AN EXTENSION OF 'GREEN PORT PORTFOLIO ANALYSIS' TO INLAND PORTS: AN ANALYSIS OF A RANGE OF EIGHT INLAND PORTS IN WESTERN EUROPE.

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ABSTRACT

Haezendonck (2001) introduced an ecological dimension in conventional port portfolio analysis for seaports and applied it to the seaports in the Hamburg – Le Havre range. Given the fast growth of inland waterway transport, and the development of inland ports in the hinterland of seaports, the analysis can also be extended to evaluate the 'green' competitiveness of inland ports, as they are considered as important enablers to reach objectives of sustainable development. In this paper, the 'green port portfolio analysis' is applied to a range of eight inland ports in Western Europe. This results in (1) a number of specific methodological issues related to the inland port environment, (2) an interesting research agenda both for policy-makers at the local and regional level as well as for inland port managers.

Keywords: Strategic management, port management & development

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1. INTRODUCTION

Stakeholder preferences and government regulation favouring the reduction of negative externalities increasingly provide powerful incentives to firms to pay more attention to environment-friendly strategic decisions and actions (Rugman and Verbeke, 1998; Hart, 1995 and Porter and Van der Linde, 1995). This is also critical for ports, given their considerable environmental impact, sometimes on an entire region (Button, 1993). When failing to consider this environmental impact, strategic port decisions and actions could potentially, negatively affect the ability of the port to compete relative to others in the range, at least if 'environmental performance' really counts. In that case, the attractiveness of port activities and new investment projects in the port area need to be assessed, not merely in terms of economic potential as measured by impact on market share and growth rate, but also in terms of environmental impact (Verbeke, 1998 and European Commission, 1998a).

This paper builds upon the environmental dimension added to the conventional port portfolio analysis, as developed by Haezendonck (2001). Traditional port portfolio analysis, see also Verbeke (1992), Winkelmans and Coeck (1993) and Verbeke, Peeters and Declercq (1995), only considers the micro-economic aspects of business activities, i.e. the average market share and the average growth rate of strategic business units which are used as key indicators of competitive positioning. In this paper, a 'green' port portfolio analysis is applied, building upon Ilinitch and Schaltegger (1995) and Burke and Lodgson (1996) that take into account a number of environmental parameters. This approach is then applied to a range of inland port traffic portfolio structures and hinterland transport. The framework allows an assessment of the relative performance of a port vis-à-vis its competitors in terms of 'environment-friendly' growth and market share by including the environmental dimension in the analysis.

This consists has four sections. Section 2 gives a description of the inland port range that was used in the analysis, and develops a framework of inland port types. In section

3, the methodological aspects of green port portfolio analysis for inland ports are described. In section 4, a green port portfolio is applied on a range of inland ports, taking into account the framework developed in section 2. Section 5 concludes with an overview of the results, and directions and suggestions for further research.

2. A FRAMEWORK TO CLASSIFY INLAND PORTS

2.1. A hypothetical range of inland ports

For the green portfolio analysis, a hypothetical range of eight Western European inland ports was considered: Basel, Brussels, Charleroi, Frankfurt, Liège, Paris and Strasbourg. These eight inland ports realized a fluvial and maritime cargo throughput of ca. 74 000 000 tons. This total represents about 52% of total fluvial and maritime cargo throughput in the top-30 of (public) inland ports in the European Union (European Commission, 2002). Cargo throughput varies from ca. 19 million tons (Paris), ca. 13,5 million tons (Liège and Duisburg), ca. 9 million tons (Basel and Strasbourg) and 2 to 4 million tons (Charleroi, Frankfurt, Brussels). The whole range grew 5,6% during the period 1997-2001.

Port	**Cargo throughput 2001 (waterborne - tons)**
Basel	8 634 148
Brussels	3 675 301*
Charleroi	2 402 892
Duisburg	13 613 000*
Frankfurt	3 234 878
Liège	13 476 094*
Paris	18 991 309*
Strasbourg	9 579 797

Table 1: Waterborne cargo throughput 2001 (source: authors, port authorities)

* = including maritime traffic

The selection of inland ports in the range was based on cargo throughput volume, in order to include both bigger and smaller inland ports, and the environment in which they operate (an urban environment and an industrial environment). In other words, we opted for a high degree of diversity in the range, taking into account several characteristics of the European inland port system. However, we cannot apply the concept of a range as it is done for seaports, as it implies strong competition between the selected ports (e.g. ports in the Hamburg-Le Havre range). In the case of inland port, internal competition does not play an important role, as inland ports normally do not compete among each other to attract traffics and/or activities, due to their position in different inland waterway networks, which have in most cases no interconnectivity. Nevertheless, benchmarking can be very useful as inland ports can exchange 'best practices' among each other to strengthen and to enhance their local and regional positions in the transportation networks.

Before performing the green portfolio analysis, the traffic structure of the eight ports was extensively analysed. The results of these analyses provide the basis for a framework to classify inland ports in several types.

2.2. Types of inland port: analysis of traffic structures

In the analysis, we did not consider separate inland terminals (sometimes also referred to as inland ports), as they are in most cases not significant in terms of cargo volume. In other words, an inland port must be considered as a collection of several terminals showing a certain degree of diversification of the traffic structure, and where a public body under the form of a port authority leases infrastructure to port companies, and manages and coordinates the development of the port and his area.

Analyzing our inland port range using conventional port portfolio analysis (see e.g. Haezendonck, 2001), we discovered certain parameters that are important when interpreting the results of inland port benchmarking analysis. First, we have to take into account the specific environment in which an inland port operates, i.e. the geographical situation and the social-economical environment of the port. Second, we have to consider the imbalance between inbound and outbound waterborne flows. When analyzing the traffic structures and confronting them to qualitative information regarding the geographical and social-economical environment of the inland ports, we can quickly identify two types: a 'metropolitan supporting' type and an 'industry supporting' type. These two types will be briefly discussed in the next sections before analyzing the specific methodological issues and the results of the green benchmarking analysis, which should allow to find more about the relation between the modal split and the type of inland port.

2.3. The 'metropolitan supporting' type

The metropolitan supporting type has a more 'urban and regional logistics' functionality, as the traffic structure is dominated by petroleum products and construction materials. These traffic categories are then further distributed by road to provide the wide urban region with raw materials and other supplies for the local construction sector and gasoline and other derived products for service stations. Metropolitan ports have been closely linked to the development of the urban regions in which they operate, as they have been located in the centre of the urban region to facilitate trade and distribution. In fact, a lot of port activity still takes place in the centre of these regions. In some cases, industrialization also influenced the development of these ports as industrial activities were developed at the boundaries of the urban region. However, the role of facilitator for urban logistics has prevailed to a large degree, and is nowadays dominated by the construction materials sector under the form of sand, gravel, cement and other components of concrete. The petroleum products sector also plays an important role, as all varieties of petrol (diesel, lead-free, regular) have to be distributed to service stations in the wide urban region. Another characteristic of these ports is that they have a major imbalance on the level of inbound/outbound waterborne flows, as inbound traffic dominates. This is due to their position in the logistical chain, as metropolitan supporting ports are in most cases the last points of the logistical chain, before the goods are delivered to the end-consumer. On the level of the modal split of hinterland traffic, this implies that road transport will play an important role, as the distances to the hinterland are in most cases relatively short (the wide urban region) compared to seaports which have an (inter)national hinterland. This characteristic will be further analyzed performing the green benchmarking analysis (see infra, section 4).

Furthermore, we can look more profoundly into the structure of these ports, as they have since long been important economic catalysts of the urban region, in particular the activities concerning distribution of consumer goods in the wide urban region. Most of the inland ports have large logistical zones, which group logistical operators (transport firms, integrators, etc.) with a regional but sometimes even (inter)national functionality (e.g. Europe's largest perishable centre is located in the Port of Brussels; the Eurofret-zone is Strasbourg is another example of an important logistical zone). Unfortunately, most of these zones have no link with the waterway, as the introduction of the JIT-concept and the poor service of most railway companies in the field of freight transport has pushed these firms to use exclusively road transport. However, we can observe a new dynamism due to the containerization of goods flows, whereby many inland ports are stimulated to develop trimodal (road, rail, barge) container terminals. These multimodal and intermodal developments should contribute to a diversification of the traffic structure, the creation of more value added activity on inland port sites, the confirmation of their role as platforms for urban and regional distribution, as well as a future improvement of the modal split of these metropolitan supporting inland ports.

Examples of the metropolitan type in the hypothetical inland port range are the ports of Brussels, Frankfurt and Paris. Construction materials clearly have a dominance in each of these ports, but intermodal developments are just getting started (e.g. Brussels) or are growing at a fast rate (e.g. Paris). There is also a significant imbalance between inbound and outbound flows (see infra, figure 9). Figures 1 to 3 show the traffic structure of these ports for the year 2001.

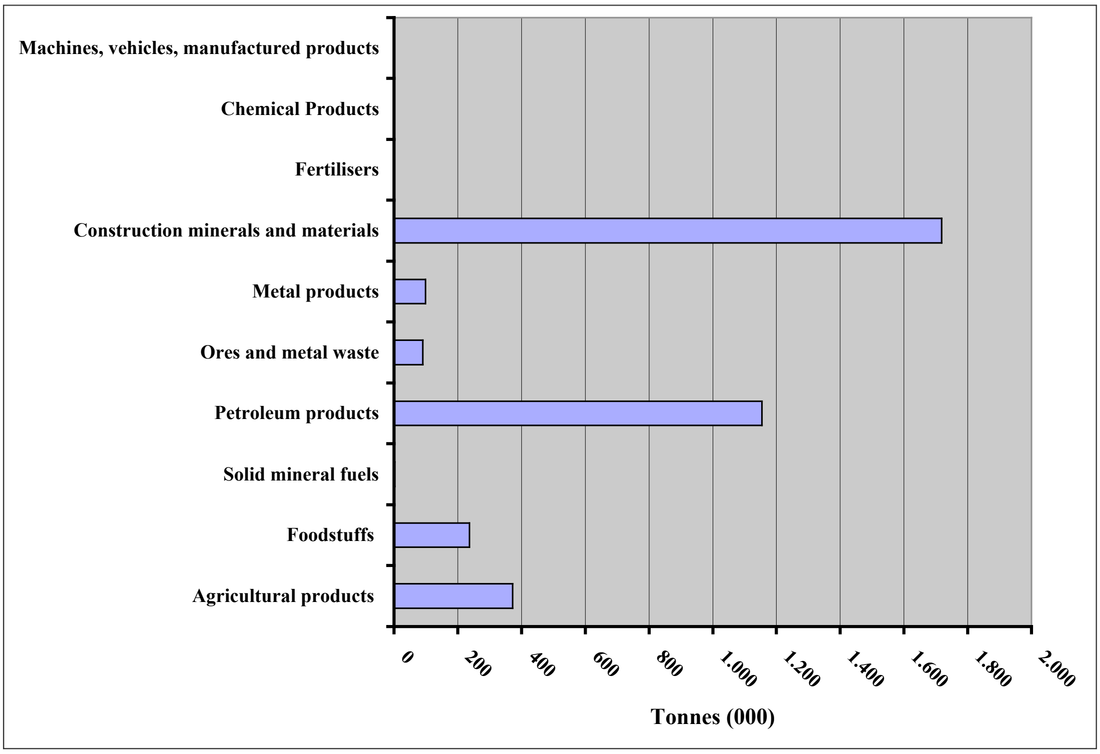


Figure 1: Traffic structure port of Brussels (2001) (Source: authors).

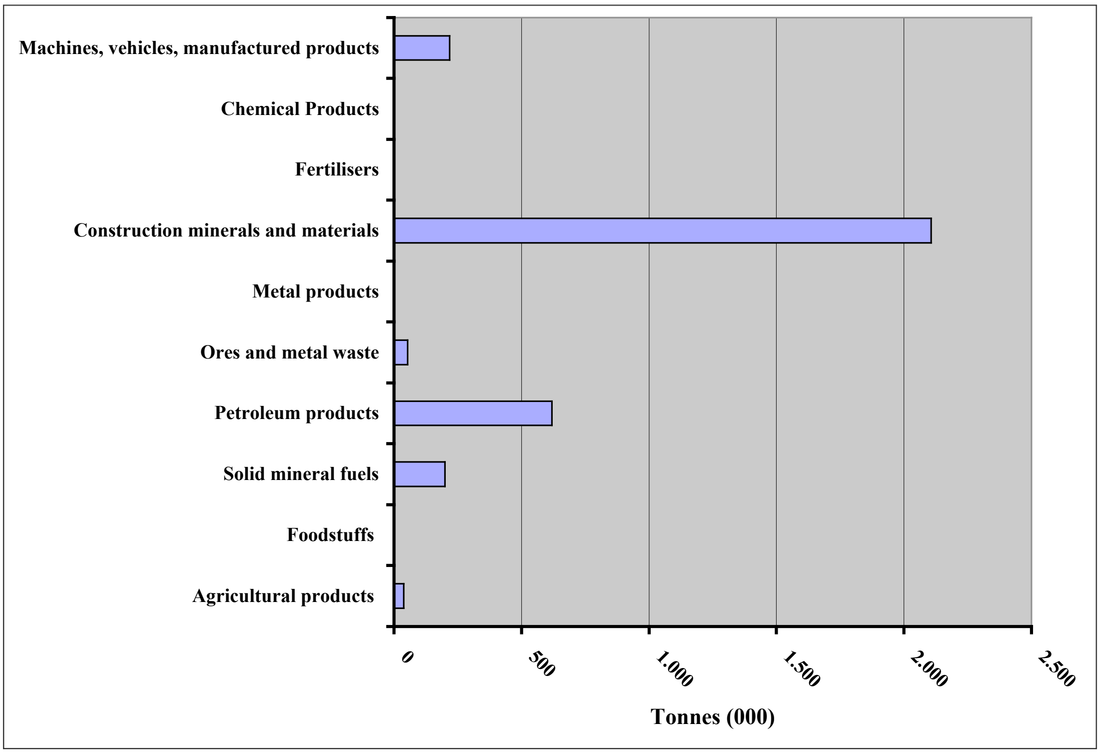


Figure 2: Traffic structure port of Frankfurt (2001) (Source: authors).

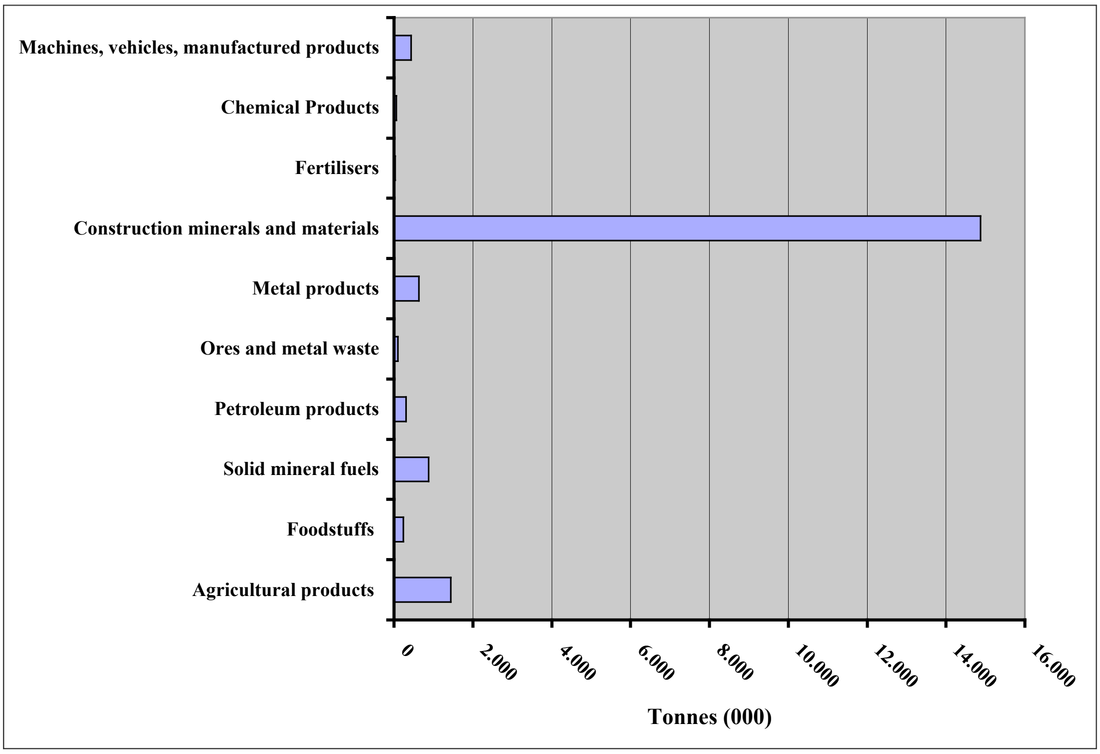


Figure 3: Traffic structure port of Paris (2001) (Source: authors).

2.4. The 'industry supporting' type

The 'industry supporting' type has a supporting role for traditional industries, such as the industrial complex of the Ruhr region (Duisburg) and the region around Liège or Charleroi where there is a concentration of steel mills (e.g. Arcelor in Liège). The presence of coal mines near these ports and the complementary industrial development explain the historical role of these ports. This industry supporting role is explained by the traffic structure, which is dominated by oil products, coal, ores, minerals and scrap, and steel products. The imbalance between inbound and outbound waterborne traffic is not as clear as compared to the 'metropolitan supporting' type, as a large part of inbound waterborne flows (e.g. coal, ore,…) is used in industrial processes, with outbound waterborne flows of finished products (e.g. steel products) contributing to a better balance.

From an evolutionary perspective, de-industrialization and delocalization has led to large industrial sites waiting for redevelopment in these ports. However, the presence of trimodal infrastructure attracts new activities on these sites, aimed at Value Added

Logistics (VAL) and European Distribution Centres. A well-known example is the 'Logport' project in Duisburg, where a site of 265 hectare, a former steel mill of Krupp that was closed in 1993, was redeveloped as a logistics zone with international exposure. A trimodal container terminal with a yearly capacity of 400 000 TEU was built on site, and is the catalyst of the further intermodal expansion of the Port of Duisburg. The port of Liège also concentrates new redevelopment projects on (international) logistics activities. This kind of redevelopment projects will also further diversify the traffic structure of these ports as more conventional cargo and containers traffics will be attracted.

Examples of the industrial type in the hypothetical inland port range are Duisburg, Charleroi and Liège. Their traffic structure is dominated by oil products, coal, ores, minerals, scrap and steel products and they don't have a systematic imbalance between inbound and outbound waterborne traffic. Figures 4 tot 6 show the traffic structure of these ports for the year 2001.

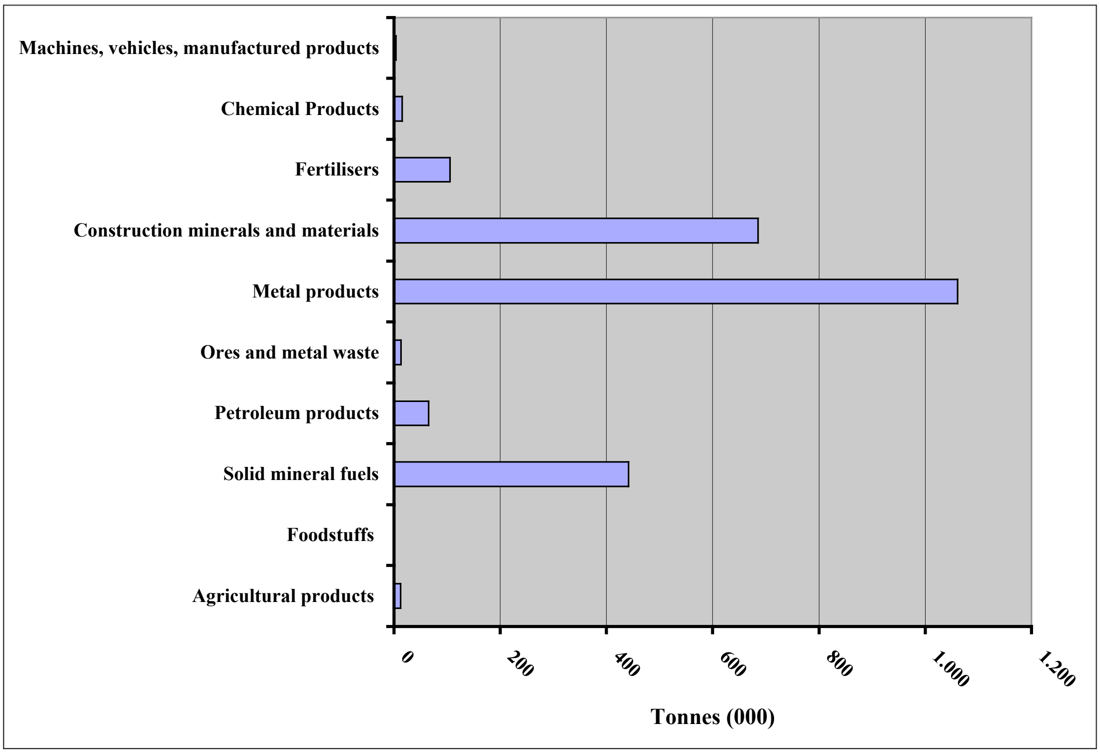


Figure 4: Traffic structure port of Charleroi (2001) (Source: authors).

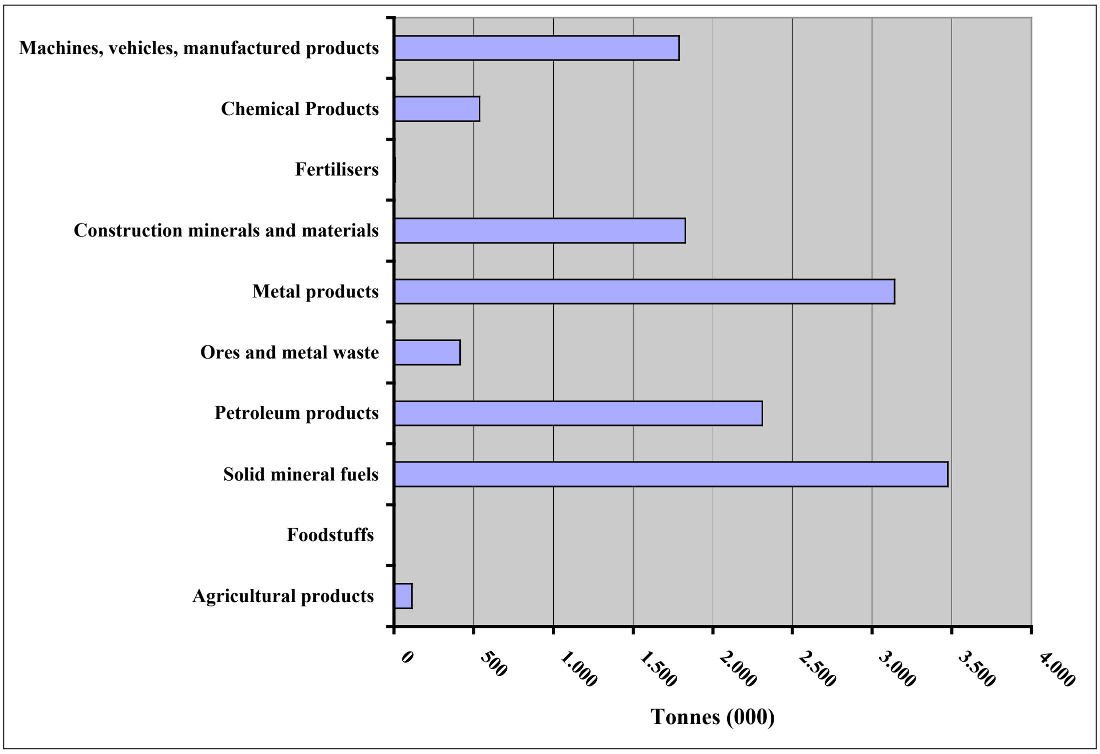


Figure 5: Traffic structure port of Duisburg (2001) (Source: authors).

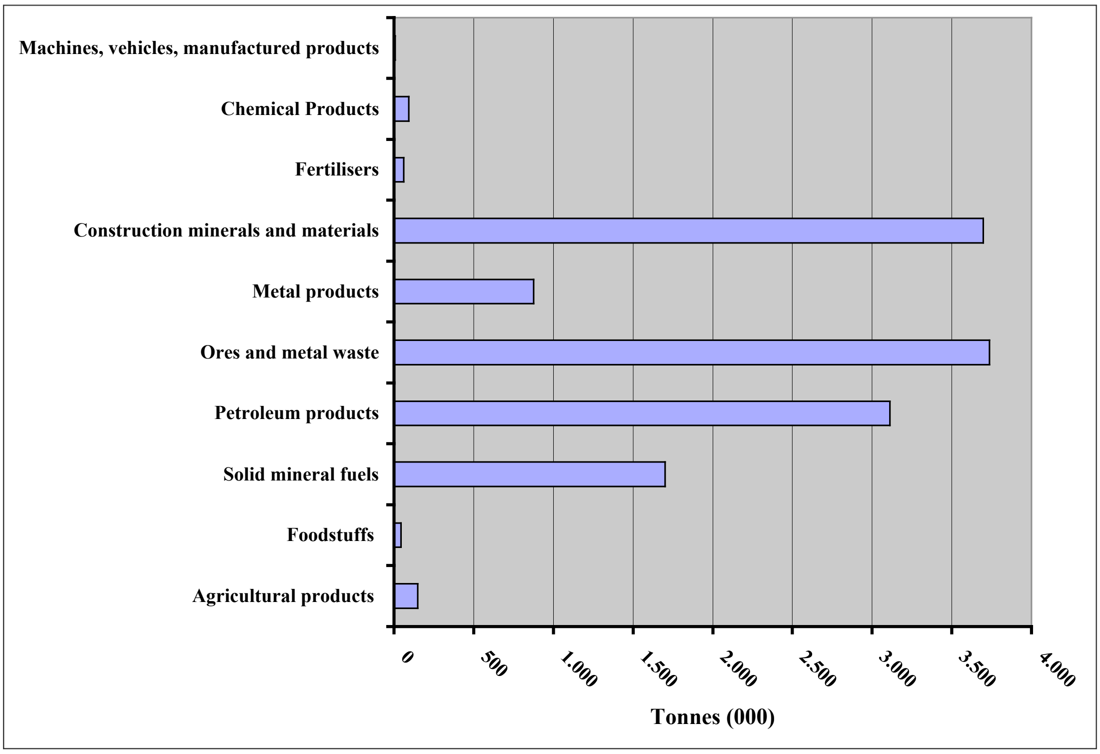


Figure 6: Traffic structure port of Liège (2001) (Source: authors).

2.5. Stuck in the middle?

Analyzing our hypothetical range, two ports seem to belong neither to the industry supporting, neither to the metropolitan supporting type, i.e. the Rhine ports of Strasbourg and Basel. In fact, a close look at their traffic structure shows that they possess characteristics of the two types. The main traffic categories in the Port of Strasbourg are construction materials, oil products, and food and agricultural products. Looking at this traffic structure, it could be argued that Strasbourg leans more towards the metropolitan type (dominance of oil products and construction materials). However, the second parameter of the framework (imbalance inbound/outbound) shows that outbound traffic clearly dominates inbound traffic for these two traffic categories. As a consequence, the metropolitan or regional logistics function for hinterland distribution is not as omnipresent as in the ports of e.g. Brussels and Paris. The example of the port of Strasbourg shows that the parameter of imbalance between inbound and outbound waterborne traffic is necessary to make a clear distinction between inland port types, as the exclusive use of the traffic structure parameter (which gives a main direction of the prime functionality of the port) can be misleading. As outbound traffic plays a large role (see also infra, figure 9 and figure 10), we can conclude that Strasbourg leans more towards the industry supporting type. Figure 7 shows the traffic structure of the port of Strasbourg for the year 2001.

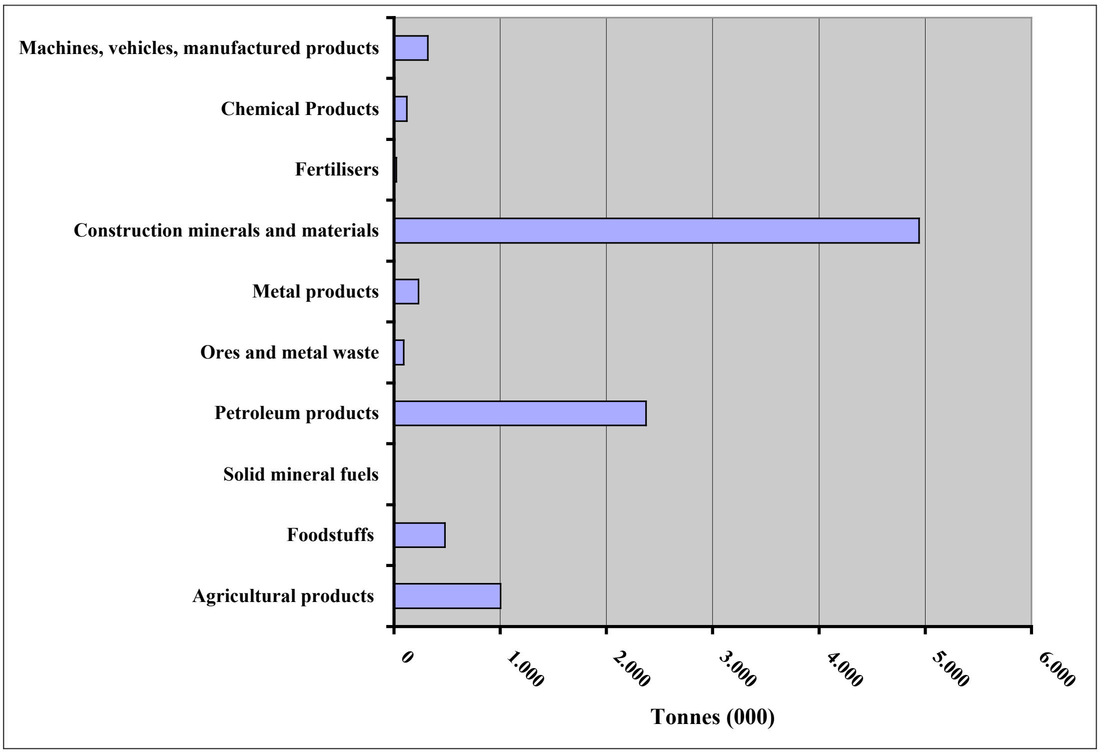


Figure 7: Traffic structure port of Strasbourg (2001) (Source: authors).

The traffic structure of the port of Basel is dominated by oil products, steel products and chemical products. Construction materials only play a marginal role. The dominating traffic categories show in this case a supporting role for the regional and even national economy, in particular oil products and chemical products to support the chemical industry. Steel products are imported via the port and transhipped to trains, which transport them further into the Swiss hinterland. This traffic structure, together with the qualitative information mentioned above, doesn't fit into the two classical types of inland ports, as we can identify both an industry supporting role and a metropolitan or regional logistics functionality, which is a characteristic of the metropolitan supporting type. On the level of the imbalance inbound/outbound traffics, inbound traffics have a clear dominance in the Port of Basel, which is also a characteristic of the metropolitan type (see also figure 9 and figure 10). Figure 8 (next page) shows the traffic structure of the port op Basel for the year 2001.

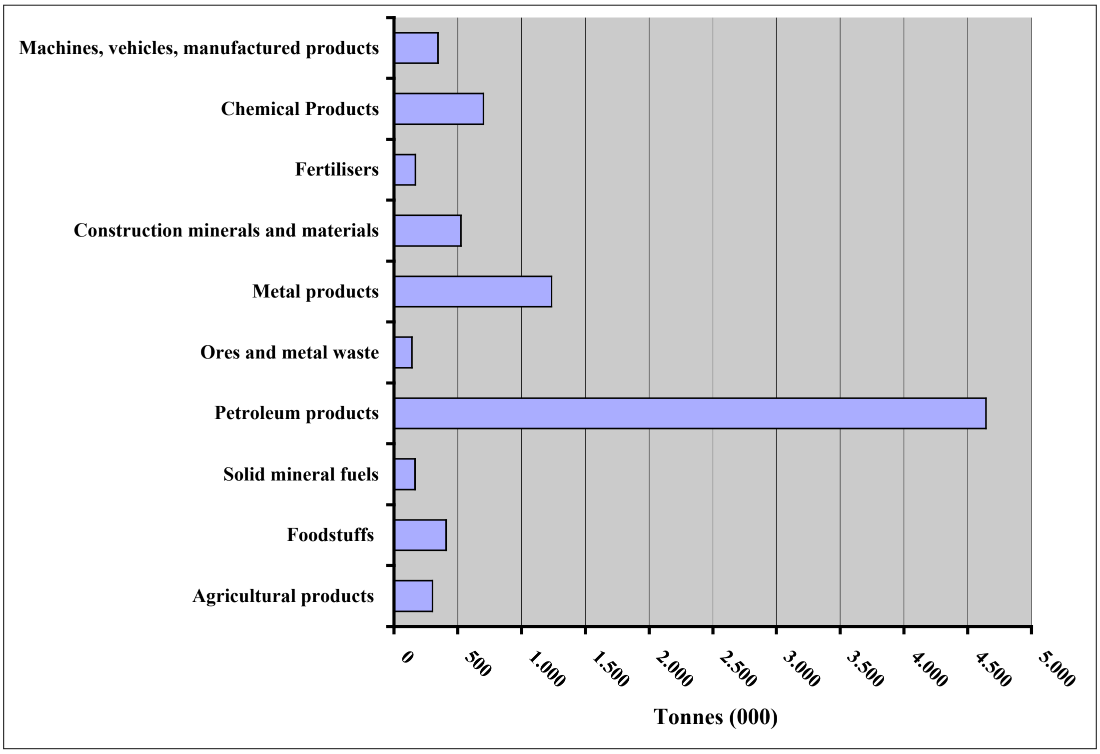


Figure 8: Traffic structure port of Basel (2001) (Source: authors).

2.6. A framework for the classification of inland ports

Figure 10 (next page) shows the framework and the relative position of the ports. These relative positions are based upon a quantitative (traffic data) and a qualitative (industry/economy structure of the hinterland, geographical situation) judgement of the traffic structure and the imbalance between inbound and outbound traffic flows. The imbalance between inbound and outbound waterborne traffic is a quantitative measure and is represented in figure 9 (next page), and supports the analysis of the types in the preceding sections.

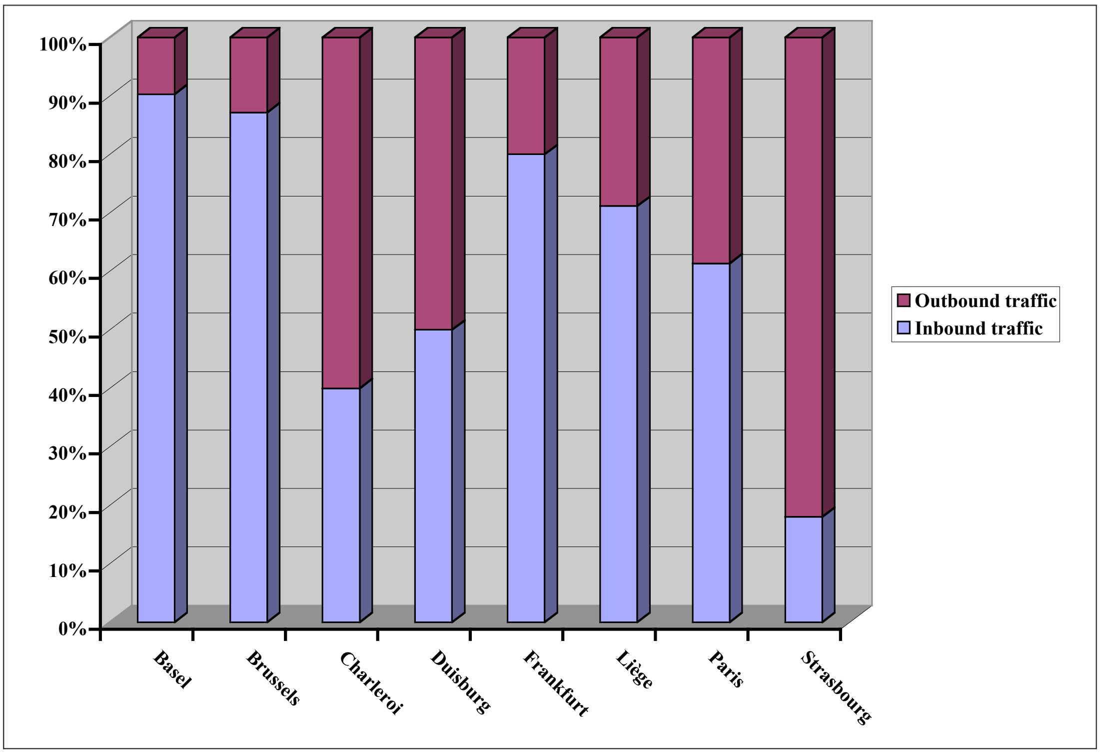


Figure 9: Imbalance between inbound and ontbound traffic (2001) (Source: authors).

Figure 10 then shows the classification of inland ports.

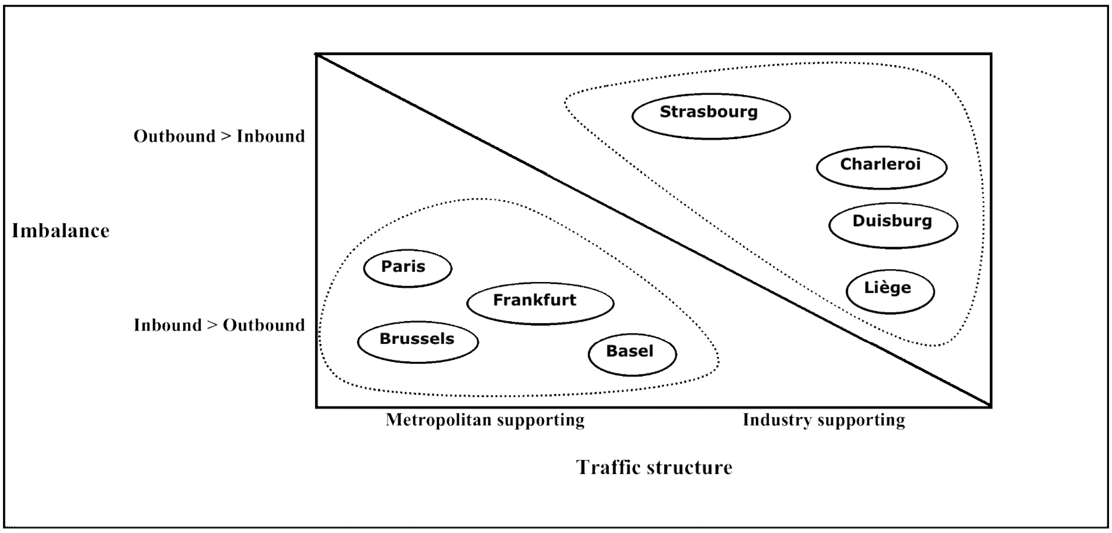


Figure 10: Classification of inland ports

In Figure 10, there are two important clusters:

- Paris, Brussels, Frankfurt and Basel are characterized by a structural imbalance on the inbound/outbound side (dominance of inbound traffic) and a traffic structure with primarily a metropolitan / regional distribution functionality.
- Duisburg, Charleroi, Liège and Strasbourg are characterized by a more balanced situation between inbound and outbound traffic, and a traffic structure with primarily an industry supporting functionality.

2.7. Further analysis of the clusters

The structural imbalance between inbound and outbound waterborne traffic in metropolitan supporting type ports is explained by the fact that these ports often function as end-points of the waterborne part of the transportation chain. These ports are – as mentioned in subsection 2.3. - mainly used as regional or urban multimodal platforms to supply the wide urban region with primarily construction materials (sand, cement, …) and oil and petroleum products for the network of filling stations or distribution for households (surprisingly, the port of Paris seems to be an exception as petroleum products are not dominant in the traffic structure). Furthermore, the relative position in the framework will most likely change over time, as these ports try to adapt their strategies in order to achieve a better balance between inbound and outbound traffic. In fact, this imbalance is perceived as an important handicap, as the non-existence of a critical volume on the outbound side pushes some potential waterborne traffic to the road, as a fluvial connection can sometimes not be economically viable without this critical volume on the outbound side. In other words, it is very difficult to have a fully loaded return trip for the vessel. In the long run, it is expected that intermodal developments driven by containerization and new evolutions in bundling and groupage will diversify the traffic structure of these ports, but also can have a favourable effect on the inbound/outbound imbalance as more goods will be loaded into containers and use outbound going shuttle barges. However, the existing and future economical structure of these metropolitan regions (dominance of the service sector and further de-industrialization) will continue to be a major handicap on the outbound side as a critical loading mass is difficult to find in these regions, as important industrial activities will move to other regions in Europe and Asia. The influence of containerization on the positions in the framework in the long term could be an interesting item for further research.

However, de-industrialization tends to have larger consequences for industry supporting ports such as Duisburg, Charleroi and Liège, as large areas will become available for re-development. These areas will have a strong attraction on multinational Value Added Logistics providers or European Distribution Centres of large manufacturers, as the scale of the sites (often 30 hectares and more) allows clustering of these logistic activities. Furthermore, these ports have an historical advantage as their industrial heritage has left them with trimodal sites (presence of rail connections and infrastructure is guaranteed on almost every site), and less pressure from waterfront developments aimed at housing, offices and recreation. This explains the success rate of redevelopment projects in the ports of Duisburg and Liège.

On the contrary, the metropolitan type is confronted with important constraints concerning the scale of the available sites (which hampers clustering of logistics activities) and the continuous pressure of other stakeholders (local communities, local government) on waterfront areas suited for port activities. Furthermore, the presence of rail infrastructure is not as obvious as for industry supporting ports, as spatial and technical constraints due to the situation in the centre of dense-populated metropolitan areas hamper possible incremental developments of rail infrastructure. An additional handicap is the position in the logistical chain, as the metropolitan/regional distribution functionality implies a position close to the market for the supply of goods, which implies a lack of critical loading mass on the outbound side, as there is no substantial presence of industrial activities, and development of large logistical clusters can be hampered by spatial constraints. As a consequence, their position in the freight rail network has become very weak, and existing rail connections of waterfront sites suitable for port activities are increasingly menaced.

2.8. Implications on the modal split

The elements presented in section 2.7. implicitly lead to an important parameter that was not analyzed when developing the inland port type framework: the modal split of the total traffic flows in an inland port. The inland port types which were identified in the preceding sections, were identified exclusively on the basis of the traffic structure of the fluvial-maritime traffic, and the imbalance between inbound and outbound fluvial-maritime flows. This is obvious, as the basis of the existence of port activities and the most widely used parameter when evaluating a separate port and/or analyzing a port range is the evolution and the composition of total cargo traffic volume.

During the last years, parameters as port added value or ‘value tons’ (which led to the introduction of weighing rules, see Haezendonck, 2001) and direct and indirect employment effects of port activities have slightly taken over the agenda as the social and economical effects of a port seem to have a large impact on intra-port competitiveness, in particular when justifying the nature of existing port activities and demands for port extension projects to government and local communities. Furthermore, as the role and adoption of sustainable development principles in port strategy becomes increasingly important, ecological efficiency on the level of hinterland traffic also becomes an important parameter when evaluating port competitiveness. In the next section of this paper, a green portfolio analysis of our range of inland ports will be performed. This research will contribute to further methodological developments of the earlier applied research method (Haezendonck, 2001) and to the adaptation of the research method to the inland port environment. Furthermore, the results of the green benchmarking analysis will be confronted with the inland port types, providing on the one hand a further insight into the European inland port system and one the other hand policy implications, relevant for inland port managers as well as for government policy makers.

3. A GREEN PORTFOLIO ANALYSIS OF INLAND PORTS

3.1. Green portfolio analysis: methodology for measuring the ecological dimension

Recent literature on port competition suggests that port operators, port authorities and governments alike should focus on 'sustainable' strategic decisions and actions, including a stimulation of environment-friendly transport methods (Nijkamp, 1999). In addition, port authorities are strongly recommended to meet the guidelines of the EU common transport policy (European Commission, 1998a and 1998b) by encouraging environment-friendly solutions in the port sector.

Given the infrastructure network linking ports to their hinterland, transportation affects the environment through the use of transport vehicles (e.g. emissions into the air, water and soil and noise emissions) (Daniels and Adamowicz, 2000).

Measuring the environmental harm directly caused by a port's activities on a wider geographic region, through analyzing the externalities generated by hinterland transport, has already been introduced by Haezendonck (2001). This study proposed a methodology for performing green port portfolio analyses and will be briefly summarized in this section.

In SPA literature, it has been argued that portfolio analysis constitutes a useful tool for assessing the competitive position of ports. Two conventional micro-economic parameters, namely annual growth rate and market share, were used to assess the competitive performance of the ports. The major disadvantage of the conventional analysis originally introduced by the Boston Consulting Group is that the environmental impact of ports is not considered. In Haezendonck (2001), the environmental impact is measured of the specific mix of transport modes used for incoming and outgoing port traffic to and from the hinterland. Here, a distinction can be made between road transportation, rail and inland navigation as the most important hinterland transport modes. It could be argued that various port handling technologies, spatial design approaches, safety procedures etc., adopted in different ports can also have a differential environmental impact. However, the paucity of data regarding the external effects of such activities led to a focus on hinterland transport. From a methodological perspective, this approach could obviously be extended in the future as better comparative data become available on the externalities of port specific activities.

Haezendonck (2001) builts upon Ilinitch and Schaltegger (1995) and Jose (1996) who have advocated the use of an ecologically oriented portfolio analysis, integrating environmental elements into traditional portfolio analysis in order to address emerging strategic environmental issues. Their 'green business portfolio' matrix quantifies the environmental impact of business activities and compares it with the economic performance of these businesses, the latter being based upon conventional indicators, i.e. relative market share and relative growth rate. The economic performance dimensions are the same as those used in the Boston Consulting matrix and result in the familiar matrix with four quadrants. Introducing an environmental impact dimension leads to the development of a three dimensional matrix (growth, market share and environmental dimension). The optimal position in the ecologically oriented product portfolio analysis of Ilinitch and Schaltegger (1995) is the 'green star' that combines high economic performance with low environmental harm. A 'dirty dog' position is not a desirable position in the matrix: this position reflects products or businesses that cause substantial environmental harm without contributing significant economic benefits in terms of market share or growth rate. In addition to these two extreme cells, a number of 'middle positions' exist, such as a 'dirty cash cow', a 'green dog' or a 'green question mark'. A 'dirty cash cow' reflects a high market share in dirty technologies. A 'green dog' position suggests a combination of a weak economic performance within an environmentally attractive business.

With regard to the practical use and visualization of the green portfolio, a two-dimensional version without any loss of information was introduced by Haezendonck (2001). Here, the portfolio diagram included a green-coloured sphere for each port, enabling to visualize the environmental impact of each port considered.

In order to measure the extent to which ports are more or less environment-friendly, and as a result to obtain the green colour of the spheres in the diagram, three transport modes, namely road transport, rail transport and inland navigation are considered. The importance of a port's hinterland traffic is directly related to the cargo volumes transhipped in that port. When measuring the share of hinterland traffic in the total port traffic, and then translating this share in terms of the total throughput of the ports considered, as expressed in volume of handled metric tons, the number of tons transported to and from that port's hinterland is obtained. If the share of road, rail and inland navigation traffic in the total hinterland traffic of the considered port is known, volumes in metric tons transported per transport mode in a specific base year are obtained. In a next phase, these port specific volumes are linked to the average distance characterizing a single transport movement for each specific mode of transport (road, rail and inland navigation). This leads in Haezendonck (2001) to a volume of ton-kilometers performed by each mode. INFRAS (1995 and 2000) has provided an in-depth analysis of the average external costs generated by each individual transport mode in the EU (the actual data in these two studies reflect respectively the situation in the years 1991 and 1995) in terms of EURO per ton-kilometer. As a result, the total external costs 'created' by each seaport and for each transport mode in a particular year are calculated by multiplying the volume of ton-kilometers performed by each transport mode with the total external costs in EURO per ton-kilometer for that individual transport mode.

In section 4, the environment-oriented portfolio analysis is applied to a range of important inland ports in Western Europe.

3.2. Green portfolio analysis for inland ports: specific methodological aspects

Before we describe the results of the green benchmarking analysis, there are three main methodological issues we have to discuss. These issues were identified during the process of data collection and analysis.

3.2.1. Differences in the definition of the modal split

The first issue is related to the existence of important differences between the functionality of an inland port and a seaport. Performing the analysis for seaports, we define the modal split for a green benchmarking analysis to the distribution of flows to and from the hinterland, split out by transport mode. In other words, traffic flows are imported or exported by sea (maritime traffic), and those flows are distributed over inland navigation, rail and road transport. Sea-sea transhipment and local transport are eliminated in this case as they do have a much less significant impact on the environment (The Member states Group on Ports and Maritime Transport – North Sea Group, 1995 and Haezendonck, 2001).

The situation is more complex for inland ports, as a relatively large number of operations between transport modes that do not have a direct link with the waterway, e.g. road-road operations or rail-road operations. An example is the Eurofret logistical zone in the Port of Strasbourg, which is close to the container terminal but where road-road operations are dominant. Another example is the TIR- logistics centre in the Port of Brussels, where operations consist of 100% inbound road transport and 100% outbound road transport. This different situation is explained by the different functionality of inland ports versus seaports. Seaports have in most cases a national and even international functionality and scope in terms of hinterland distribution (e.g. most seaports in the Hamburg – Le Havre range), sometimes referred to as their functionality as a 'mainport'. An inland port is part of this national or international hinterland of seaports and has only a regional, and in some specific cases a national functionality in terms of hinterland distribution. This is clearly the case for metropolitan supporting inland ports, as they have a functionality of urban or regional logistical platform. As a consequence, the functionality of an inland port area needs a larger approach when defining the modal split. In other words, inbound cargo flows come via road, rail or inland waterway and are distributed to the hinterland by road, rail or sometimes again inland navigation. This larger approach is sometimes confirmed by the way port authorities of inland ports communicate with their government and local community stakeholders to prove the importance of the port area in economical terms, as they often mention the total traffic (inland navigation, rail transport and road transport) as a complementary measure to the fluvial (and in some cases maritime) traffic. This confirms that inland port authorities have a broader view on their port activities than exclusively the fluvial (and maritime) part.

3.2.2. Data collection

This modified approach concerning the definition of the modal split leads to a second, more practical issue of data collection (availability and reliability of data), more specifically concerning the amount of road traffic. This is an important issue, as road transport is responsible for the majority of negative externalities (INFRAS, 2000). Whereas all inland ports of the hypothetical range have very detailed and reliable data on fluvial and rail traffic, only a few inland ports have year to year reliable data on road transport (Basel, Charleroi, Liège) and publish them accordingly. Other ports base their road traffic on periodical survey's (e.g. Brussels), and in the case of Paris, Frankfurt and Strasbourg there only exist estimations of port managers and/or their statistical departments. As a consequence, analyzing and benchmarking the modal split over periods of longer than 5 years is very difficult, as in most cases there only exist data on one base year, and the majority of other data on road traffic volume of the analysis will be extrapolations of this base year.

This lack of availability and reliability is primarily caused by two problems. A more external problem is the lack of willingness of port companies to supply data on road transport. This could be linked, among other causes, to the very stringent and - on a pan-European level- different regulations on road transport (driving times, maximum charging volume, working conditions, etc.), which makes it difficult for transport and port companies to work within the acceptable limitations of the regulatory framework. Of course, the effect of smuggling cannot be neglected as well. As a lot of road-road operations have to be taken into account when calculating the modal split, this problem can lead to large differences. A more internal problem is the ICT-evolution, as most inland ports lag behind in implementing ICT to manage and process data flows concerning traffic. It is expected that this problem will be solved in the short term, as most inland port authorities are investing in more adequate IT-infrastructure. This should contribute to a more transparent and uniform method of data collection as most inland ports use specific measurement and reporting systems and/or methods, which complicate the benchmarking analysis exercise.

Despite all problems mentioned above, as all data were supplied directly from port authorities (in most cases via personal contacts), it is assumed that the data are reliable.

3.2.3. Average distances of hinterland traffic

This third issue relates to the lack of availability of data concerning the average distances to and from the hinterland of road, rail and inland navigation transport for inland ports. In order to calculate the environmental impact of hinterland transport from and to ports, the average length of a transport activity should be estimated in addition to the actual amount of cargo transported towards the hinterland. As such, data in ton-kilometers are obtained which can then be related to the externalities in euro per transport mode. Whereas these average transport distances could be calculated for EU seaports using data provided by Eurostat (2000) and ECMT (2000), resulting in an average distance for road traffic of 110 km, 250 km for rail transport and 200 km for inland navigation and which were validated by various port experts (Haezendonck, 2001), there are no available data of average transport distances to and from inland ports in the EU. There is also very little evidence that these distances, obtained for seaports, could be used for inland ports. Moreover, it is doubtful that even if average distances to and from a specific inland port were available, these distances could be used as an average for the considered range of inland ports, given the diverse nature and functionality of the ports in this range. Therefore, we could not estimate the environmental impact of inland ports on the calculated externalities in euro per ton-kilometer. Instead, we use the quotient of environment-friendly modes (rail and inland navigation, in % of the modal split) to road transport (less environment-friendly, in % of modal split) as an approximate to measure the environmental impact of the considered inland ports, see section 4.1 in this paper.

Furthermore, the problem concerning the average distances of hinterland traffic can not be limited to the container traffic as all traffic categories have to be taken into account, given the large role of the bulk segment in inland ports and given the non-existence of significant container volumes of some ports in the range (e.g. Brussels, Charleroi). Furthermore, we have to take into account the type of inland port as set out in sections 2.1. to 2.7. There will exist important differences between “metropolitan” inland ports and “industrial” inland ports, as hinterland distances are very likely to be dependent of the degree of urban or regional logistics functionality, as determined by their traffic structure and imbalance between inbound and outbound traffic. A higher degree of urban logistics functionality of the port will lead to shorter distances, which favours road transport as speed and flexibility are important. The lower the degree of urban functionality (or the more industry supporting), the larger traffic volumes will generally be but also the distances will be longer as the industry's raw materials are imported from a more global perspective, but intermediate or even finished goods as a result of industrial processes will also be exported to a larger hinterland.

3.2.4. Conclusion

These three issues leave open a very interesting research agenda for academics, as well as for port managers and government policy makers. Whereas the first issue is a more conceptual one, the issue regarding data collection needs a large input from inland port managers (e.g. under the form of more cooperation and interoperability of reporting), whereas the issue regarding average distance of hinterland traffic needs more input from academics as the research on average hinterland distances from/to inland ports has an important societal value. However, cooperation between the different stakeholders (in this case academic researchers, government representatives and port managers) will be necessary to solve these methodological issues. In the next section, a green benchmarking analysis of eight inland ports is performed, on the basis of their modal split data from 2001. This analysis should allow further analysis of the green competitiveness of inland ports and the description of inland port types, but should also be a catalyst for further research in the field.

4. GREEN BENCHMARKING ANALYSIS: EMPIRICAL ANALYSIS

4.1. Introduction

When performing a conventional portfolio analysis, ports are positioned according to their total traffic in the observation period, without distinction among relevant commodity groups or traffic categories. The total market share of each port is indicated on the X-axis as a percentage of the total range traffic. The annual growth rate of the traffic is represented on the Y-axis. The bold vertical line expresses the theoretical average market share, i.e. assuming all ports in the considered range have the same market share. The horizontal bold line allows to make the distinction between relatively fast and slow growing seaports, as it indicates the average annual growth rate of the entire port range in the considered period. The designation of the quadrants on the basis of the performance measures for ports, i.e. ‘Star Performers’, ‘Mature Leaders’, ‘Minor Performers’ and ‘High Potentials’, as suggested by Haezendonck (2001), is also used in this paper.

The two dimensional display, including market share (X-axis), annual growth rate (Y-axis) and environmental dimension (green colour of the disks), as developed by Haezendonck (2001), is used to visualize the results of the empirical analysis in this paper.

However, with regard to the green inland port portfolio application in this paper, the determination of the green coloured disks in the analysis (i.e. the environmental impact of the considered port) will not be based on the extensive calculation of euro per ton-kilometer as suggested by Haezendonck (2001), see also section 3.1. Here, it will be merely based upon the modal split data of the inland ports included in the analysis. First, data on the average transport distances from and to inland ports with regard to a specific mode are not available, see also section 3.2.3. In addition, in Haezendonck (2001), there was a clear link between the modal split of the transport from and to a port and the final calculated environmental impact of that port. As a result, using the quotient of the modal split percentages of the environment-friendly modes and the modal split percentage of the most environment-unfriendly mode (i.e. road transport), offers a simple and useful alternative estimate of the environmental impact of an inland port.

The lighter the green colour of the display in the figures in the next sections, the more environment-friendly the port's hinterland traffic is in terms of external effects. If the disk is dark green or black, the larger the road transport share in the port's hinterland traffic and the 'dirtier' it can be considered.

4.2. Green port portfolio analysis of total range of eight inland ports in Western Europe (2001)

Figure 11 shows the green benchmarking analysis of the total range (total traffic, 2001).

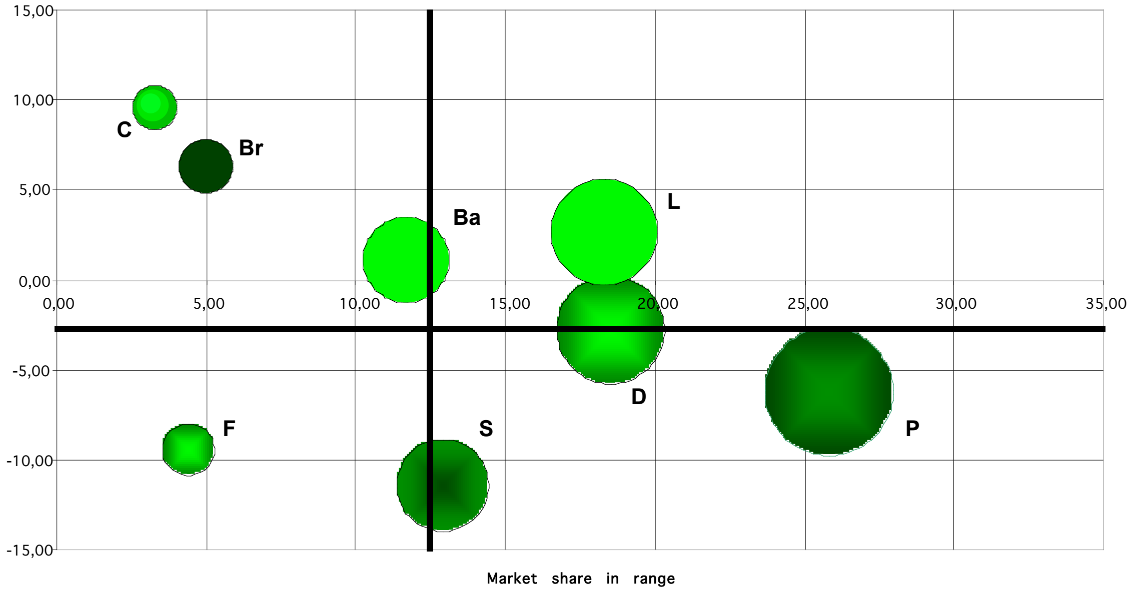


Figure 11: Green port portfolio analysis of total range of considered inland ports in Western Europe (total traffic, 2001). (Source: authors).

In Figure 11, the port of Strasbourg is shown to be an overall poor performer. This port is a 'Minor Performer' in economic terms as well as in terms of environmental friendliness of its hinterland traffic. The port of Paris performs poorly on growth and environment-friendliness, but has the largest market share in the range and is as a result a rather dirty 'Mature Leader'. Brussels was also a 'dirty' port with 78% of road traffic in 2001, but combined a high growth rate with a relative low market share and revealed as a result a ‘High Potential’ in economic terms. The port of Frankfurt performed poorly in economic terms, but on the contrary shows to be average in environmental impact terms. The ports of Basel and Duisburg are situated close to the intersection of the four quadrants and were rather good performers in environmental terms. The ports of Charleroi and Liège were both ‘Green’ performers, but Charleroi noted a very high growth rate (‘High Economic and Environmental Potential’), whereas the port of Liège had a larger market share and was the only ‘Star Performer’, both in economic and environmental terms.

According to the identified clusters in inland ports, see Figure 10, it is interesting to perform a green portfolio analysis on both clusters separately.

4.3. Green port portfolio analysis of subrange of industrial inland ports in Western Europe (2001)

Figure 12 shows the green port portfolio analysis of the industrial cluster of inland ports in Western Europe (total traffic, 2001).

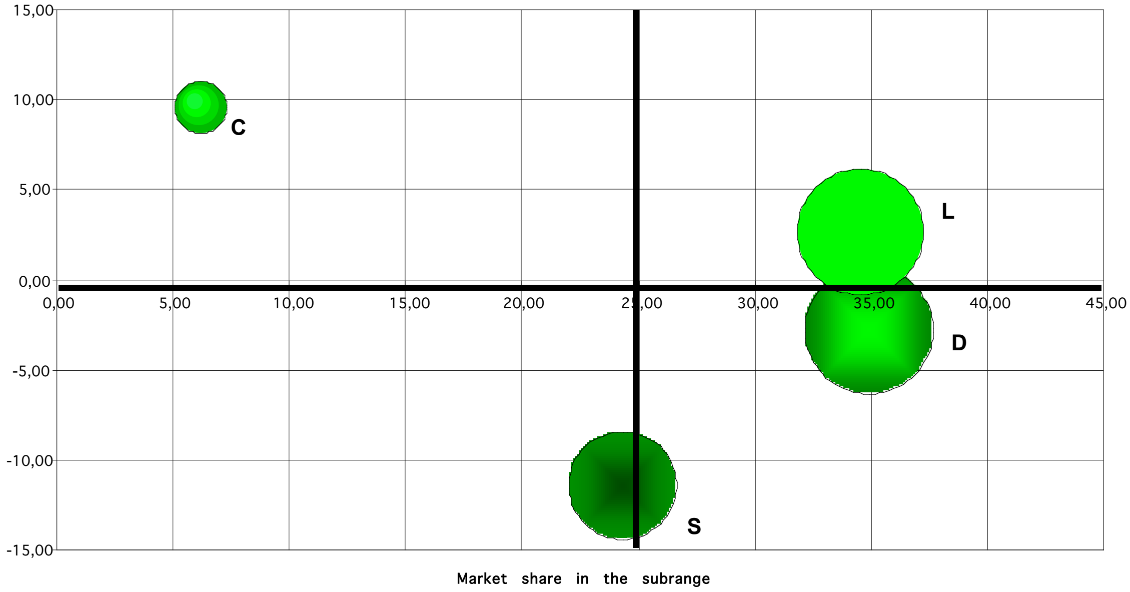
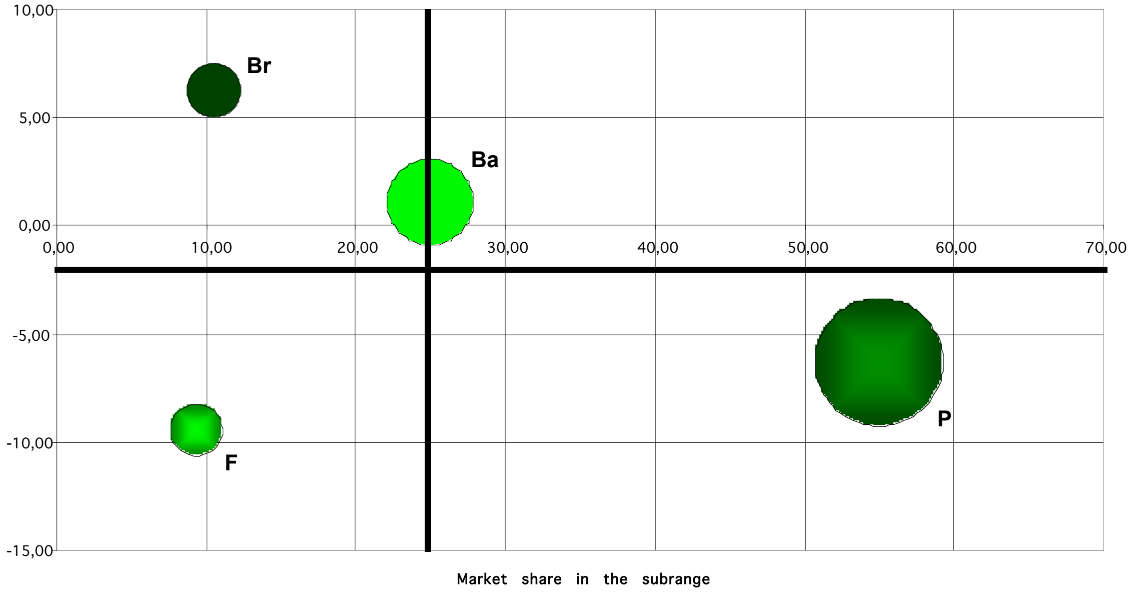


Figure 12: Green port portfolio analysis of industrial cluster of inland ports in Western Europe (total traffic, 2001). (Source: authors)

Figure 12 shows that the Belgian inland industrial ports of Liège and Charlerloi are the best performers, as well in economic as in ecological terms. Duisburg combines an average ecological performance with a 'Mature Leader' position. Strasbourg is the poorest industrial port, combining a rather unfavourable economic position ('Minor Performer') and shows to be a rather dirty port with respect to its competitors in the industrial sub range. This is explained by the presence of large logistical zones, where road-road operations play an important role.

4.4. Green port portfolio analysis of sub range of metropolitan ports in Western Europe (2001)

Figure 13 shows the green port portfolio analysis of the metropolitan cluster of inland ports in Western Europe (total traffic, 2001)



The visualization in Figure 13 indicates that apart form the port of Basel, metropolitan ports are performing rather poorly in environmental terms. The port of Frankfurt shows to be cleaner than Paris and Brussels, but is a poor economic performer. The port of Basel is definitely the best overall metropolitan performer.

The figures above show no significant relation between economic performance in terms of growth and market share and the use of ecologically sound means of transport. In fact, Figure 2 shows that one of the three best performing ports in terms of annual growth, namely the port of Brussels, is also the worst performer in terms of negative environmental impact. An interesting observation, however, is that the ports situated in the 'Mature Leader' quadrant (Paris and Strasbourg), were also relatively 'dirtier' than the average port in the range.

It is interesting to see that apart from the ports of Basel and Strasbourg, which seemed to be rather at the edge of their respective clusters (see Figure 10), metropolitan ports show a poorer environmental performance than the industrial clusters. This is largely due to their position in the logistical chain, as they are the last points of the logistical chain before goods (mainly construction materials and petroleum products) are delivered to the end-consumer or wholesalers/retailers in the metropolitan region, which favours road transport (small volumes, short distances). In addition, industrial inland ports are more situated in the favourable economic quadrants ('High Potentials', 'Star Performers' and 'Mature Leaders'), whereas the metropolitan ports tend to be less performing without any 'Star Performer' and with Frankfurt as a 'Minor Performer'. This could be attributed to the lack of available sites to support further growth, but also to pressure from local community stakeholders, who would rather choose residential or leisure development of available waterfront sites above port development. The favourable position of Basel concerning ecological performance is largely explained by the overall presence of trimodal infrastructure, but also by the role of the port as a gateway to the more larger Swiss hinterland, complementing the role of metropolitan and regional distribution and to some extent even the role of industry supporting logistical platform.

5. CONCLUSION

In this paper, the conceptual framework, which introduced an ecological dimension in portfolio analysis, as developed by Haezendonck (2001), was empirically tested on inland ports. Based on the modal split, i.e. the decomposition of a port's overall hinterland traffic into traffic volumes using different transport modes, the performance of this port in terms of its environmental impacts can be determined. Here, a three dimensional analysis was adopted (average market share, average annual growth rate and environmental impact related to a port's hinterland traffic). In a first phase, the competitive position of a port or a port operator can be evaluated by means of traditional product portfolio analysis (horizontal plane). The second phase of the environmental portfolio analysis then consists of evaluating the modal split of the ports involved in terms of the external costs they create and their potential for contributing to a more socially desirable situation by inducing a shift towards more environment-friendly transport modes.

The basic difference between conventional portfolio analysis and ecological portfolio analysis is that a shift is created from thinking in terms of maximizing total throughput of cargo in the port towards thinking in terms of minimizing the external costs generated by this same port.

No significant relation can be found between economic performance in terms of growth and market share and the use of ecologically sound means of transport.
It could however be observed that most metropolitan supporting ports show a poorer environmental performance than the industrial clusters. In addition, industry supporting inland ports are more situated in the favourable economic quadrants, whereas the metropolitan supporting ports tend to be less economically performing.

The reason why some ports succeed in economic terms while not performing well in terms of relative external costs can be partly found in the fact that the purchasers of transport services are often not directly faced with the environmental harm and related external costs of these services. Indeed, unless they are forced to bear a major part of the external transport costs (according to the 'polluter pays' principle), they face no incentive to change their modal choice. However, to the extent that stakeholder preferences increasingly favour more environment-friendly behaviour, products and services, it is possible that a modal shift would occur, even if external costs are not fully internalized, see also European Commission (1998b).

Moreover, it should be noted that some ports face more difficulties than others in providing satisfactory alternatives to road transport, especially inland ports. It can be observed that the attractiveness and efficiency of transport to and from the hinterland of ports is often heavily influenced by the physical availability and possibility of specific land transport means. Some ports do not have favourable inherited factor conditions or are with respect to their functionality unable to increase the use of more environment-friendly modes of transport (e.g. Brussels and Paris). Another handicap is their position in the logistical chain, as metropolitan supporting ports are in most cases the last points of the logistical chain, before the goods are delivered to the end-consumer. On the level of the modal split of hinterland traffic, this implies that road transport will play an important role, as the distances to the hinterland are in most cases relatively short (the metropolitan region), which favours the use of road transport.

Given the empirical analysis presented in this paper, a number of important inland port related questions still need to be answered.

First, does a favourable or unfavourable environmental position result from ‘natural’ or ‘created’ factor conditions? In the case of using inland navigation, a favourable position may mainly result from natural, i.e. inherited factor conditions, such as the availability of inland waterways. The favourable position of e.g. the Dutch seaports can be largely explained by this element: the use of inland navigation is primarily based on a ‘natural’ advantage, rather than being the result of a deliberate strategic choice of government, the port authorities or the port operators or as the result of ‘created’ factor conditions. In the case of inland ports, metropolitan supporting inland ports have mainly a natural disadvantage as their historical location in the centre of the urban region hampers the development of additional rail infrastructure, as large pieces of land have to be given up for residential development to create trimodal port sites. Furthermore, the creation of additional rail infrastructure in dense populated metropolitan regions causes environmental externalities from a local community perspective under the form of spatial rupture, vibrations, noise, visual harm, etc.. Nevertheless, ‘created’ factor conditions cannot be excluded as well, as a lot of rail connexions in metropolitan ports were eliminated by (mostly monopolistic) national rail operators, or are not used because the (mostly monopolistic) rail operator does not give priority to rail developments in inland ports, as traffic volumes are relatively low compared to seaports. Hence, a favourable position in ecological terms should not only be attributed to ‘high quality’ strategic decision making.

Second, what is (or can be) the impact of strategic decisions by government or other stakeholders on obtaining a more favourable, i.e. a more environment-friendly position? At present, the impact of government environmental policies in this area appears rather limited (Helm, 2000). In addition, the stakeholder demands for environment-friendly modes of transport are not really well developed yet (Button, 1999). In the future, stakeholder demands and strategic elements (e.g. deliberate choices of governments to stimulate environment-friendly transport modes in the context of seaport traffic through command-and-control policies or direct incentives such as road taxes) may become more important drivers to obtain a favourable environmental position.

Third, to what extent should the environmental and economic performances of a port be viewed as complements or substitutes? The analysis included in this paper suggests that there is little linkage between economic and environmental performance. Both types of performance could be considered as complements, as they do not appear to be mutually exclusive by definition. Given the expected rise in importance of environmental performance in the future - from the perspective of various port stakeholders - government, port authorities and port operators should at least contemplate the implications of engaging in behaviour instrumental to maintaining or improving the environmental performance of the port related activities they can influence.

Fourth, to what extent should the ecological performance of an inland port be used for ‘real’ competitive benchmark purposes of an inland port vis-à-vis other inland ports? Besides the type of inland port (metropolitan or industrial), ecological performance also depends heavily on the position in the network, and more particularly the seaports, which the inland port depends on. The ecological performance of a seaport relies heavily on the presence of an inland waterway network in the hinterland of the seaport (see e.g. Rotterdam or Antwerp, where this network is present). Inland ports in the hinterland of seaports function are the end-point of the waterborne part of the transportation network, and are geographically closer to the market. This close position to the market implies that in most cases, road transport will play a dominant role in further hinterland transportation. When volumes are relatively small (e.g. urban distribution), this can even lead to a very ‘dirty’ position (e.g. Paris and Brussels) where in reality, these inland ports contribute substantially to the ecological performance of the network as a whole as their presence and functioning stimulates more ecological transport into the hinterland of the seaport. Given these aspects, it could be more appropriate to benchmark separate networks of seaports and inland ports, if conclusions on the real competitive position, or the necessity of port activities in dense populated regions, were to be taken.

At this stage of the research, the analysis rather contributes to the identification of good performers within clusters of similar ports. Hence, the conclusions of the analysis should be interpreted very carefully by inland port managers and government representatives, and the results should rather serve as a facilitator for the exchange of best practices, and not as a definitive assessment of the ecological performance.

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