterland. The hub-feeder hierarchy in case (a) further strengthens the competitive position of the larger ports. Situation (b) demands the availability of rail hubs in the immediate or more distant hinterland. The inclusion of bundling points in the hinterland promotes the formation of multi-port gateway regions and increases the complexity and range of possible routing patterns. As discussed earlier, numerous hub-and-spoke railway networks have indeed emerged in the 1990s, thereby allowing higher service frequencies and the inclusion of smaller container ports in the network (e.g.

Qualitynet of Intercontainer-Interfrigo (ICF) with hub Metz-Sablon in the north-east of France). However, European rail liberalization has partly contributed to the recent decline of many of the hub-and-spoke networks. A further decline of hub-and-spoke rail networks in Europe could seriously affect the future growth potential of smaller and new ports as they would remain confronted with the vicious circle effect.

## *3.5. Infrastructural layer*

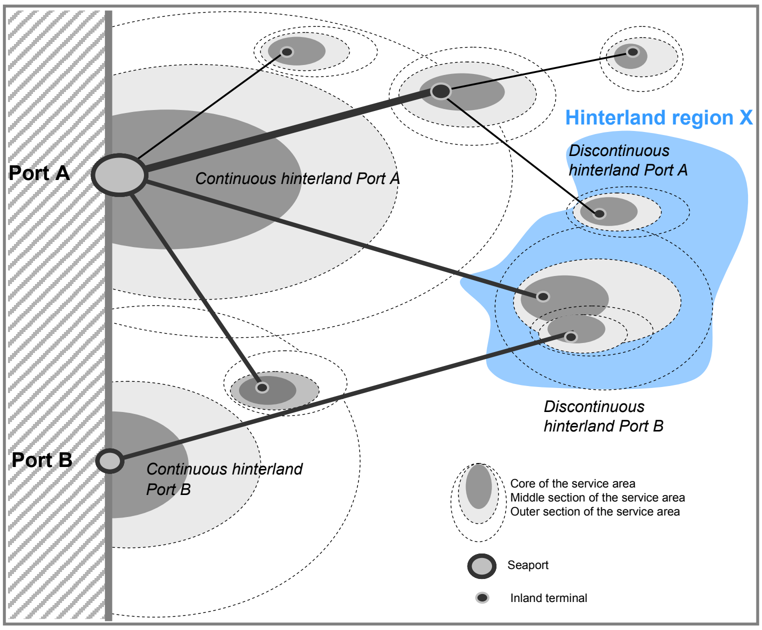
The infrastructural layer is the third layer in the 'four-layer' approach to port-hinterland dynamics. The availability of adequate infrastructure in transport nodes (ports, dry ports, inland terminals) and on the links in the network is a prerequisite for the development of activities by transport operators (transport layer) and logistics players (logistical layer).  Infrastructure should act as a strong enabler of port-related market dynamics that lead to efficient and sustainable co-modal freight transport services.

The planning and construction of major port and inland infrastructures typically takes many years, while the planning and implementation of shuttles usually varies between a few months up to one year. This difference in responsiveness generally leads to time lags between changes at the logistical and the transport level and the necessary infrastructural adaptations needed to meet these changes adequately. The observed time lags are key to explaining undercapacity (congestion) and/or overcapacity situations in hinterland networks and port systems in Europe. Periods of high trade growth are typically characterized by an infrastructural scarcity in markets. When scarcity reaches a continuous high level, logistics players start to consider capacity problems as the new normal. They can adjust their logistics networks by increasing time buffers in the system (a measure which comes at an extra cost) or by finding alternative routes with a lower 'resistance' to their needs in terms of costs and reliability. Seaports who find themselves on inefficient or capacity-tight corridors obviously are in a disadvantageous position. With the current economic downturn, many market players are reassessing capacity issues.

A poor responsiveness of infrastructure development to the demand at the transport and logistical layers leads to negative effects on market players. Infrastructure investments not valorized by market players have to be avoided. But even sound investments in new infrastructures can have a negative impact on existing networks. The rents on earlier investments by transport operators can be undermined by (1) underinvestments in infrastructure, (2) 'supply push' infrastructure investments in other places aimed at redistributing flows in Europe. The latter issue needs careful attention by policy makers since an 'unnatural' rebalancing of flows can undermine the success of existing shuttle networks as the redistribution of flows puts a downward pressure on the scale and frequencies in existing shuttle networks and thus makes these networks less successful.

Infrastructure development combined with efficient co-modal services can have various effects on the geography at the logistical layer. The development of large scale intermodal line infrastructures increases the mobility of logistics and economic activities. Trunk lines to major gateways or multi-gateway port regions give inland regions a better accessibility to overseas markets. Infrastructure thus acts as a facilitator to increase the participation of land-locked and peripheral regions in global production and logistics networks. Infrastructural developments can also multiply the routing options available between specific inland regions and overseas regions (see e.g. hinterland region X in figure 3.14). Given the increasing need for flexible logistics networks (see earlier in this report), inland regions typically vie for a good accessibility to more than one gateway port. Many regions even aim at attaining a high connectivity to more than one multi-gateway port region (see later). Infrastructural developments make that (large) gateways face less 'resistance' in reaching the natural hinterland of other ports and promotes inter-port competition via the formation of so-called discontinuous hinterlands.

*Figure 3.14: Discontinuous hinterlands and the role of trunk lines*

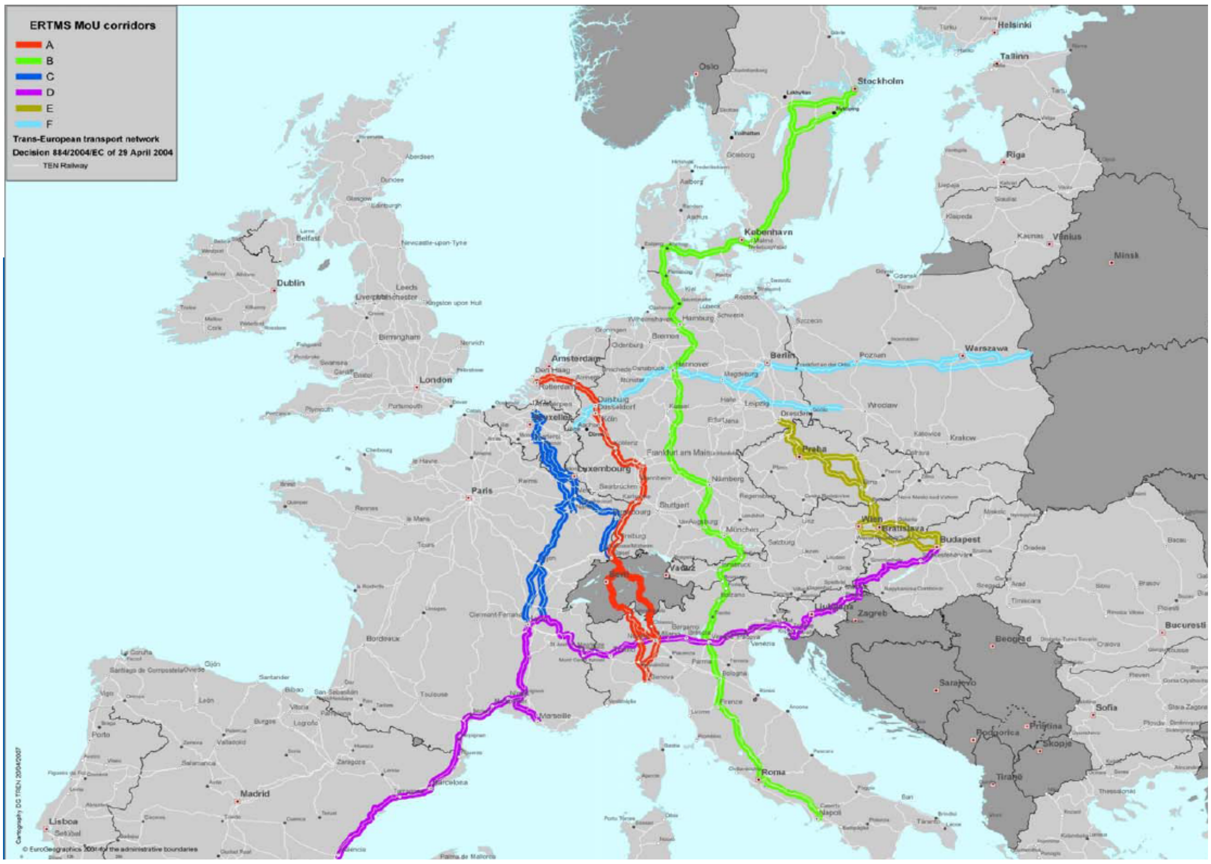



Strong multi-port gateway regions are typically confronted with a strong demand pull for infrastructural capacity. For example, the Rhine-Scheldt Delta and the Helgoland Bay ports face the fact that no new major corridor infrastructures have been developed in the recent past (the rail-dedicated Betuweroute in the Netherlands being one of the last major accomplishments). The focus has therefore been on stretching existing capacity on the corridors via advanced traffic management systems and the implementation of effective cargo bundling and cargo coordination systems. While measures to optimize the use of existing capacity are obviously the right way to go, there are limits to the 'stretching' of the use of existing capacities. In Eastern Europe and parts of Southern Europe the focus is more on developing the much-needed corridors in the first place.

The inland transport network in Europe have taken shape in the last decades. The inland waterway infrastructure network is defined in terms of inland waterways and canals (most of which have been built a long time ago). The main axes include (a) the Rhine and its tributary rivers (Main, Neckar, Mosel), (b) the river system in the Benelux and northern France, (c) the Rhône-Saône basin, (d) the Northern network around the Elbe and Weser and associated canals, (e) the Rhine-Main-Danube linking the Alpine Region to the Black Sea. The Seine-Nord project is among the most significant infrastructure projects with potentially structural effects on port competition and cargo routing in the Benelux and Northern France.

The shortsea network is captured by the Motorways of the Sea concept. From a functional perspective, a distinction can be made between three types of shortsea services using the European waters: (a) the roro and ropax services (see earlier section 2.2), (b) the feeder services between main ports of call for deepsea vessels and feeder ports, and (c) other intra-European shortsea services. The infrastructural implications of the development of shortsea are primarily felt at the level of terminal infrastructures in seaports. For segment (a) the infrastructural needs are situated in the area of berthing facilities equipped to deal with the bow, side or stern ramps of roro vessels and back-up land for parking and additional services. The type and scale of terminal infrastructures needed in European ports to accommodate segment (b) depends a lot on the dynamics in hub-feeder dynamics in Europe (see later). The almost pure sea-sea transhipment ports in the Med (cf. Algeciras, Taranto, Cagliari, Gioia Tauro, Marsaxlokk) generally accommodate deepsea and feeder vessels alongside the same berths using the same post-panamax container cranes. A number of large European container ports which combine an important gateway function to the hinterland with substantial sea-sea transhipment flows are opting for the development of separate shortsea terminals to handle (part of) shortsea flows. A good example is Rotterdam.

Figure 3.15: ERTMS Corridors



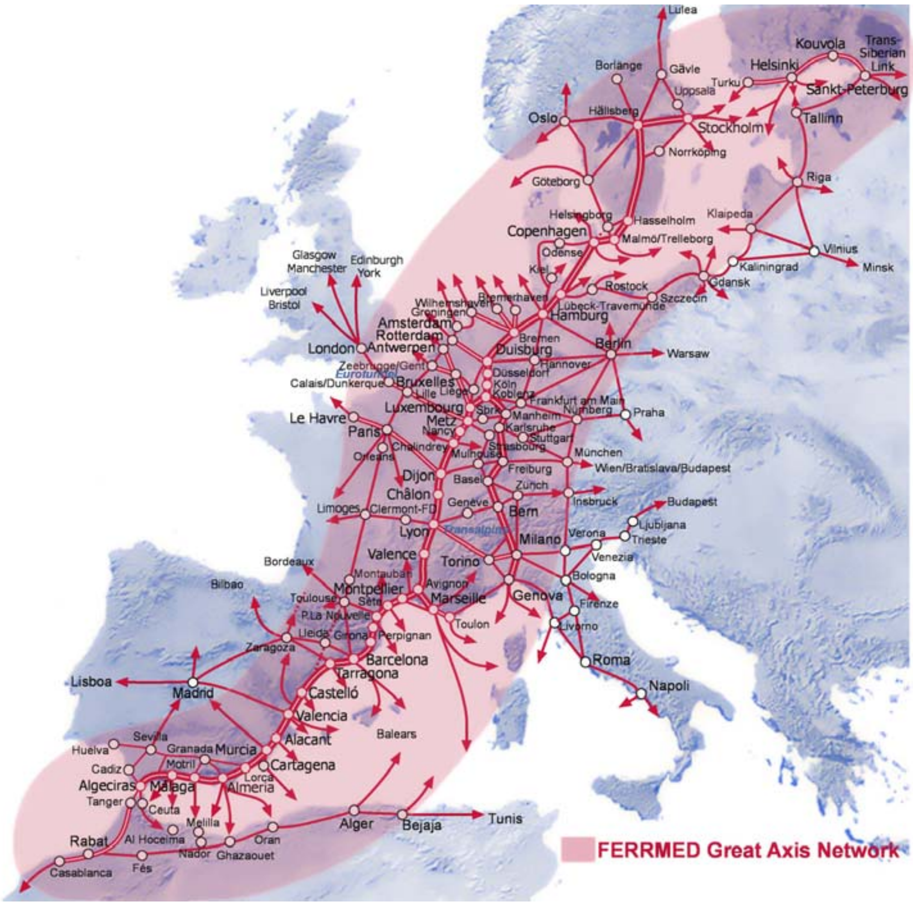

Source: DG Tren

Rail infrastructure development has seen a major organizational change following rail liberalization: infrastructure managers are now responsible for the management and development of rail infrastructures in Europe. The access to services and infrastructure, capacity constraints on lines and in terminals, and path allocation procedures have become major issues in the liberalized market. Market players continue to express concerns over the reliability and the commercial speed of European services. While market have been liberalized, the creation of pan-European/cross-border railway services is still hindered by technical issues such as differences in railway gauges (cf. Iberian Peninsula, Russia), electric networks and signaling systems. The existing lack of technical harmonization historically has had a huge impact on the structuring of rail infrastructure networks in Europe and also on the potential for the development of cross-border shuttles in some regions, particularly on the border between Spain and France. In the past years, a wide range of actions has been launched in the area of interoperability, infrastructure management (cf. RailNetEurope) and the development of a priority network for rail freight in Europe. The implementation of the European Railway Traffic Management System (ERTMS) and the recent identification ERTMS Corridors are major steps forward. ERTMS aims at replacing the different national train control and command systems in Europe through the replacement of existing national automatic train protection systems (ATP) and the development of a radio system for providing voice and data communication between the track and the train. As such, ERTMS enhances a seamless European railway system. The ERTMS Corridors are depicted in figure 3.15. To establish a rail network giving priority to freight, a step by step approach will be followed starting from routes with high business potential. Authorized applicants will be able to request freight paths on international corridors. The general idea is to strengthen cooperation between infrastructure managers and Member States in view of better managing the corridors. Such an approach requires investments in bottlenecks and the development of parameters for a sound infrastructure planning. It also demands efforts to improve the service quality along the corridors.

The ambition to create a competitive pan-European rail freight network based on clear standards is also reflected in the FERRMED initiative. FERRMED is a multi-sectoral association aimed at enhancing the European competitiveness by

- promoting the so-called FERRMED Standards;
- the improvement of ports and airports connections with their respective hinterlands;
- the conception of Great Rail Freight Axis Scandinavia-Rhine-Rhone-Western Mediterranean. The FERRMED axis, which passes through the regions of the European Union with important economic and logistic activities (see figure 3.16), should enhance a modal shift to rail.
- A more sustainable development through the reduction of pollution and climate change emissions.

*Figure 3.16: Proposed Great Axis Network of FERRMED*




Source: FERRMED, www.ferrmed.com

# 4. Hinterland flows in Europe

## 4.1. Introduction

In section 2, an analysis was made of the geographical spread of cargo volumes in the European port system and the associated cargo concentration patterns at the local, regional and European scale. Section 3 discussed the market dynamics behind the routing of good flows via the European port system. The discussion included an analysis of the underlying factors that lie at the heart of port and modal choice and of observed patterns in distribution networks, rail services and barge services. The role of infrastructure was placed next to market-based considerations at the logistical and transport layers.

This section of the report is aimed at providing a deeper insight in the routing of hinterland flows between the seaport system and the hinterland. While a detailed traffic flows analysis would be a first best approach to tackle this issue, such an exercise is extremely difficult in a European context. The availability of good hinterland statistics remains a problem. Eurostat provides extensive databases on flows in Europe, but it is difficult to extract containerized flows on specific port-hinterland relations. The hinterland traffic information available at the level of port authorities in Europe is often fragmented (only one port or a few ports, only a few hinterland regions). Moreover, the statistical hinterland data used by individual port authorities is not always consistent both in absolute figures as well as in the deployed definition. In short, there still is a lack of useable hinterland data to allow for a very comprehensive hinterland flow analysis based on real data.

An alternative approach would be to rely on model results. Modeling has become a common approach to the policy evaluation of large infrastructure projects in ports and in land and maritime access routes. For example, Veldman et al (2005) developed a logit model for the routing of West European container flows in the context of the assessment of the economic impact of a river deepening project. Variables in the model include the hinterland transport cost and the transit time of routing via port p and hinterland mode m, a maritime resistance cost of port p and the quality of service aspects of port p related to the frequency of services offered. The model attempts to explicitly incorporate quite some dimensions of a generalized logistics cost approach. Another example at a broader level is TRANS-TOOLS. The project TRANS-TOOLS aimed to produce a European transport network model covering both passengers and freight, as well as intermodal transport, which overcomes the shortcomings of current European transport network models[9]. When developing transport flow models, researchers have to overcome quite a number of methodological issues such as the calibration of data from a base year, the specification of all sorts of cost functions which reflect the real costs and the inclusion of capacity profiles for segments in the modal networks. However, the main problem associated with modeling relate to the assumptions and simplifications that lie at the heart of such models. Hence, the multitude of port selection factors and modal choice criteria (see e.g. section 3.3.2) implies that modeling port-related hinterland flows and associated port market shares remains a very difficult exercise. Obviously, this observation does not imply transport modeling is meaningless. It only means users of such models should be aware of these limitations when interpreting model results.

Given the above statistical considerations, this section does not portray to provide a detailed traffic flow analysis for the European port system. Based on data obtained from various reports, port authority websites and press releases, we try to identify the general trends in the hinterland routing of goods flows through the European port system.

## 4.2. The immediate hinterland as the backbone for port volumes

Local or immediate hinterlands remain the backbone of ports' cargo bases. This is very apparent when looking at the inland distribution patterns of dry and liquid bulk products. A large part of the volumes is relatively captive to the discharging ports since the customers are typically located in the port or in the vicinity of the port (steel plants, power plants, oil refineries, chemical companies, etc..). The gateway function for major dry and liquid bulks of major European ports only involves

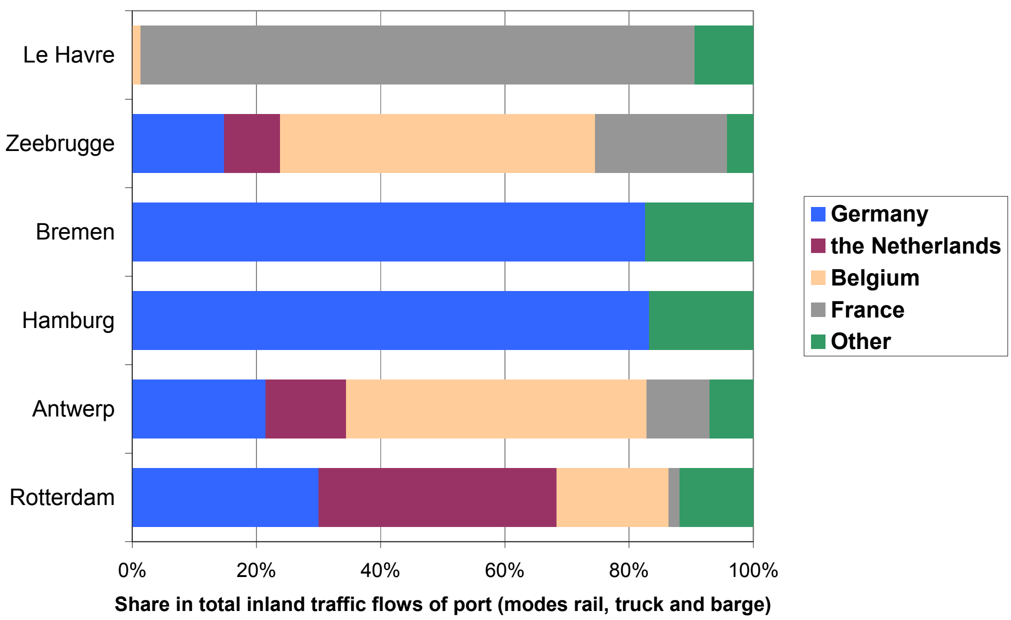
[9] The main shortcomings in earlier models include the unsatisfactory representation of mix of traffic (short/long distance and freight/passenger), the (partly) missing presence of intermodality and freight logistics in models, differences in implementation of Origin-Destination base year for freight traffic in some models, outdated character of some models, no sufficient linkage of network based transport models with socio-economic effects and external effects.

one traffic direction (incoming seaborne cargo), a limited number of market players and a few nodes, i.e. the port and a limited number of destinations in the hinterland.

For containerized cargo, however, the hinterland profile involves numerous origins and destinations dispersed over a vast hinterland, a large number of economic players and two traffic directions. Nevertheless, the local or immediate hinterland also remains very important in the container sector. Even large European gateways have a high proportion of container flows that is generated by the port city and its immediate region. About 40% of containers leaving or arriving at Antwerp by truck are coming from or going to markets within a radius of 50km of the port. The most significant distance class for Rotterdam is the 100-200km radius. This is directly related to the port's role as a cargo generating location linked to the strong manufacturing base of the immediate hinterland (the Netherlands and the Ruhr area in Germany). Catalonia generates significant flows for Barcelona. Port traffic in the Ligurian ports to a large extent is dependent on the North-Italian hinterland. Gothenburg has largely based its traffic position on the industrial base in southern Sweden. The importance of the local/national hinterland is further underlined by figure 4.1. About 89% of the land transport flows out of Le Havre are linked to France. About half of the land-based container flows of the Belgian ports of Zeebrugge and Antwerp has an origin or destination in Belgium, while Germany represents more than three quarters of the land-based container volumes of Hamburg (83% in 2004 and 78% in 2007) and Bremerhaven. In 2007, the region Hamburg alone generates 17.8% of the total land-based containerized cargo flows of the port of Hamburg. The Dutch hinterland generates 38% of Rotterdam's total rail/truck/barge flows.

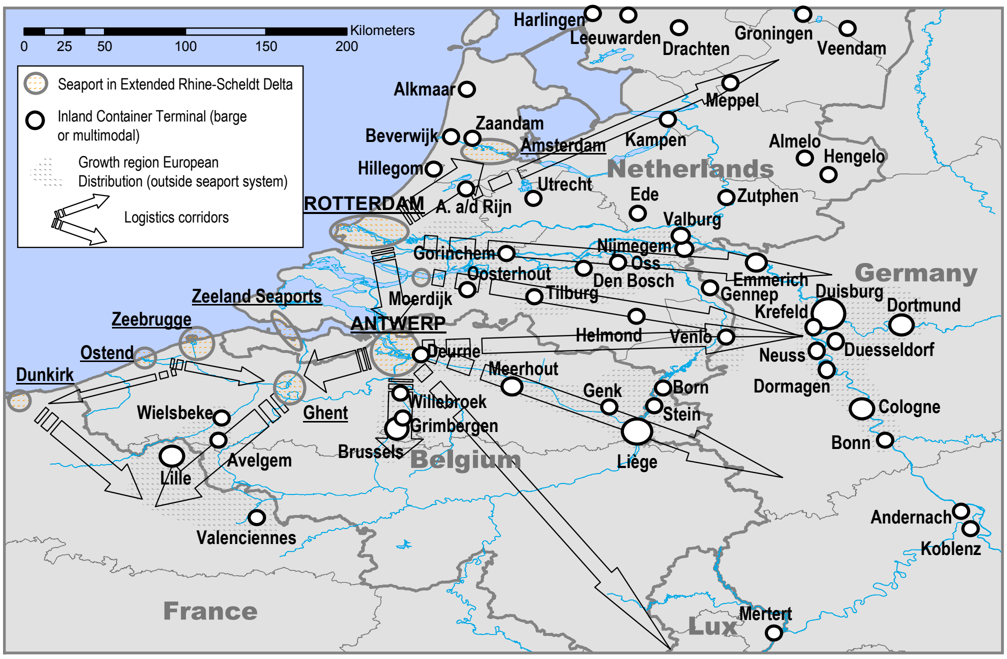
The importance of the local hinterland in ports' cargo bases is the result of the large consumption and production centers (e.g. automotive clusters, petrochemical clusters) surrounding Europe's major ports. It is also a result of emerging logistics poles consisting of a set of gateway ports and logistics zones in the immediate hinterland (see figure 4.2 for an example). Logistics companies frequently set up close to one another, since they are attracted by the same location factors such as the proximity of markets and the availability of intermodal transport and support facilities. The geographical concentration of logistics companies in turn creates synergies and economies of scale, which make the chosen location even more attractive and further encourage concentration of distribution companies in a particular area. Regional trunk lines enhance the location of logistics sites in seaports and inland ports and along the axes between seaports and inland ports. Seaports are the central nodes driving the dynamics in such a large logistics pole. But at the same time seaports rely heavily on inland ports to preserve their attractiveness. The geographical concentration of logistics sites stimulates the development of inland terminals.

*Figure 4.1: The hinterland distribution of containerized cargo by road, rail and barge in the main container ports of the Le Havre-Hamburg range – figures for 2004*



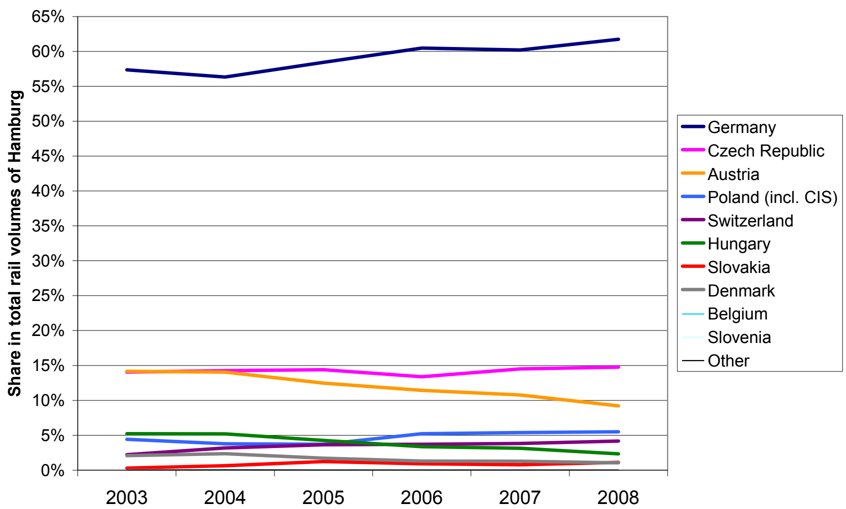

Source: own elaboration based on data compilation

*Figure 4.2: The Extended Rhine-Scheldt Delta and the formation of a large logistics pole*




Source: own elaboration

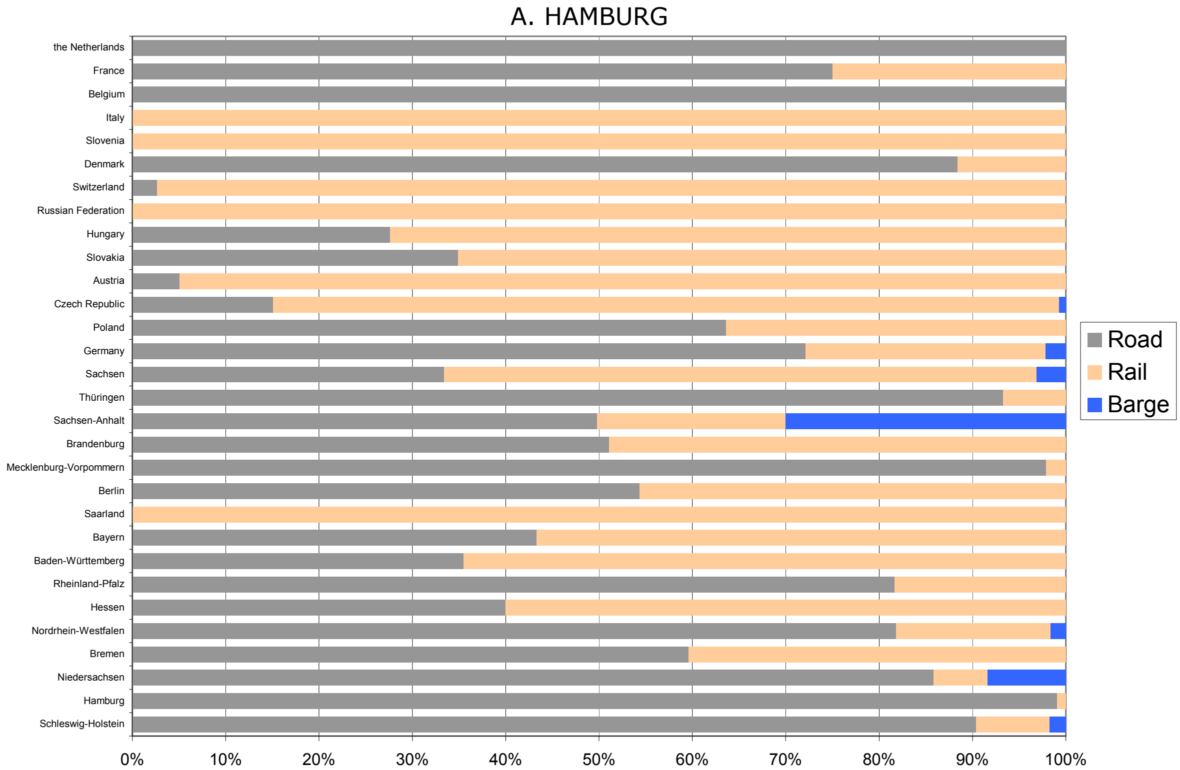
*Figure 4.3: Inland distribution of rail-based container flows to/from the port of Hamburg (2003-2008, based on TEU figures)*

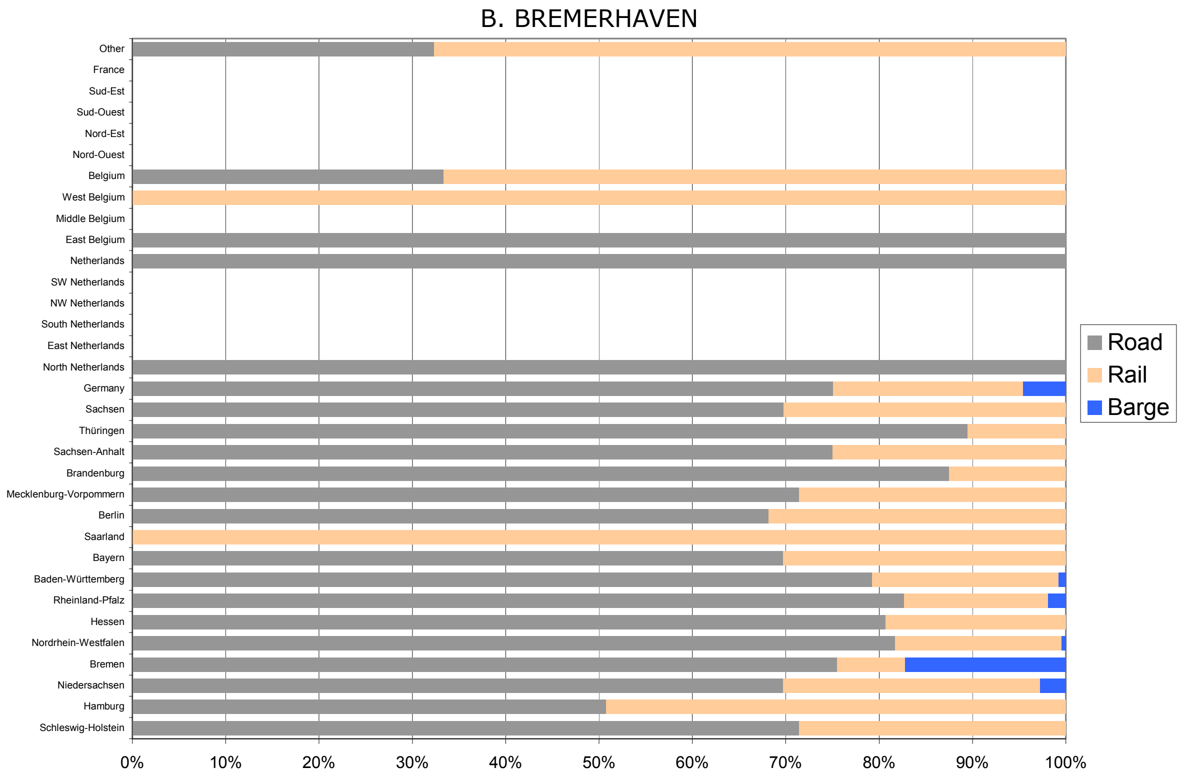



Source: HPA

As such, the results for the Rhine-Scheldt delta in figure 4.1 are influenced by the presence of a large number of European Distribution Centres in the broader logistics pole. A large portion of the containers flows by road are destined for European distribution centres (EDCs) or other logistics centres in the immediate hinterland of seaports. In normal circumstances, the containers arriving in these EDCs are stripped and after some value adding manipulations the cargo is regrouped to reach the final destinations - even in the more distant hinterland - by truck in a conventional non-containerized form. As such, the penetration level (in terms of distance) of road haulage in the hinterland transport of containerized cargo of the ports in the Rhine-Scheldt Delta tends to be higher than suggested by the traffic figures in figure 4.1. This 'EDC-effect' is one of the reasons why 27% of the total container throughput of the European container port system is routed via the Rhine-Scheldt Delta. Any major changes in the design of distribution networks, e.g. via a move of EDCs to other regions or a redesign to a system of RDCs, can have an impact on container flows passing through the multi-port gateway region (see also discussion in section 3.3.1).

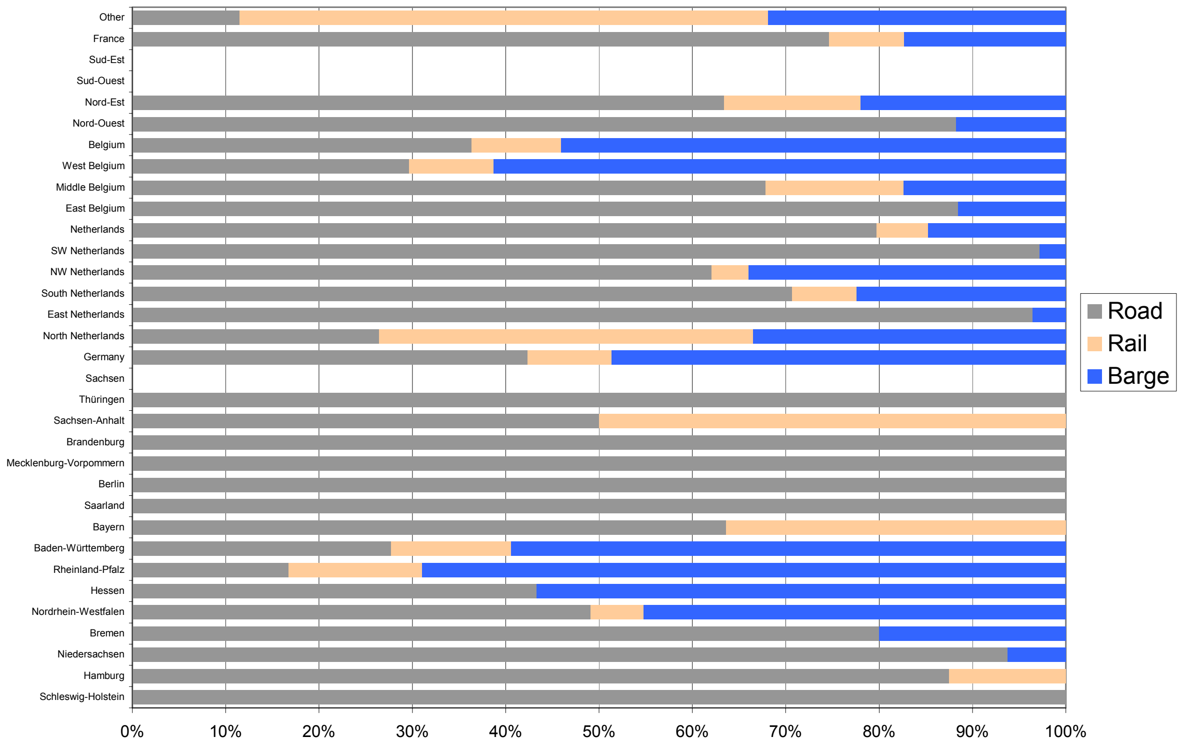
*Figure 4.4: Modal split per hinterland region for the top four container ports in Europe*

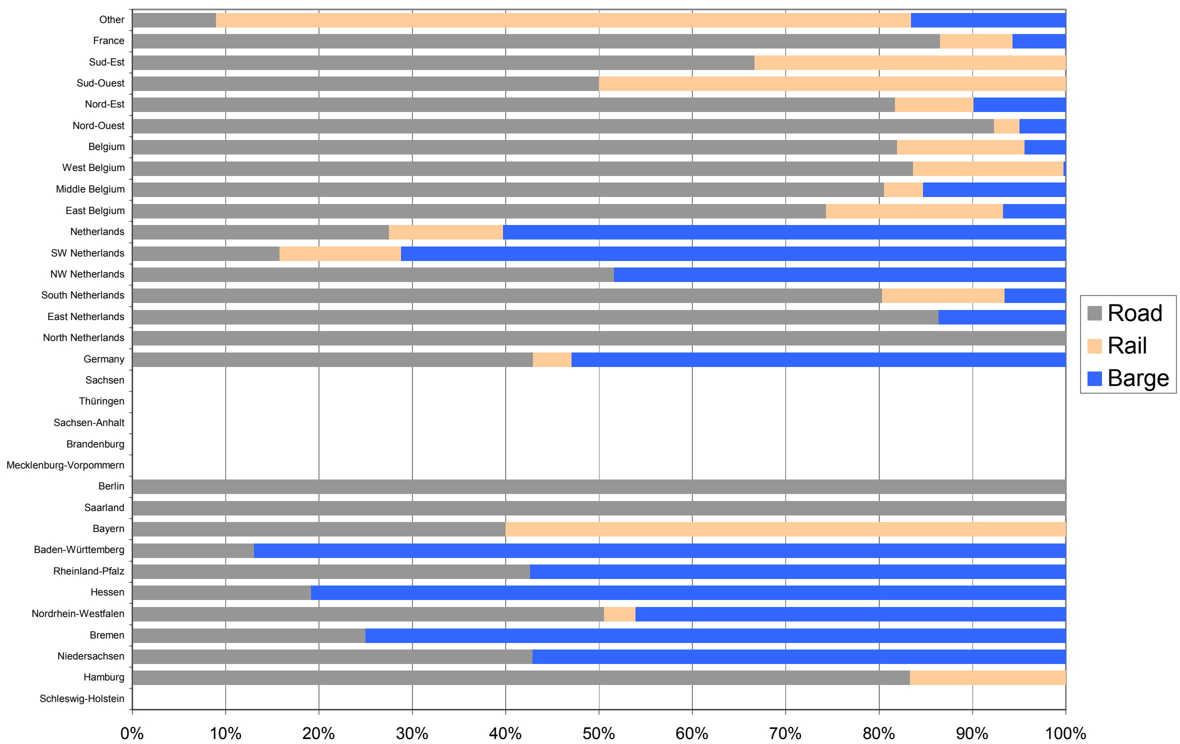



Source: own elaboration based on data compilation

*Figure 4.4: Modal split per hinterland region for the top four container ports in Europe (continued)*




Source: own elaboration based on data compilation

A port's geographical distribution of container cargo differs with the transport mode considered. For most ports, inland barge volumes are strongly concentrated on the respective main waterway axes (i.e. the Elbe for Hamburg, the Weser for Bremerhaven, the Rhône for Marseille, the Seine for Le Havre, the Danube for Constanza). The main barge ports Rotterdam and Antwerp show a more divers distribution of containerized flows: the axis Antwerp-Rotterdam, the Rhine Basin, Northern

France and the Benelux. The specific cost structure of rail shuttles (i.e. pre- and or endhaul costs by truck, large share of handling costs in total railing cost) makes that rail-based flows tend to penetrate deeper in the hinterland than road-based flows. The port of Hamburg provides a good example (figure 4.3). While Germany generates about 80% of Hamburg's land-based flows, German volumes represent about 60% in Hamburg's rail volumes. Figures 4.4A to 4.4D give insight into the modal split for the main hinterland regions of the four largest container ports in Europe. Large differences in modal split can be observed, but in general rail has a larger market share on longer distances.

A major concern in many ports is the strong reliance of more local container volumes on trucks. While road haulage has always played a major role in shaping competition among ports of the same multi-port gateway region for the immediate hinterland, intermodal transport is slowly but surely acquiring a strategic role as well. Logistics sites in the immediate hinterland typically value the flexibility a multi-port gateway system offers in terms of available routing options for import and export cargo. In a logistics world confronted with mounting reliability and capacity issues, routing flexibility is one of the keystones for the logistics attractiveness of a region. For example, the logistics attractiveness of large parts of Belgium and the Netherlands for EDCs is partly due to the reality of having several efficient gateways at disposal.

## *4.3. Gateway regions increasingly vie for distant contestable hinterlands*

The market environment of the European container ports looks quite different compared to 15 years ago. The number of members of the European Union increased from fifteen in the mid 1990s to 27 in 2008. At the same time, economic centers in East and Central Europe, the Nordic triangle and the Iberian Peninsula have taken up an important position next to the traditional economic heartland of Europe. The Western European markets are becoming mature. The total market volume in Europe's most important countries and in traditional market sectors such as consumer goods or automotive are showing moderate growth rates which contrast the boom in these markets of the 1970s and 1980s. A large number of manufacturing companies have set up business in lower cost regions in Eastern Europe. This development has led to larger bi-directional East-West flow within the European Union of raw materials and consumer products. The traditional 'blue banana' is approaching the shape of a boomerang as a result of extensions to central and east Europe and significant investments in the Mediterranean (Spain in particular). The expansion of the 'blue banana' also goes hand in hand with the development of trade flows in the Baltic area, Central Europe and the Latin arc (stretching along the coastline from southern Spain to northern Italy).

*Figure 4.5: The 'blue banana' in transition*


Source: Cushman & Wakefield, Healey & Baker

The Europe-Far East trade became the most important trade route in the mid 1990s. The China factor has its full effect on liner shipping and has reoriented the focus of many container ports towards the East. This has led to a balance shift from the Atlantic Rim to the Suez route to Asia. This shift has opened windows of opportunity for the Med to play a more important role in accommodating international trade flows.

The expansion of the 'blue banana' goes hand in hand with a strong development of trade flows in the Baltic area and the Latin arc (stretching along the coastline from southern Spain to northern Italy). Up to now, northern ports, in particular Hamburg, have benefited the most from the EU enlargement, whereas new development opportunities might arise for port systems in the Adriatic, the Black Sea and the Baltic Sea. A large part of this transportation is taking place via road transport, but also rail and inland waterway transport (especially over the Danube River) play a role. The Czech Republic, Poland, Slovenia and Hungary have strong rail networks while road networks in the Eastern European countries are less well developed. A rise in multimodal transport infrastructures is taking place on the borders between Eastern and Western Europe particularly on the borders of Germany (with Germany having both well developed road and rail transport infrastructures).

The local hinterlands remain the most important cargo base for container ports around Europe, even for the largest gateway ports in Europe. However, a port with a strong local cargo base will sooner or later be tempted to increase the inland penetration of its intermodal offer so as to increase its capture area. From that moment on the existing dense network of direct shuttles to nearby destinations might be complemented by inland services to more distant destinations built around one or more inland hubs. Extensive cargo concentration on a few trunk lines opens possibilities to economies of scale in inland shuttles (through the deployment of longer trains or larger inland barges) but even more likely to higher frequencies. Containers for the more distant hinterland benefit from a port's strong local cargo base as local containers often provide the critical mass for allowing frequent deepsea liner services. The limitation in the number of ports of call per loop enhances a concentration on trunk lines.

*Table 4.1: The position of major multi-port gateway regions vis-à-vis important contestable hinterland areas in Europe*

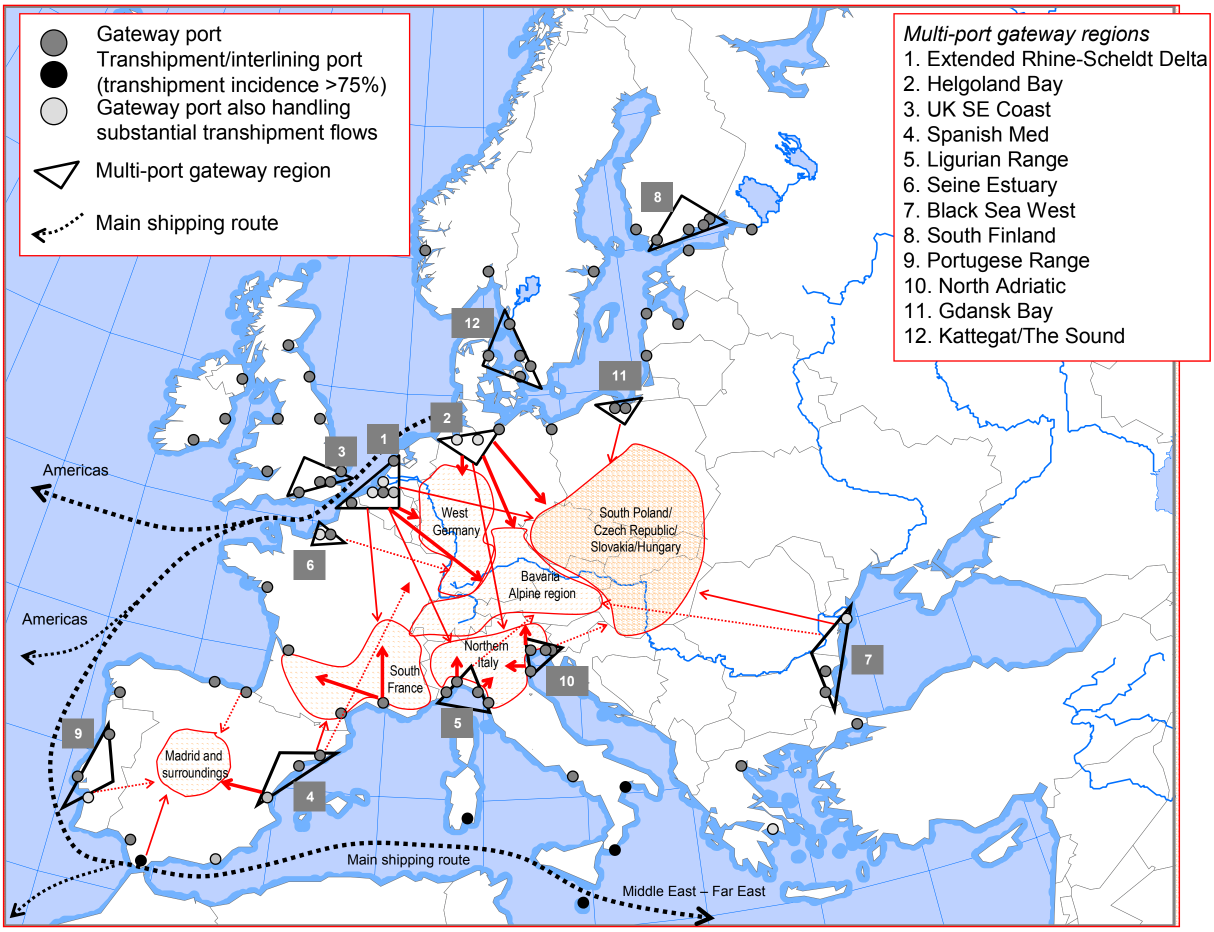
| | | Major battle hinterlands | | | | | |
|---|---|---|---|---|---|---|---|
| | Core hinterland regions (estimated share in total land-based container flows between brackets) | West Germany (*) | South Germany (Bavaria) Alpine countries | Madrid and surroundings | Southern Poland Czech Republic Hungary | Northern Italy | Southern France |
| Rhine-Scheldt Delta | Benelux (59%)<br>West-Germany (*) (23%) | ++ | ++ | - | + (Rott.) / ° | + (rail) | + (Antw.) / - |
| Helgoland Bay | North-Germany (**) (47%)<br>West-Germany (*) (17%)<br>Bavaria (12%) | ++ | ++ | - | ++ | + | - |
| Spanish Med | Catalonia<br>Madrid and surroundings | | | ++ | | | - / + (Barc.) |
| Ligurian Range | Northern Italy | | x / ° | | | ++ | x |
| Seine Estuary | Northeast France (70%) | ° | - | | | | + |
| Black Sea West | Romania/Bulgaria | | ° | | ° / + | | |
| Portugese Range | Portugal | | | ° | | | |
| North Adriatic | Northeast Italy / Croatia | | x / ° | | x / ° | ++ | |
| Gdansk Bay | Poland | | | | + / ° | | |

++ = core hinterland region for gateway region, successful intermodal services
+ = rather important hinterland region for gateway region, successful intermodal services
x =potentially major hinterland region for gateway region, but success limited
- = minor hinterland region for gateway region
° =potential hinterland region for gateway region, intermodal services planned or started-up recently

(*) Includes the states Rheinland-Pfalz, Hessen, Nordrhein-Westfalen, Baden-Württemberg, Saarland
(**) Inludes Schleswig-Holstein, Hamburg, Bremen, Niedersachsen, Berlin, Mecklenburg-Vorpommern, Brandenburg, Sachsen-Anhalt

Source: own compilation based on market data and insights

Figure 4.6: The main contestable hinterlands in mainland Europe (see also table 4.1)




Inland corridor formation has allowed seaports to access formerly captive hinterlands of other ports. Moreover, the rise of economic centers in Eastern and Central Europe creates opportunities for different multi-port gateway regions and standalone gateways to develop water-based and land-based transport networks to these areas. Major contestable hinterlands are increasingly being served not only by the ports of one gateway region, but by several multi-port gateway regions (see table 4.1 and figure 4.6). For example, the Black Sea port region/Constanza, could develop into a new gateway region to Europe. Constanza is strategically located at the eastern end of the pan-European waterway transport Corridor VII, which links the North Sea and the Black Sea as well as pan-European transport Corridor IV, linking Berlin and Istanbul over land. From the Suez Canal to Constanza is only 950 nm compared to 3400 nm to Rotterdam and many shipping lines have introduced direct services from the Far East with vessels in the range of 2000 to 3500 TEU (e.g. Bosporus Express of CMA-CGM and Tiger Service of MSC). The trend for Constanza to develop further into a major gateway for the region opens up opportunities to land-locked countries such as the Czech Republic, Hungary and Austria to connect to developing gateways in the east. Also other port regions such as the Gdansk Bay and the North Adriatic can potentially take-up a more prominent role compared to the current modest position in the European container port system. Section 3.3.2 discussed the potential of such port regions in the framework of the discussion on the generalized logistics costs.

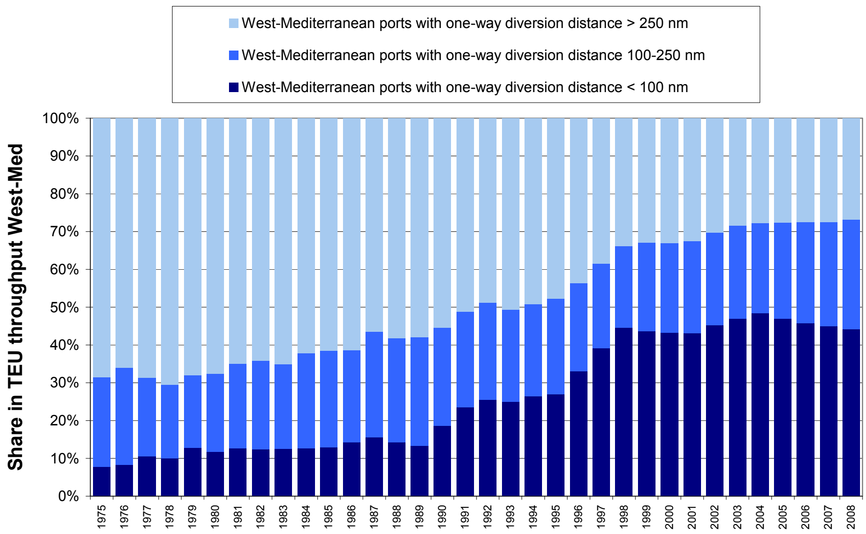
The multiplication of corridors brings about a change in the relationship between gateways and their hinterland. On the one hand, the inland penetration strategy is part of maritime gateways' objective of increasing their cargo base. On the other hand, interior regions are recognizing that it is in their interest to establish efficient links to as many gateways as possible. For example, the Czech Republic is upgrading its trans-European travel corridors intensively (in particular, the 4th corridor connecting Germany with South-Eastern Europe (Istanbul). This strategy not only prevents these regions from becoming captive to one specific gateway. It also improves the locational qualities of these interior economic centers. Hence, the linking up to more gateways implies more routing options and flexibility for shippers and logistics service providers who want to set up business in the region. The performance profile of each of the corridors in terms of infrastructure provision (capacity), transport operations (price and quality of the shuttle services) and the associated logistical control (i.e. the management in a supply chain context) is a key attribute for this kind of competitive play among various multi-port gateway regions.

## *4.4. The shortsea and feeder network as an indispensable part of European cargo distribution patterns*

Cargo distribution patterns in Europe not only rely on inland transport modes (road haulage, rail and barge). Shortsea and feeder flows form an indispensable and growing segment in the connectivity between European regions.

Section 2 of this report already referred to the importance of roro and ropax services in connecting European ports. The dynamics in the container feeder market need some further elaboration. In the Mediterranean, extensive hub-feeder container systems and shortsea shipping networks emerged since the mid 1990s to cope with the increasing volumes and to connect to other European port regions. Before that time, Mediterranean ports were typically bypassed by vessels operating on liner services between the Far East and Europe. Terminals at the transhipment hubs are typically owned, in whole or in part, by carriers which are efficiently using these facilities. Marsaxlokk on Malta, Gioia Tauro, Cagliari and Taranto in Italy and Algeciras in Spain act as turntables in a growing sea-sea transhipment business in the region.

*Figure 4.7: The market shares of container ports in the West Mediterranean. Ports grouped according to the diversion distance from the main shipping route (1975-2008)*

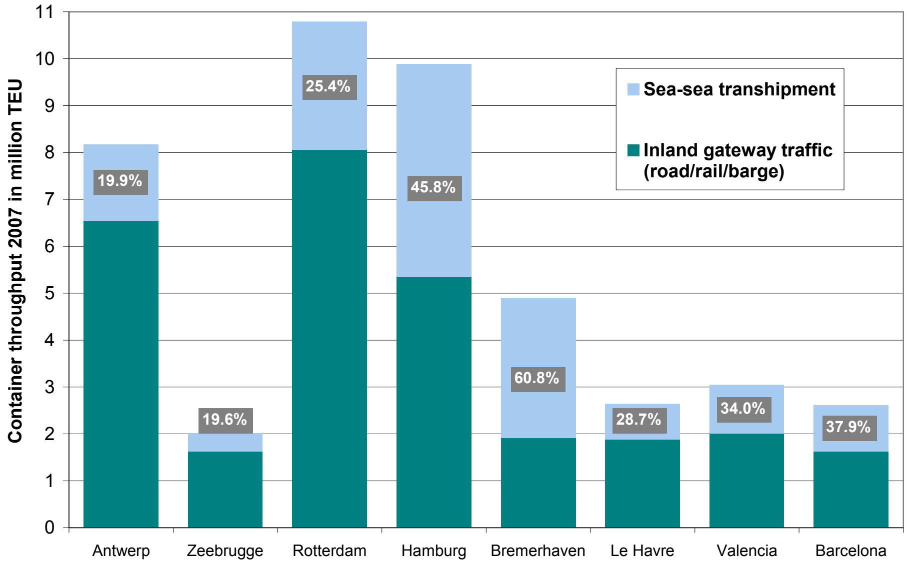



Source: aggregation based on statistics respective port authorities

While quite a number of shipping lines still rely on the hub-and-spoke configuration in the Med, others decided to add new liner services calling at mainland ports directly. In reaction, mainly Italian transhipment hubs have reoriented their focus a bit, now also serving Central and East Med regions. The net result of the above developments has been a slight decrease in the market share of the West Med hubs in recent years and a growth in the market share of mainland ports located between 100 and 250 nautical miles from the main maritime route (figure 4.7). The transhipment business remains a highly footloose business. This has led some transhipment hubs such as Gioia Tauro and Algeciras to develop inland rail services to capture and serve the economic centres in the distant hinterlands directly, while at the same time trying to attract logistics sites to the ports.

In Europe, hubs with a transhipment incidence of 85% to 95% can only be found in the Med. Northern Europe does not count any pure transhipment hub. Hamburg, the North-European leader in terms of sea-sea flows, has a transhipment incidence of about 45%, far below the elevated transhipment shares in the main south European transhipment hubs (figure 4.8). Barcelona and Valencia are among the large Med ports combining an important gateway function with significant transhipment flows, i.e. a transhipment incidence of respectively 38.8% and 43.9% in 2008. According to MDS Transmodal (2006), sea-sea transhipment in UK ports represented only 7% of total lolo throughput in 2004. All Scottish ports together only handle about 300,000 TEU, a situation leading to significant container flows by truck and rail coming from gateway ports in the south and southeast of the United Kingdom.

*Figure 4.8: Inland gateway traffic and sea-sea transhipment in a selection of ports with a significant combined gateway-transhipment function (figures 2007)*

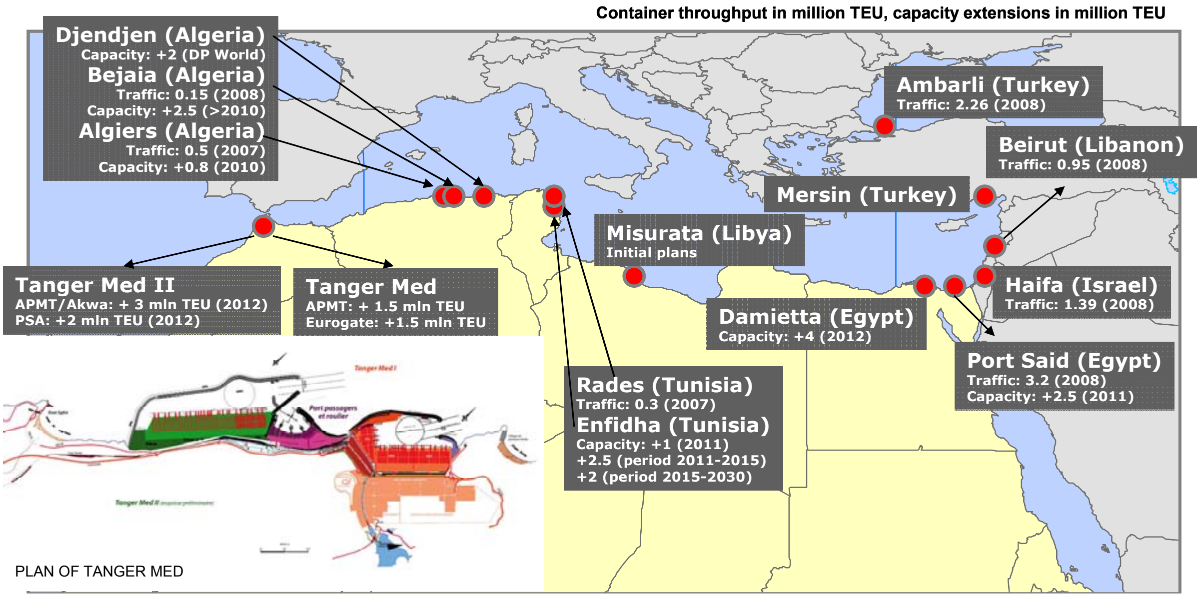



Source: based on data of respective port authorities

The connectivity of the Baltic region to overseas trading areas primarily relies on feeder services to hub ports in the Le Havre-Hamburg range. The existing symbiotic relationship between the Baltic port system and the main ports in the Le Havre-Hamburg range (Hamburg and Bremerhaven in particular) is a prime example of how ports in different regions can actively deploy their mutual dependence. In the last couple of years, terminal development in the Baltic Sea is characterized by scale increases in terminal surfaces and equipment. For example, the terminals in Poland are equipped to handle relatively large container vessels, notwithstanding the fact that a very substantial share of the ports' container volumes is feedered from the Le Havre-Hamburg range. Baltic ports are gearing up to welcome more direct calls of mainline vessels. This is particularly felt in the port system at the entrance of the Baltic (Kattegat/The Sound). Ports like Gothenburg and Aarhus are already acting as regular ports of call on quite a few intercontinental liner services. While these ports have a good position to act as turntables for the Baltic on many trade routes, the insertion of these ports as regular ports of call on the Europe–Far East trade remains uncertain. The large vessel sizes deployed on this route, the associated reduction in the number of ports of call and the additional diversion distance make regular direct calls to the multi-port gateway region Kattegat/The Sound less viable compared to other trade routes. A similar type of discussion on the hub-feeder option versus the direct call option applies to other port regions in Europe such as the UK port system and the Adriatic port system.

The dynamics in the transhipment business has implications on freight distribution patterns in Europe. A hub-and-spoke based network means less cargo concentration in mainland destination ports and as such a more dispersed or fragmented inland transport system. Alternatively, traffic growth can lead to an undermining of the position of transhipment hubs in favor of a limited number of large-scale mainland ports, each connected to intermodal corridors.

*Figure 4.9: Major ports and future terminal developments in non-EU Med ports*




Source: own elaboration based on industry data and Grand Port Maritime de Marseille

A last point relates to the impact of developments in non-European ports on the European container port system. The growing container terminal market in the Maghreb countries increases competition in the Med region, but at the same time opens new growth opportunities for existing European transhipment hubs and gateway ports in the Med. Algeciras (stronghold of APM Terminals of the AP Moller Group) relies a lot on east-west and north-south interlining and is facing competition from newcomer Tanger Med where APM Terminals has also set up business recently. Tanger Med (I and II) and Algeciras ports are expected to run at equal capacity in 2012. Morocco's economic growth in 2009 is expected to amount to 5.2% (figure of the Centre Marocain de Conjoncture – CMC - forecasts made in April 2009). Tanger Med is hoping to bring in dividends from factory delocalization movements to Maghreb countries, particularly to Morocco. Other major port developments are planned in Algeria and Tunisia (figure 4.9). Cargo activity in the port of Algiers has strongly increased in recent years in line with Algeria's strong oil revenue figures. The Algerian government has developed a policy to upgrade the Algerian ports and improve terminal performance. The port of Djendjen is being positioned as a deepwater port for large container ships. The management of the Port of Algiers and that of Djendjen has been privatized recently allowing a strong involvement of DP World. Plans are being implemented to transform the deepwater port of Enfidha in Tunisia into a major Central Mediterranean transhipment hub and a prime economic and logistics activity zone. Construction would be phased. Libya has no ports with dedicated container handling facilities yet. There are some initial ideas to develop a deepwater container terminal in Misurata.

# 5. Conclusions

1. European ports are increasingly functioning not as individual places that handle ships but within supply chains. The supply chain focus on port competition holds clear implications on the role of hinterland connections. Port hinterlands have become a key component for linking more efficiently elements of the supply chain, namely to insure that the needs of consignees are closely met by the suppliers in terms of costs, availability and time in freight distribution. The position of a port in supply chains is heavily determined by the capacity, price and quality of the inland segment (both infrastructure as well as transport services). Ports and their hinterland connections are at the heart of a competitive, sustainable and cohesive European transport network.

2. Infrastructure investments are not to be treated in isolation. Infrastructure should act as a strong enabler of port-related market dynamics that lead to efficient and sustainable co-modal freight transport services in Europe. The development of large scale intermodal line infrastructures increases the mobility of logistics and economic activities. Trunk lines to major gateways or multi-gateway port regions give inland regions a better accessibility to overseas markets. Infrastructure thus acts as a facilitator to increase the participation of land-locked and peripheral regions in global production and logistics networks. Infrastructural developments can also multiply the routing options available between specific inland regions and overseas regions. Seaports who find themselves on inefficient or capacity-tight corridors are in a disadvantageous position.

3. The observed distribution of cargo flows over the European container port system and the associated inland transport segment is the result of a complex interaction between market-based considerations of market players at the logistical layer (shippers, logistics service providers) and operational considerations of players at the transport layer (shipping lines, rail operators, barge operators, etc..). The market-based considerations at the logistical layer are linked to the total generalized logistics costs including out-of-the-pocket costs of transporting goods between origins and destinations and the port (including cargo handling costs), time costs of the goods, inventory costs linked to the holding of safety stocks and indirect logistics costs linked to the aggregated quality within the transport chain. The market-based considerations at the transport layer are associated with the trade-off between, on the one hand, a cost-driven exercise to minimize the operational costs linked to the transport service networks (liner services, rail shuttles, etc..) and, on the other hand, a customer-oriented differentiation exercise (e.g. serve local markets with direct calls of mainline vessels).

4. Quite a number of market players and actors try to play the first violin in developing hinterland networks that best meet the requirements of supply chains. Integration, coordination and competitive dynamics are shaping hinterland networks. Logistics service providers, shipping lines and terminal operators have gone through an unprecedented wave of consolidations. This has led to powerful terminal networks, carrier groups and third party service providers (3PL) which are actively following vertical integration strategies with a clear inland dimension. Logistics integration in the transport industry results in a concentration of power at the port demand side. European seaports increasingly have to deal with large port clients who possess a strong bargaining power vis-à-vis terminal operations and inland transport operations. Market players thus show an increased network orientation and aim to maximize network effects and synergies. However, market players cannot be expected to be the promoters of a pan-European intermodal network system that leads to higher efficiency at the macro-level rather than the level of the firm. Moreover, other objectives such as sustainability need to be considered as well.

5. There exists a tension between cargo concentration and cargo deconcentration in the European port system. These concentration dynamics are influenced by complex interactions between actors and factors. An increasing number of European ports is present on the competitive scene. While the European container port scene becoming more diverse in terms of number of ports involved, a lot of cargo is concentrated in a limited number of ports. Moreover, large differences in growth patterns can be observed among multi-port gateways regions. The container handling market remains more concentrated than other cargo handling segments in the European port system, as there are strong market-related incentives for cargo concentration in the container sector. Out-of-pocket costs alone are not sufficient to understand the current routing of containerized goods in Europe. Co-modal bundling effects, connectivity effects and aggregated service quality effects at specific gateway ports make that a ‘natural’ gateway for a certain hinterland region is not necessarily the port closest to that hinterland region. The combination of the above effects also makes that environmental impacts per TEU-km generated by cargo passing through large gateways are typically lower compared to ports which are not able to benefit from the same connectivity and bundling effects. The present cargo distribution patterns in Europe are a reflection of complex interactions between actors, factors and the infrastructural, transport and logistical layers identified in this report.

6. The configuration of intermodal networks (rail, barge, shortsea) proofs to be of crucial importance to the European port system. A certain level of traffic concentration in a seaport system is required in order to allow a virtuous cycle of modal shifts from road haulage to high-volume transport modes. But even port systems with a low degree of concentration have embraced intermodal transport. Extensive cargo concentration on a few trunk lines opens

possibilities to economies of scale in inland shuttles but even more likely to higher frequencies. Smaller ports and new terminals often seek connection to the extensive hinterland networks of the larger ports, thereby strengthening the functional synergy between ports in the same multi-port gateway system. Cargo bundling on trunk lines is shaping the hinterland access of multi-port gateway regions and major stand-alone gateways.

7. Shortsea and feeder flows form an indispensable and growing segment in the connectivity between European regions. Europe's long coastline and its specific geographical characteristics are clear invitations to further develop shortsea and feeder networks based on mutual dependence among ports in the same and different regions.

8. Local or immediate hinterlands remain the backbone of ports' cargo bases. Even large European gateways have a high proportion of container flows generated by the port city and its immediate region. The importance of the local hinterland in ports' cargo bases is the result of the presence of large consumption and production centers (e.g. automotive clusters, petrochemical clusters) surrounding Europe's major ports and the emergence of large regional logistics poles consisting of several logistics zones. The existing geographical concentration of logistics sites has stimulated the development of inland terminals. Gateway ports are the central nodes driving the dynamics in such a large logistics pool. But at the same time seaports rely heavily on inland ports to preserve their attractiveness. The creation of large logistics poles poses new challenges in the relations between seaports and inland ports. While road haulage has always played a major role in the immediate hinterland, intermodal transport is slowly but surely acquiring a strategic role as well. But the challenge remains to increase the share of co-modal solutions and to bundle cargo on short distances. The significant role of local hinterlands to ports' traffic bases and the existing functional interactions between gateway ports and inland centres in regionally-based logistics poles are important structuring elements in the European transport network.

9. In a logistics world confronted with mounting reliability and capacity issues, routing flexibility is one of the keystones for the logistics attractiveness of a region. Interior regions are recognizing that it is in their interest to establish efficient links to more than one gateway. The linking up to more gateways implies more routing options and flexibility for shippers and logistics service providers who want to set up business in these regions. The need for a high level of flexibility is also reflected in the complex networks designed by logistics actors and transport operators. Logistics players tend to opt for a flexible network design offering various routing alternatives. A transport network that guarantees routing flexibility will allow for a high responsiveness of infrastructure networks to continuous changes in routing decisions of market players.