2010 / 2

Port Competition Revisited

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ABSTRACT

Port competition is an important topic in transport economics. This is due not only to the large volumes of goods involved in port throughput – a direct measure of a port's competitive strength – but also to derived effects in terms of employment and investment. Strikingly, the existing literature on the subject tends to regard ports as rather homogeneous entities. In practice, it is increasingly apparent that ports are far from homogeneous environments. This paper elaborates a methodology for analyzing relationships between port operators. Moreover, competition unfolds not only between ports, but also, primarily even, between individual production companies and service providers located in those ports or making use of them, and increasingly also between entire supply chains. The chain element that contributes most to making the chain the cheapest possible, will have the highest chance of being included. This can be derived from a preliminary analysis of port selection criteria, where cost turns out to be the most important criterion. Next to that, also other factors are shown to be possibly important, depending on the conditions and the actor. These factors will have an impact on the generalized cost, and it is shown how this cost can be decomposed in basically a time and a distance component. In order to quantify that cost, it is important to have an overview of the objectives that the different actors aim at, and of the instruments they can use to make the objectives materialize, which are therefore summarized in the paper. The last section of the paper assesses the role of a number of factors which affect port competition. The most striking ones are the changes in world trade, and market structure changes on the side of shipping companies and terminal operating companies.

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KEYWORDS ports, competition, shipping companies, terminal operating companies, logistics chains, generalized transport costs

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I. Introduction

Port competition is an important topic in transport economics. This is due not only to the large volumes of goods involved in port throughput – a direct measure of a

port's competitive strength – but also to derived effects in terms of employment and investment.

Strikingly, the existing literature on the subject tends to regard ports as rather homogeneous entities. This perspective goes back to Verhoeff (1981), where ports are seen to compete with one another at different levels: within a country, for goods flows and for investment in additional infrastructure; within a cluster, for a common hinterland; and increasingly between port ranges, for investments and traffic, particularly from areas where the spheres of influences of port ranges overlap.

However, two important observations compel us to revisit port competition as a concept. First and foremost, it is increasingly apparent that ports are far from homogeneous environments. Quite the contrary in fact: their nature is inherently complex and heterogeneous, involving a variety of market players and mutual interconnections, and they therefore demand a more disaggregated approach than has been in evidence thus far. Moreover, competition unfolds not only between ports, but also, primarily even, between individual production companies and service providers located in those ports or making use of them. Additionally, there has been a clearly discernible evolution in recent years from competition between individual ports to competition between entire supply chains. In order to be successful, a port needs to be part of an efficient supply chain. Otherwise, it is likely to be competed out of the market.

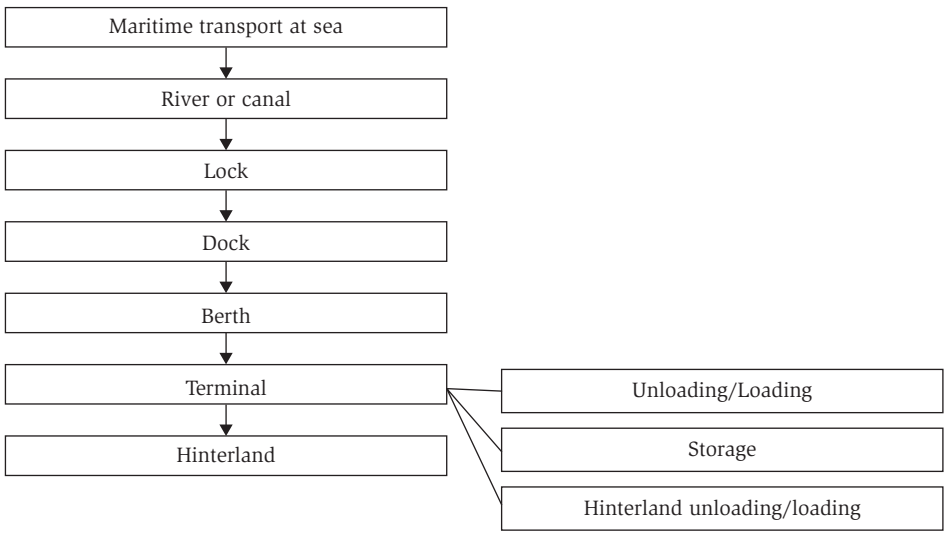
This thinking in terms of supply chains likewise presupposes the existence of different types of competition, both horizontally and vertically. Each player in a chain has specific objectives and will deploy specific tools to reach them. One such objective is profit maximisation by attracting the largest possible goods flow. However, port players operate in a dynamic environment, where ever greater movements of capital have recently led to altered ownership structures. This has been in evidence in the consolidation trend among terminal operating companies (TOCs), whereby local and national stevedores[2] have been taken over by international groups. This gives rise to the question of whether the profits generated by such groups are reinvested locally or channelled to other regions.[3]

Hence, the competitive strength of a port depends only in part on that port's own infrastructure and organisation. Concurrently, there are various external market forces at work. The purpose of the present contribution is to arrive at a typology of port competition. This requires insight not only into the nature of seaports, but also into the decision processes of all the players involved. Where does the power of decision lie in relation to, for example, the choice of route and/or port, shipping company, terminal operator or hinterland mode? Which factors influence these decisions? How do such decision affect decision-making by other players? And which decisions by which players determine the competitive position of the port in question? Is there a sequence to be discerned in decision-making or are certain decisions made quasi-simultaneously? Each of these questions must essentially be considered in the context of individual undertakings before aggregation at a higher level of analysis.

II. A Port as an Economic Entity

Traditionally, seaports are regarded as gateways for transferring cargo and passengers between vessel and shore. However, this definition is too restrictive, for the sphere of influence of a port extends well beyond its own perimeter, both towards the hinterland and the open sea. Jansson and Shneerson (1982) dissect the entire process of cargo throughput in a port into seven main sub-processes: the passage of a ship through the approach channel and subsequent mooring at the quay; discharge of the cargo from the ship's hold onto the quay; moving of cargo from the quay to transit storage; transit storage; moving of cargo from transit storage to loading platform; loading of cargo onto hinterland transport vehicle; and departure of the land vehicle from the port area. There are of course additional functions, including customs inspection, warehousing in the port, cargo preparation (pre-slinging,[4] stripping[5] and stuffing[6] of containers...), but, as the authors point out, these are supplementary rather than intrinsically part of the transfer between sea and land.

Figure 1 provides an overview of the various components and activities involved in a port call and cargo throughput.



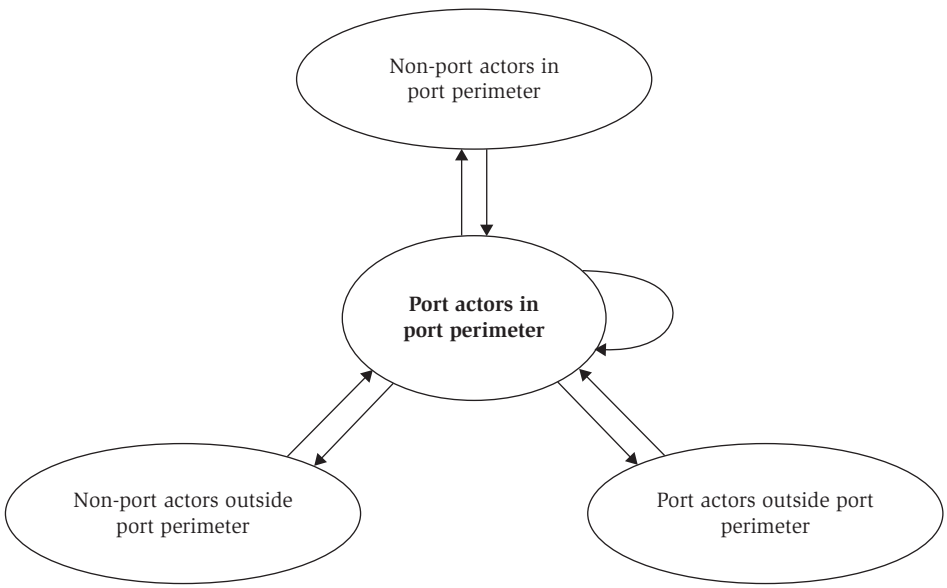
Source: Own composition.[7]

Figure 1. Theoretical Seaport Setting.

The economic function of a seaport is essentially to benefit those whose trade passes through them, i.e. through providing increments to consumers' and producers' surpluses (Goss, 1990). This means that large seaports essentially require three elements: maritime access (i.e. an appropriate coastal location or access route, as well

as sufficient draught,[8]) goods-handling capacity,[9] and distributive capacity, including adequate connections with the hinterland.

The port product may be regarded as a chain of interlinking functions, while the port as a whole is in turn a link in the overall logistics chain (Suykens and Van de Voorde, 1998). Figure 2 represents the principle relationships between the various port actors. It speaks for itself that the importance of these mutual relationships varies from port to port. Moreover, the relative significance of each of the actors and their relationships may change in the course of time. This is due to, among other things, important technological evolutions, e.g. the growing degree of containerisation, increasing ship sizes, quicker goods-handling... Such technological evolutions have improved efficiency.



Source: Coppens *et al.*, 2007.

Figure 2. Relationships between Port Actors.

This complexity underlines the importance of analysing in greater detail the function and performance of the various undertakings involved directly or indirectly in port activities. A typical port consists of more than a port authority and a terminal operating company. Today, many different players and decision-makers are active within ports, and indeed within the maritime sector as a whole (Meersman *et al.*, 2009). The other actors may be roughly divided into two groups: the port users and the service providers. Among the port users are, first and foremost, the shipping companies. Also belonging to this group are the shippers and industrial enterprises who are established within the port perimeter and have land in concession. The service providers

are a heterogeneous group: pilots, towage services, agents, forwarders, ship repairers, suppliers of foodstuffs and spare parts, waste reception facilities, and bunkerers.[10] Stevedores, who are increasingly evolving into TOCs, constitute a special case. They provide services (transhipment, storage, stripping and stuffing…) to shipping companies and shippers, for which they are effectively remunerated. At the same time, they pay the port authorities for terminal concessions.

As this overview of the various players in seaports already suggests, ports are highly heterogeneous environments. It is important that we should have good insight into the relative weight and market power of all of these players in order to fully understand their mutual relationships, capital participations and forms of management control. A recent study by Coppens *et al. (*2007) focuses on the case of the Port of Antwerp. It considers how to quantify the relationships between the various players in the port, how the situation of each of these players may be expected to evolve, and how the empirical study of one port can lead to the recognition of similar structures in others.

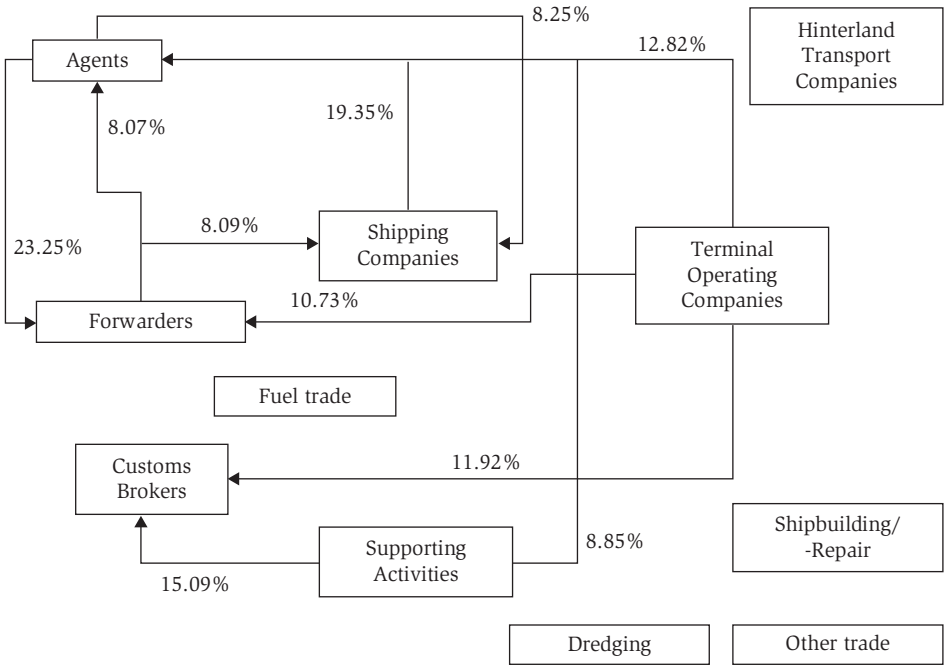
Relationships between the various port actors may be quantified by linking a regional input-output table with microeconomic data (Coppens *et al.*, 2007). In this manner, the principal customers and suppliers of all these actors can be determined. It is also important that insight should be acquired into the financial flows and spillovers between the various actors.[11]

In what follows, we consider the main economic findings for the port of Antwerp. A distinction is made between the relationships with customers on the one hand and with suppliers on the other.[12]

The influence of a port actor – i.e. Antwerp – on its customer – i.e. another port actor – is measured by means of forward linkages. The linkage of industry *i* to customer *j*, relative to the output of customer *j*, is measured by means of the *decomposed forward linkage*. It measures the total effect of an industry on its customers.[13] Figure 3 provides an overview of the decomposed forward linkages.

The arrows show the deliveries from one port actor to the others. The percentages show the effect of the deliveries relative to the output of the customer. Referring to Coppens *et al.* (2007, p. 17), we see that shipping companies have a strong decomposed forward linkage with agents (8.25%) and, to a lesser extent, with forwarders (8.09%). Terminal operating companies have a fairly strong downstream output influence on agents (12.82%), customs brokers (11.92%), and forwarders (10.73%). Agents have particularly strong links with shipping companies (19.35%). Agents have a substantial decomposed forward linkage with forwarders. Customs brokers have no strong decomposed forward linkage with supporting activities (15.09%).

The influence an Antwerp port actor has on its suppliers – in this case an Antwerp port actor – is defined by *decomposed backward linkages*. Decomposed backward linkages give the linkage of industry *j* to its supplier *i*, relative to that supplier's output. It measures the total effect of an industry on its suppliers.



Source: Coppens *et al.*, 2007.

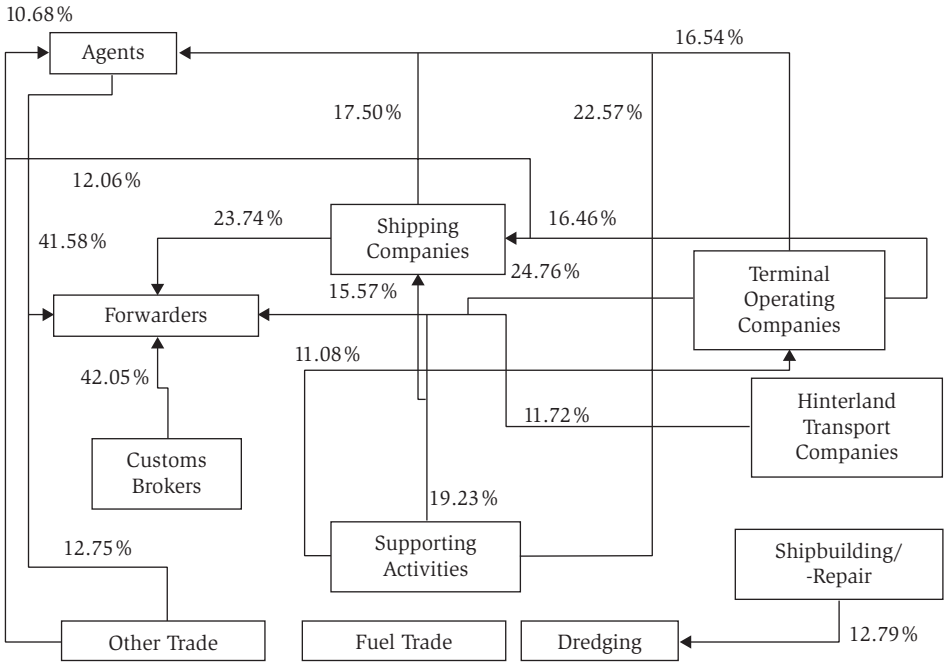
Figure 3. Decomposed forward Linkages.

Figure 4 shows the most important backward linkages between the port actors. The arrows represent the deliveries – mostly services – from one port actor to the other. The percentages show the effect of the deliveries on the supplier, relative to its output.

Referring once again to Coppens *et al.* (2007, p. 19), we see that forwarders have a very strong influence on their suppliers relative to the latter's output: agents (41.58%), customs brokers (42.05%), supporting activities (19.23%), shipping companies (23.74%) and terminal operating companies (24.76%). Agents have an important influence on terminals operating companies (16.54%), shipping companies (17.50%), supporting activities (22.57%) and other trade (10.68%). Dredging has a great upstream influence on shipbuilding and repair (12.79%) and shipping companies on terminal operating companies (16.46%), supporting activities (15.57%) and other trade (12.06%). TOCs have an influence on supporting activities (11.08%).

In the case of Antwerp, the importance of forwarding is quite apparent: many of the financial flows are generated through mediation of this activity. This implies that, for a port with this particular structure, future incentive Programs should in any case be geared to this activity. Substantial cargo flows reach Antwerp through consolidation. Shipping companies use the volume of this cargo as a basis for determining their sailing and port call schedules. This kind of analysis and port-political strategy can

make port throughput less footloose. Obviously the role of certain other port players should not be underestimated either.



Source: Coppens *et al.*, 2007.

Figure 4. Decomposed backward Linkages.

This kind of analysis can also provide insight into how the largest players (shipping companies, terminal operating companies...) may, in the longer run, try to gain greater control over the supply chains through takeovers of smaller yet strategically important players. There have already been examples of takeover attempts targeted at shipping agents, but it is equally likely that terminal operators will continue to integrate, horizontally and/or vertically.[14]

The above analysis suggests that ports, as economic entities, have evolved considerably. They have become heterogeneous structures, a cluster of different undertakings that contribute to varying degrees to the success of the port and, at the same time, are directly or indirectly affected by evolutions in the strategic position of that port as well as elements exogenous to the port perimeter. Each decision by an influential port player and/or service provider within the supply chain shall set in motion a causal nexus. This can give rise to potential bottlenecks earlier in the chain, which may not be immediately visible, but which ultimately can seriously compromise the position of the port.

III. Structuring Port Competition

The nature of port competition has evolved from rivalry between (homogenous) ports to a competitive struggle between supply chains. Successful supply chains are like well-oiled machines in which every nut and bolt is perfectly attuned. Modern seaports are crucially important nodes in international supply chains and their associated networks. The success of the supply chain as a whole depends on the competitive strength of the seaports belonging to that chain and vice versa.

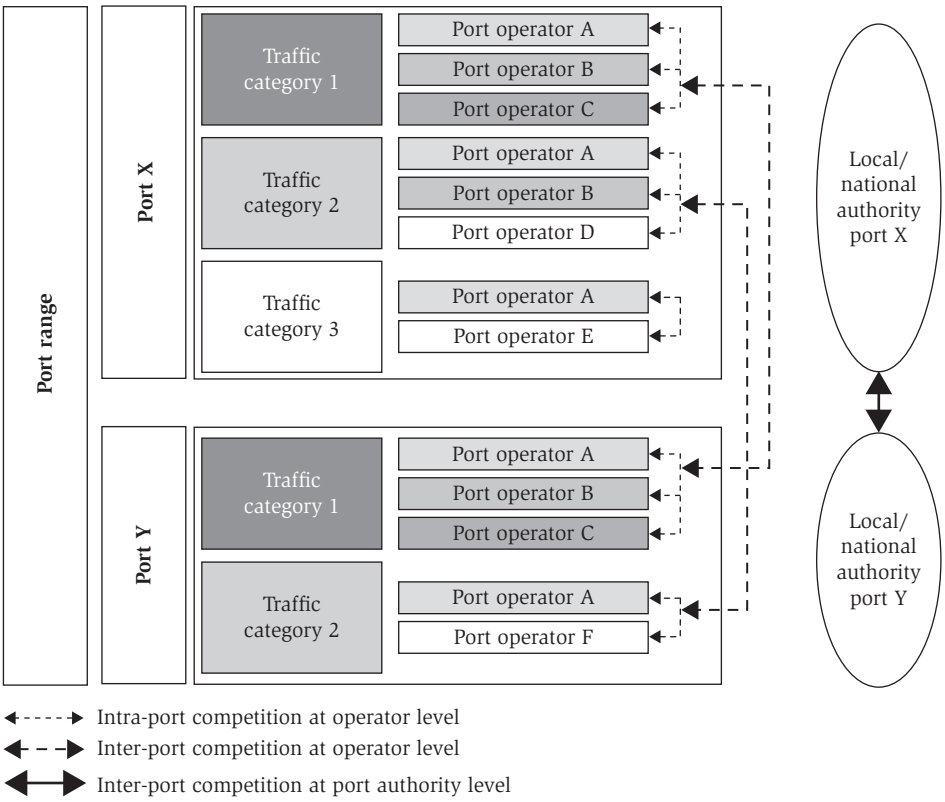
In the past, one has tried to structure and/or model this process in various ways, taking due account of a number of external factors. Ports are, after all, increasingly regarded as links in the supply chain. This implies a continuous trade-off with other links of that chain. Insight into this balance is crucially important, if only in order to understand one's own competitive position. Moreover, a good understanding of the functioning of logistics chains also sheds light on the historical development of ports.[15]

A. A Definition of Port Competition

In the literature, one often refers to Verhoeff's definition of port competition (1981). He distinguishes between four levels of seaport competition: competition between port undertakings; competition between ports; competition between port clusters (i.e. a group of ports in each other's vicinity with common geographical characteristics); competition between ranges (i.e. ports located along the same coastline or with a largely identical hinterland).

The factors influencing competition may vary from level to level. The competitive strength of individual undertakings within a port is determined mainly by the factors of production (labour, capital, technology, and energy). Competition between ports, port clusters and port ranges on the other hand is also affected by regional factors, such as the geographical location, the available infrastructure, the degree of industrialisation, government policy, the standard of performance of the port (measured in terms of proxy variables, such as the number and frequency of liner services, and the cost of transhipment, storage and hinterland transportation).

Van de Voorde & Winkelmans (2002) consider three levels or types of port competition, which are illustrated in Figure 4. The first one is intra-port competition at operator level between operators within a given port with regard to a specific traffic category. Inter-port competition at operator level occurs between operators from different ports mainly within the same range and serving more or less the same hinterland. And finally there is inter-port competition at port authority level focusing on the utility mission of seaports.



Source: based on Van de Voorde, E. and W. Winkelmans, 2002, p. 12.

Figure 4. Different Levels of Port Competition within a Port Range.

As we have already pointed out, this traditional approach to port competition must now make way for an approach based on competition between supply chains, in which seaports, and seaport undertakings, are merely links. As the most important consideration is the overall cost of the supply chain, it is inevitable that, besides throughput, the industrial and commercial functions (including warehousing and distribution of goods) as well as hinterland transportation will come to occupy an increasingly important position.

Choosing an appropriate port of call is an interactive and simultaneous process, governed largely by the principles of supply and demand. Demand for port throughput, i.e. the choice of port, is a function of a number of well-defined variables: the goods flows (cf. the derived nature of transport demand); the extent of the 'merchant haulage'[16] and 'carrier haulage'[17] nature of the goods flows; the generalised cost associated with the supply chain to which the prospective port of call belongs, including the rates charged.

Supply is determined by a combination of players who together represent the port of call as a product. Each player contributes to the generalised cost of the supply chain. The balance obviously depends largely on supply and demand, and additionally also on factors such as third-party cargo, which can ensure that there is sufficient volume to make a port call.

A port and the undertakings established in it compete directly with a limited number of other ports, usually within the same range. There are few types of goods flows for which ports belonging to different ranges might compete directly (e.g. in the fixing of shipping schedules and in determining ports of call). Consequently, the crucial question in port competition is what determines the choice of port? In other words, why is one port preferred to another? Why are certain undertakings located in that port chosen? What are the preferred hinterland transport modes and routes?

Port users think predominantly in financial and economic terms. Frankel (1991) asserts in this respect that "they consider the net revenue contribution of a port call which is usually defined as the difference between the added revenue generated by the port call minus the costs of making the port call". Costs are understood to include all possible items: vessel-related costs (e.g. the time factor, taking into account possible delays), port-related costs (port dues, pilotage...), cargo-handling costs, cargo-storage costs, feeder costs.

Thus, the objective for management, be it of the port or of the undertakings concerned, is clear to see: to minimise the cost of transhipment and delay of vessels. For that matter, the principle of cost minimisation applies to all links in the transport chain, in the sense that the ultimate goal must be to arrive at the lowest possible cost for the chain as a whole.

The port that contributes to the cheapest logistics chain is, in theory at least, most likely to be called at. The ultimate decision process of the port user would appear, then, to be a matter of common sense: does the port considered offer advantages compared to other ports serving the same hinterland? Does the port offer sufficient advantages in order to be considered as an additional port of call for an existing or yet-to-be-established liner or indeed feeder service? The decision process of the port user concerns the transport chain, but he will also have to take due account of market factors (e.g. potential customers, competition from other shipping lines and consignors[18] of goods...).

B. **Structure of a Supply Chain, Including the Decision Process.**

The question arises which player in the supply chain takes which decisions. Additionally, insight is required into which decisions are taken autonomously and which are taken in consequence of or with a view to previous decisions, often at a different level.

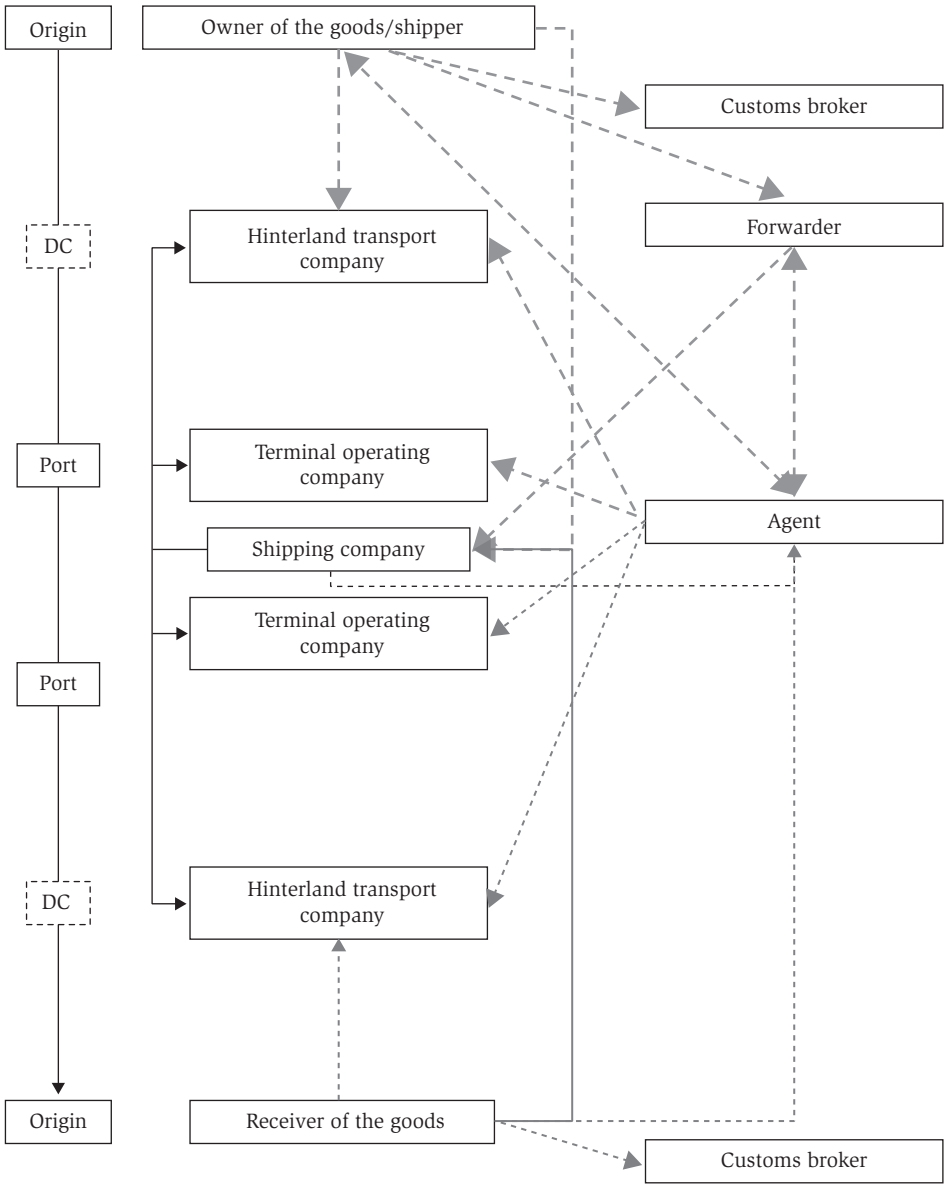
Earlier studies (e.g. Coppens, 2007) have shown very clearly that certain players are particularly influential. This holds for the owner and/or shipper of the goods, the forwarders and the shipping companies. TOCs, on the other hand, are highly dependent upon the decisions taken by these three other parties, even though TOCs themselves are also required to make long-term commitments by investing in superstructure (e.g. storage capacity) and terminal infrastructure (e.g. cranes, straddle carriers…).

It is thus important to gain a clear understanding of the manner in which goods move along a supply chain and exactly which parties are involved in this process, as is represented in Figure 5. Dashed lines mean alternatives to the direct path that may be taken, thus involving one ore more intermediaries.

The owner or shipper of the goods will, with or without mediation of a forwarder, choose a certain shipping company. This is shown through the bold lines in Figure 5. In the reverse case, marked through the non-bold lines, the receiver of the goods will make that choice. In its turn, this shipping company will, in conjunction with the consignor or otherwise, opt for a specific route and thus for a port of call. Upon arrival in port, either through mediation of an agent or not, a choice is made for a TOC. Other services may also be called on (e.g. bunkering, ship repair, ….). The final stretch of the journey requires a choice of hinterland mode and operator. This land stretch may be decided by the sender (in bold) or receiver (not in bold) of the goods, or be taken in charge by the shipping company. DCs[19] (in dashed boxes) may be used on the land stretch. Shippers may also call at customs brokers for intermediation.

The selection of a transport solution, including mode and operator (e.g. a shipping company), is an important decision for the goods owner or the shipper, with or without the involvement of a forwarder. The shipping company is often also involved in the specification of the supply chain. They often decide through which port the goods are to be shipped. This choice for a port of call depends first and foremost on the availability of cargo, which will in turn depend largely on the geographical location and the size of the hinterland. The latter factor is determined in part by the presence of competing ports. Two further decisions, namely the choice of TOC and the subsequent choice for a hinterland mode and operator, are a direct function of the choice of port. Conversely, the available hinterland options are likely to influence the selection of a port, as obviously once a port has been selected, one is limited to the modes and operators on offer. Out-of-pocket expenses are usually the most important consideration in this respect, alongside other aspects, all of which are translatable into monetary units as part of the generalised costs.

On the basis of an extensive literature study and own surveys, Aronietis et al. (2010) have drawn up the following list of factors directly or indirectly influencing the selection of a port: cost; location; port operations quality and reputation; speed/time, infrastructure and facilities availability, efficiency, frequency of sailings, port information system, hinterland, and congestion.



Source: own composition.

Figure 5. Structure of the Supply Chain.

Some remarks are in place here. For one thing, while the aforementioned criteria are undeniably important for the final selection of a port, their relevance varies from player to player within the supply chain. Cost minimisation, for example, is important to every player in the chain, but clearly a shipping company has greater scope than

2010 / 2 Review of Business and Economics

some other players for restricting costs while being able to maintain a price level that guarantees a wide profit margin. Ultimately, though, someone has to foot the bill, namely the (new) owner of the goods.

Table 1 assesses the importance of each variable to each of the port players involved in the selection of a port of call. While Table 1 provides a fair indication, it essentially remains a reflection of stated preference. Obviously, cost is an important consideration, but precisely how decisive is it? Time management would also appear to be crucial, so that the question arises: how does the trade-off work out between time management and cost? This issue is illustrative of the urgent need for a quantification of all decision variables that present themselves in the context of a supply chain. On the basis of such a toolset, one could take adequate account of the own business strategies of each type of player, irrespective of whether their prime concern is cost minimisation or maximisation of market share or profit. Ultimately, the goal must be to reduce the decision-process to a single variable, namely the generalised cost, while taking adequate account of the cost and value of time, and possibly also of external costs.

Table 1. Decision Variables in Choosing a Port.

	Owner/Shipper of Goods	Forwarder	Shipping Company	Terminal Operators
Cost	xx	x	xx	xx
Location	xx	x	xx	xx
Port operations quality and reputation	xx	xx	xx	xx
Speed/time	x	x	x	xx
Infrastructure and facilities availability	x		xx	xx
Efficiency	x	xx	x	xx
Frequency of sailings	x	x	x	
Port information system	x	x	x	xx
Hinterland	x	x	x	xx
Congestion	x	x	x	xx

xx: very important
x: important

Source: Based on Aronietis *et al.*, 2010.

C. **Modelling Port Competition: A General Framework**

It is important for a port authority to know who the port user is, who makes the choice of port and which factors influence this choice. However, the term 'port user'

covers quite a heterogeneous group that includes shipping companies, consignors of goods, owners of goods, goods handlers, ... It is a group whose members would appear to depend on one another, but who are nevertheless often engaged in a fierce competitive struggle. Consequently, it is not always easy to determine who ultimately makes the choice of port. In addition, there is the question of which cost variables are most significant in the decision process (cf. the problem of factor assessment). In this respect, one needs to realise that the cost structure is determined by both exogenous factors (e.g. scale increases in world trade, or rapidly developing cargo-handling equipment) and endogenous factors within the port's direct sphere of influence.

One may assume that any decision taken within a supply chain will be based on cost, and preferably the generalised cost. This holds equally well for partial aspects of the supply chain. The preferred approach is one whereby the cost of a consignment is subdivided into time costs and distance costs. The time costs are allocated to each consignment in accordance with duration, while distance costs are allocated in accordance with mileage. Most costs can be regarded as either a time-related or a distance-related cost (Blauwens *et al.*, 2008).

Time costs are a function of the passing of time and hence they are incurred even when a ship is lying alongside the quay, during loading or unloading of the cargo. The total time cost associated with a consignment is determined not by the distance to be covered but by the total number of hours to be performed. The number of hours performed is the measure of the time cost to be allocated to each consignment. Typical examples are the wages of the crew and annual insurance premiums. In sum, they encompass the fixed costs associated with maintaining a particular capacity within a transport firm (Blauwens *et al.*, 2008).

Distance costs are incurred on top of time costs. In other words, they are added to cost associated with the duration of the consignment and arise only when the vehicle is moving, not when standing still. Transport assignments involving greater distances over the same duration will therefore involve higher total costs. Typical examples of distance costs are fuel consumption, maintenance costs of the vehicle fleet, and damage liabilities (Blauwens *et al.*, 2008).

In addition to time and distance costs, there is a third category of costs which, by their very nature, fall outside the above division. Typical examples include commissions, expenses associated with the repatriation or redeployment of crews, tolls and port dues. Even in approximate terms, these kinds of costs cannot be seen as proportional to either time or distance. Depreciation costs also belong to this third category, though a distinction can be made here between fixed and variable depreciation.

This yields the following equation:

$$TC = h.H + d.D + Z \qquad (1)$$

Where TC = total costs
h = time coefficient
d = distance coefficient

Table 2. Players within a Supply Chain and their Respective Objectives and Instruments.

Player	Objective	Instrument
Shipper and/or owner of goods	Minimisation of generalised cost, including time cost	Power of negotiation, dependent on size, strategic importance of product…
Forwarder	Ibid., plus profit margin	Ibid.
Shipping company	Maximisation of profit, i.e. maximisation of differential between revenue (price times quantity) and total costs. Price is a strategic variable and a function of costs incurred and pricing by competitors. Total costs are the sum of own incurred costs (e.g. cost of labour) and rates paid to third parties (e.g. terminal rates) Other possible objectives: maximisation of market share or gaining tighter control over the supply chain	Rates. Cost control (capacity, volume, timing, cooperation…) Marketing Service
Port authority or operator	In the case of a private or liberalised entity: profit maximisation, possibly combined with maximisation of market share within the port range Total cost consist mainly of own incurred costs; very little in rates to third parties. Alternative objective may be to contribute to cost minimisation for the supply chain (out-of-pocket and time-related costs), or the maximisation of cargo volume handled.	Pricing Maritime access Concessions policy Socio-economic deliberation
TOC	Profit maximisation, i.e. maximisation of differential between total revenue (price times quantity) and total costs. Price is a function of a number of variables (captive nature of the cargo, willingness to pay, location and service characteristcis of the terminal…). The cost consists mainly in operational capital cost, labour, and charges (e.g. concessions) paid to port authorities. Other objectives may include the estblishment of a long-term relationship with the customer.	Pricing Technological choices The provision of value added services
Hinterland operator	Profit maximisation, i.e. maximum differential between total revenue and cost. Price is a function of a number of variables (customer willingness to pay, distance of transport, …). Cost consists primarily in labour and, to a lesser extent, operational capital costs. Other objectives may include increasing market share.	Rates Capacity Flexibility Speed

Source: own composition.

H = time factor (in hours)
D = distance factor (in miles or kilometres)
Z = other costs

Model (1) can be specified in further detail, resulting in appropriate submodels for each transport relationship or activity (e.g. throughput and/or storage), using other time and/or distance coefficients. And even further differentiation is feasible. Examples that come to mind are trucks on a ferry, accompanied or not by a driver, or the use of different distance coefficients for loaded and empty trucks, due to a difference in terms of fuel consumption and maintenance costs.

The above model is suitable for medium to long-term decision making. For the purpose of day-to-day decisions, it may be useful to calculate costs in a different way. It may for example make sense to ignore the fixed costs in situations where these kinds of costs will be incurred regardless of the decision taken. In such cases, one restricts oneself to the variable costs, by taking account only of the distance coefficient and by setting the time coefficient at zero. Obviously this approach is unfeasible in the case of long-term contracts. Here, a price must be set using a regular time coefficient, at average cost, for both transport vehicle and crew (Blauwens *et al.*, 2008).

Another complication may arise from the prevalence of joint productions, i.e. transport services whose outputs are interconnected (e.g. liner services). When loading different consignments into a single vehicle or vessel, each consignment must at least pay the differential cost of its inclusion in a journey that would have taken place in any case. On top of the amount equal to this modest differential cost, the combined consignments must generate margins that are sufficiently wide to cover the total costs of the round trip.

The above model not only provides a general framework for the quantification of the total supply chain, but it is also useful for calculating the cost associated with subsections of that chain (cf. III.D).

D. **Quantification of the Supply Chain**

The supply chain is made up of various subsections, players and processes. Consequently, decision-making unfolds at different levels and involves different parties. This can give rise to conflicts of interest. After all, the price charged by one party to another represents a cost to the latter and will inevitably have an impact on its operating result.

Table 2 provides an overview of the principal players within the supply chain and their assumed objectives. A shipper and/or owner of goods will, with or without mediation of a forwarder, compare different available logistics options. The choice for a particular supply chain shall be based on who offers the lowest generalised cost, i.e. a cost that takes into account not only out-of-pocket expenses (such as the rates

charged by shipping companies, ports, terminal operators, hinterland modes) but also of time costs and costs associated with reliability and risk. In setting its prices, and in determining its routes and sailing frequencies, a shipping company may be led by the objective of profit maximisation. Due account will be taken of the cost level, including the prices charged by other players. Likewise, port authorities, TOCs and other players within the port perimeter may be driven by the goal of profit maximisation. A similar reasoning applies for the hinterland operators.

In order to gain insight into the behaviour of the various players who codetermine the selection of a port, modelling and quantification are required at different levels of analysis. The framework provided by the basic model (1) remains valid. This way, it is possible to get a handle on all relevant tradeoffs between the players involved, at all possible levels of the supply chain. It also offers the opportunity to analyse how potential actions affect cost.

IV. **Competition-Affecting Variables**

Port competition is a dynamic concept. This implies that the competitive process, including the selection of a port, is constantly subject to exogenously and endogenously induced change. Any such change affects the behaviour of the various players involved. Moreover, the impact on the various players will be variable, so that the balance between them inevitably also changes.

A typical example in this respect is the enhancement of productivity at a given terminal. As ports are links in logistics chains, it does not always make sense to consider the productivity of a terminal or port as an isolated entity. Resolving a pressure point in one link may simply transfer the problem to another. In this manner, productivity improvement in one section of the logistics process can actually increase cost elsewhere (Valleri and Van de Voorde, 1996, p. 127). Increasing the capacity of vessels, for example, will spread the cost of sailing over more containers, but at the same time it requires a greater processing capacity and thus the deployment of more substantial means at the terminal. Otherwise, the bottleneck will simply be shifted from the maritime route to the port and hinterland section of the transport chain.

The various port actors usually manage one or several links in the logistics process. The fact that goods handlers, shipping companies and port authorities tend to hold different views on productivity is due to the specific inputs and outputs in their part of that process.

Hence the necessity of gaining and maintaining insight into the principal potential developments for the future, as well as their likely impacts on each of the players in the maritime supply chain. The following synthesis may serve as a basis in this respect (Pauwels *et al.*, 2008):

- First and foremost, there is the changing context of the world economy, with growth in international trade and hence in maritime commerce, and characterised by an international redistribution of labour and capital, and an integration and globalisation of the markets. The world economy continues to be the motor of the maritime sector (Meersman and Van de Voorde, 2001; Meersman and Van de Voorde, 2006).
- Shipping companies are strategically important customers of ports. On the one hand they attract traffic and activity to ports, while on the other they are attracted by such industrial and other activity. Freight passes through the ports, after which drayage may be taken care of either by the ocean carrier (i.e. 'carrier haulage') or the shipper (i.e. 'merchant haulage'). We have also witnessed substantial scale increases on the part of shipping companies in recent times. This has been achieved first and foremost through horizontal cooperation and/or mergers and takeovers. Furthermore, shipping companies have set their sights on terminal operators and inland transport services, as operations are increasingly approached from the perspective of complex supply chains, whereby each link must contribute to the constant optimisation of the chain as a whole. This has altered the competitive balance in the market, as shipping companies have gained in power through their overall control over supply chains.
- We have also witnessed important structural evolutions within ports. Traditional stevedoring firms have evolved towards more complex TOCs, more often than not because a shortage of working capital has necessitated mergers, takeovers and externally financed expansion projects. In some cases, the external capital has been provided by shipping companies.

The question arises which scenarios may unfold in the future. Will long-term economic growth persist? And, if so, will it continue to translate into growing demand for maritime transport, or will future economic growth manifest itself primarily in services and not so much in industrial production? Will the above outlined evolution towards scale increases based on horizontal and vertical mergers continue to manifest itself? And what are the likely consequences in terms of vessel size, especially in the container business? What timeframe are shipping companies looking at in their quest for further cooperation? What strategies are market players other than the shipping companies likely to pursue?[20]

These are crucially important questions to the sector and its players, yet all are shrouded in uncertainty. One may therefore reasonably assume that each market player will try to anticipate on likely strategic moves by other players. Container shipping companies are a case in point: while they complain about relatively low freight rates as a consequence of overcapacity, they nevertheless continue to invest heavily in even more capacity. The underlying strategy of these shipping companies is clear to see: in response to already low freight rates, they are attempting

to deploy additional capacity at a lower operational cost per slot. Moreover, they consider a mixed fleet as a means of spreading risks. Additional cost control can be achieved through mergers and takeovers, and the capacity reduction this would entail.

Strategic and financial considerations by the holdings that control the shipping companies will keep capacity further in check, through strategic alliances, new partnerships, the rerouting of vessels. These evolutions may/will give rise to changes in direct port calls. Moreover, rerouting may also imply shifts in freight volumes to be transported to and from the hinterland. On the other hand, it is perfectly conceivable that a port may compensate largely or even wholly for a drop in direct port calls through additional (maritime) feeder services.

There is little doubt what impact the above developments will have on the maritime logistics chain in its entirety. In the short to medium term, these kinds of rationalisations are bound to result in a radical reorganisation of services. We shall witness the emergence of new alliances within which further mergers and takeovers will occur. On the side of the shipping companies, the market will stabilise, though there will of course be fewer players following the inevitable rationalisation and concentration drive.[21]

We have further witnessed a concentration movement among terminals, prompted in part by a need for ever-greater growth capital and the inability of the original owners to raise such huge sums. This concentration movement, coupled with new market entries by players such as PSA, HPH and DP World, has also created a buffer against a potential verticalisation drive initiated by the shipping companies.

Obviously, the prospect of even further concentration among terminal operators poses an economic threat to shipping companies, as reduced competition may lead to lower productivity growth, longer vessel-handling times and, perhaps most importantly of all, higher rates. The latter evolution is primarily a consequence of the fact that shipping companies no longer have a choice between any number of rival terminal operators, but are increasingly dependent upon large players who operate in different locations and are therefore able to negotiate longer-term package deals for services in those different ports.

We may assume with a high degree of certainty that shipping companies will not be prepared to (continue to) undergo this evolution. As their relative market power is at stake, it seems logical that they should put greater effort into acquiring so-called dedicated terminals, be it under joint ventures with locally active terminal operators or otherwise. This need not be detrimental to the port authorities' cause, as it will at least make shipping companies less footloose, in the sense that a long-term relationship is forged that makes them less likely to relocate (Heaver *et al.*, 2001). In the short term, such dedicated terminals may however lead to lower utilisation rates of available capacity.

Clearly, each of these developments will have an impact on crucial decision variables, such as cost, price, and supply and demand. As the various players are not af-

fected in the same way, their strategies will vary accordingly. This explains the highly dynamic nature of the maritime supply chain and associated consequences in terms of port competition.

V. Conclusion

Port competition is attracting ever greater attention from an economic, social political and business perspective. This is due not only to the substantial social and economic significance of seaports within a regional and national context, but also to the fact that their short, medium and long-term future is shrouded in uncertainty. Moreover, ports are clearly highly heterogeneous and complex environments, characterised by a multitude of market players and interconnections. Competition unfolds not only between ports, but also, primarily even, between production companies and service providers located in those ports. Furthermore, there is a clearly discernible trend from competition between individual ports to competition between supply chains. Successful ports belong to successful supply chains.

The purpose of this contribution was to arrive at a typology of present-day port competition. This requires insight into the various functions of a port, as well as into the decision processes of the various port players. It is clear that each port player has an own agenda, including strategic objectives and tools to reach them. Much will depend on the behaviour of the largest and most influential customers of ports, i.e. the shipping companies. These players may determine their behaviour individually or within the context of so-called strategic alliances. They may even go so far as to wholly or partially give up their footloose behaviour in favour of a particular port or dedicated terminal. In order to gain a clear understanding of such strategies, a detailed analysis is required at shipping company level.

The speed at which the various market players within the maritime supply chain shall take specific initiatives shall depend on a battery of exogenous and endogenous variables. As is the case with pricing in the maritime sector, and with successfully covering oneself against price fluctuations and other risks, timing is what ultimately determines who will emerge as the winner.

NOTES

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2. The companies that load and unload ships.

3. A similar reasoning applies to port investments. Public authorities invest in port infrastructure and hinterland connections, but the question arises who benefits from the return on investment.
4. Fixing cargo before it is put into a container.
5. Emptying cargo from a container.
6. Filling a container with cargo.
7. A berth is as quay wall prepared for loading and unloading containers, for instance through cranes.
8. The draught is the depth a vessel goes into the water, and therefore the minimum depth that a river needs to be, including a safety margen.
9. The output of a port is usually defined in terms of number of passengers or tonnage per unit of time (year/month/day) passing through the port in either direction, i.e. 'throughput'.
10. A bunkerer delivers fuel to maritime vessels.
11. For a detailed account of the methodology used see Coppens *et al.* (2007, 3-10).
12. All actors get assigned one activity code, which corresponds to its main company seat, therefore including all financial flows resulting from other activities by the same actor under its main seat. This may lead to an underestimation of the importance of those other activities inside a seaport, and at the same time an overestimation of the main activity.
13. For detailed empirical results we refer to Coppens *et al.* (2007, p. 15, table 3.2).
14. The forms of integration that will manifest themselves will however be more flexible than they have been in the past: vertical integration among shipping companies will, for example, tend to involve alliances and mergers, while horizontal cooperation with TOCs shall tend to consist in joint ventures and dedicated handling.
15. Ports in developing countries, for example, are often at a different stage in this evolutionary process than the ports of North-West Europe. Nonetheless, the two types of port are interconnected. For example, the further 'jumboisation' of bulk carriers may be slowed down by the fact that certain ports of call in the developing world lack the required facilities to handle such vessels.
16. Merchant haulage is the case where the shipper or receiver take charge of the port hinterland transport.
17. With carrier haulage, the shipping company takes charge of port hinterland transport.
18. The consignor is the owner of the goods, who has to take a decision on whether and how to transport.
19. Distribution Centres.
20. In recent years, most port and higher public authorities have concentrated mainly on the container business. The question arises whether this is or has been a wise strategy. After all, not all cargo can be containerised. Moreover, the added value and profits realised in, say, project cargo are usually significantly higher than in containerised cargo.
    Consider the following two (related) examples:
    1) The petrochemical industry is extremely important to the ports of Rotterdam and Antwerp: it provides significant employment and represents substantial added value. It is, moreover, a non-footloose industry that also fulfils an important supply function to other companies and sectors. At the same time, however, it is sensitive to changes in environmental legislation and industrial policy.
    2) The revenue realised by the major ports usually consists in a cyclical and a non-cyclical component. Revenue from concessions (to both industrial concerns and TOCs) are relatively stable in the short to medium term, i.e. they are less sensitive to cyclical fluctuations.
21. Insofar as concerns alliances, there is a certain similarity with evolutions in the airline industry. The main difference is that, in the latter, all the large carriers have joined such al-

liances, while only the comparatively smaller airline companies have stood by the sideline. In the maritime sector, there are also large companies that continue to operate outside of an alliance, e.g MSC and CMA-CGM.

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