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**EMPIRICAL AND THEORETICAL ANALYSIS OF THE
DEVELOPMENT OF INLAND WATERWAY SERVICES IN
FRANCE**

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Abstract

Ports that are able to offer scale economies on land by using combined transport gain a competitive advantage in their port range thanks to the large hinterland that they control. The recent rapid expansion of combined waterway-road services at French ports, Le Havre and Marseille, led us to carry out an empirical and theoretical analysis of the causes and conditions that underlie this development. In order to more clearly understand the dynamics of the French situation, attention has been broadened to include other competing European ports, Antwerp and Rotterdam.

Although the reasons behind the process of expansion have not been exactly the same in Marseille and Le Havre, a few major factors have been identified: the growth in maritime traffic, the appearance of combined transport operators, the impetus provided by the public authorities concerned by environmental issues and wishing to develop a defensive strategy in order to protect the hinterland of its ports, and last but not least, the involvement of a few very large shipping lines. Based on lessons drawn from this French case, a theoretical model is presented in this paper. It highlights the interdependence between the setting up of combined waterway-road services, the competition between ports and the competition between shipping lines.

Empirical and theoretical analysis of the development of inland waterway services in France

1. INTRODUCTION

Containerization permits major economies of scale and lower costs of freight (Brooks, 2000). On the sea, this is achieved by the use of vessels with increasingly large capacities (Cullinane et al., 2000). Hinterland transport is a vital factor in enabling seaports to assemble or distribute the large numbers of containers that the larger vessels take on or drop off. The ports which manage to combine concentrated maritime services with high-capacity inland services gain the position of principal load centre in their port range because they control a large hinterland (Hayuth, 1992; Heaver, 2002; Robinson, 2002; Notteboom, 2004).

This paper carries out an empirical and theoretical analysis of the causes and conditions that underlie the development of combined waterway-road transport from the two major French container ports, Le Havre and Marseille. In order to more clearly understand the dynamics of the French situation, attention must be broadened to include other competing European ports, notably Antwerp and Rotterdam. These Northern Range ports compete with French ports in their own hinterland by using both barges and rail. Both Antwerp and Rotterdam have more fully exploited the European waterway system, the Rhine in particular. Thus the development of waterways in France cannot be understood solely by referring to specifically French factors, it is also necessary to consider the competition between Europe's two largest ports with a view to dominating the European hinterland.

The first part of the paper sets out to describe the necessary conditions for the development of combined waterway-road transport from a seaport. An empirical analysis of the factors which have impelled and maintained the use of inland waterway transport to and from the ports of Le Havre and Marseille is then conducted. The competitive approaches between ports and between competing shipping lines are highlighted. Based on conclusions drawn from an examination of French ports in the European context, we conclude by proposing a theoretical model for port development that takes account of the impact of inland waterway services in order to supplement those models already described in the literature.

2. THE NECESSARY CONDITIONS FOR THE DEVELOPMENT OF INLAND WATERWAY SERVICES

2.1. The factors which determine the competitiveness of inland waterway services

For many technical, economic and social reasons, the road is today the dominant transport mode for inland services to and from European ports. However, as a high-capacity mode, inland waterways also have considerable advantages over the road, and they frequently share these with rail (Van Slobbe, 2002):

- in the case of high volume traffic flows, inland waterways provide a means of avoiding congestion in port conurbations, on the corridors that serve the hinterland and also in hinterland conurbations,
- inland waterway transport has high fixed costs and low variable costs so costs per kilometre and per TEU become lower the higher the transport capacity and the container capacity utilization ratio. Water transport is more energy efficient and has lower costs per tonne-kilometre than either road or rail,
- it facilitates the repositioning of large numbers of empty containers at low cost,
- it provides an alternative mode to the road, whose negative externalities are becoming increasingly unacceptable, in response to environmental and societal pressures (ECMT, 2006a).

Unlike the road, which possesses a very large interconnected network, inland waterway services can only carry goods to a limited number of destinations which are entirely dependent on the infrastructure. To reach the end customer, it is necessary to organize pre-and end haulage by road over a short distance whose per-kilometre price is higher than for long distance road transport (Niérat, 1992). The entire transport process is therefore longer and slower by inland waterway than by road. Put briefly, combined waterway-road transport is considerably less flexible than road transport.

To gain market share, combined waterway-road transport must be more competitive than road transport, both with regard to the price of door-to-door services and the quality of the service provided (Vellenga et al., 1999). Five factors are essential for the competitiveness of inland waterway transport: the waterway infrastructure, the characteristics of the market, services and terminals, the road transport services on the end leg and the organization of the market. Table 1 shows the necessary conditions for the development of inland waterway transport on a factor by factor basis.

Table 1: Necessary conditions for the development of inland waterway transport.

Infrastructure	The existence of an inland waterway network which permits services to the hinterland, particularly the largest cities. The greater that network's density and interconnectivity with other basins, the greater the possibilities of serving a large hinterland.
The characteristics of the market	The greater the volumes at the seaport or the final destination, the more advantageous it becomes to use inland waterway services (Notteboom, 2002). In addition, the more distant the markets from the port the greater the opportunities to exploit waterway transport.
The services and the terminals	It is necessary for inland waterway services to be reliable and frequent and offer a transit time which is acceptable in comparison with road and rail. There must be a network of inland waterway terminals or inland hubs, where traffic flows are concentrated and broken up in order to be routed to their final destinations (Konings, 2006). It is essential for these to be well located with respect to the market.
End-haul road transport	Terminal handling costs in the barge terminal should not be too great to threaten the competitiveness of the combined waterway-road services in compared to all-road transport.
The organization of the market	There is a need to provide the shipper with an integrated end-to-end service between the maritime terminal and the final destination (Panayides et al. 2002). This requires the participation of combined transport operators to set up an end-to-end service.

Table realised by Fremont, Franc and Slack

2.2. The decisive role of operators as regards setting up combined transport

Two of the five factors which determine the competitiveness of inland waterway transport are structural: the infrastructure and the characteristics of the market. The players which organize transport exercise little control over them. The infrastructure is either there or not. While it is true that the public authorities may decide to build or modernize a river canal, such decisions are rare, due to the considerable investments which are required. As far as the location of markets is concerned, this depends to a very high degree on the organization of the urban system.

In contrast, inland waterway services, inland terminals and end-leg road services depend on the largely individual operations of the barge carriers, terminal operators and road hauliers. In most cases they act separately, and this separateness is the major obstacle to the development of competitive barge transport. Thus, an essential condition for the development of inland waterway services is the insertion of combined transport operators who can achieve vertical integration of the transport chain (ECMT, 2006b). Various

participants in the transport chain may play this integrating role, each with different motivations, interests and objectives.

2.3. The interests of the various players in the transport chain

The shipper's goal is to obtain the lowest transport cost for the inland leg, additional logistical services (customs clearance, storage, etc.) and in some cases the use of an environmentally friendly transport mode. It may be in the shipper's interests to use combined waterway-road transport, but not to organise the service since transport is not his main activity. The shipper will therefore not be interested in becoming an integrator, particularly if he is shipper with limited cargo volumes.

There may be many advantages for a freight forwarder in taking on the role of integrator. It enables it to provide its shipper customers with an end-to-end service. It can attempt to lower transport costs on the inland leg and thereby expect to become more competitive than its direct competitors (other freight forwarders) or more indirect competitors such as shipping lines. By capturing more freight, it increases the scale of its activities. Only freight forwarders that handle large volumes are able to take on the role of integrator.

Shipping lines become involved in inland transport when they undertake carrier haulage. Their objectives are partly the same as those of the freight forwarders with which they are in competition. Shipping lines are interested in controlling freight as a means of filling their vessels. Using inland waterways enables the shipper to reposition its empty containers if the market is not balanced. Only shipping lines which control large volumes of traffic can take on the role of integrator.

In order to develop combined waterway-road transport, both freight forwarders and maritime shipping lines can purchase slots on a one-off basis from a barge carrier or charter a fixed number of slots which carries both a commercial and an operating risk.

It is very much in the interests of barge carriers and the operators of large inland terminals to become integrators in order to develop their activities. Providing inland waterway services allows the operators of seaport terminals to offer shipping lines the ability to return their containers back to the seaports and ensure smooth passage through the port. But unlike freight forwarders and shipping lines, the three last types of players are neither in direct contact with the shippers nor in control of container flows.

Last, when the other players prove inadequate, the port authority can act as an integrator, at least during an initial phase, in order not to lose the benefits of inland waterway

services, in particular in the context of a competition between ports in the same range in order to preserve its hinterland.

Vertical integration between these actors may take various forms, for example mergers/acquisitions or joint ventures. It depends on one of the actors being interested in strengthening its control of the entire transport chain. Integration of this type may take place between carriers. It can also arise from the initiative of a freight forwarder.

3. WATERWAYS IN FRANCE: THREE STAGES OF DEVELOPMENT

The development of the European inland barging network began with the creation of links between the two largest ports in the Northern range, Antwerp and Rotterdam, and the Rhine river basin. In relation to this large cluster with concentrated traffic flows, Le Havre and Marseille are peripheral ports and the latter does not even belong to the same maritime range. The necessary conditions for the development of combined inland waterway transport existed as early as the 1980s on the Rhine. The French market only changed very recently. Three stages can be identified.

3.1. Until 1994: the absence of inland waterways as a transport mode in France

Until 1994, inland waterway transport played no role in serving the hinterlands of the two largest French ports. This contrasts with the situation in Rotterdam and Antwerp where, at that date, barge transport carried a considerable proportion of hinterland traffic flows (Table 2).

Antwerp and Rotterdam possessed the necessary conditions for the development of inland waterways:

- a very large arterial river, the Rhine, with tributaries (the Moselle, Meuse and Danube) which serves the largest European markets and where, since the Congress of Vienna in 1815, the principle of the free movement of freight vessels has applied,
- port traffic was already large and posing the problem of a possible saturation of land corridors and urban conurbations,
- the increase in the number of inland waterway services and inland terminals,
- a market which was principally organized at the time by barge operators.

The available inland waterway transport at the Rhine ports was supplemented by a supply of rail transport, in particular towards Southern Europe, and especially France via Lyon.

The setting up of the European rail shuttle in 1994 provides one of the most striking proofs of the ability of high-capacity modes to extend port hinterlands. The two French ports of Le Havre and Marseille found themselves challenged in their domestic markets. No use was made of the inland waterway infrastructures of the Seine and the Rhône.

Table 2: The modal split for hinterland traffic flows in 1994

	Rotterdam	Antwerp	Le Havre	Marseille
TEUs	4,5	2,2	0,9	0,7
Road	51,3 %	64,5 %	82,5 %	83,7 %
Rail	14,5 %	7,8 %	16,9 %	16 %
Barge	34,2 %	27,7 %	0,6 %	0,3 %

3.2. 1994 to 2004: The appearance of combined transport operators in France

1994 marked the renewal of container barge transport in France. On the Seine, the combined waterway-road transport company LogiSeine was set up. This firm brought together a barge carrier, the Compagnie Fluvial de Transport (CFT), a terminal operator in Le Havre (Terminaux de Normandie), and the company that managed the Gennevilliers and Bonneuil terminals (Paris Terminal SA). Immediately following its creation, LogiSeine set up services that included barges on the river Seine between Gennevilliers, Rouen and Le Havre and the organization of road pre- and end-haulage between the inland terminal and shippers. The scale of this operation has grown progressively and almost continuously, exhibiting an annual growth rate of 30% since it was set up.

Containerized barge services to the port of Marseille are even more recent, dating really only from 2001 when the company River Shuttle Container (RSC) was set up. This combined transport operator, like LogiSeine on the Seine, offered integrated services between the port of Fos-sur-Mer and the regions of Bourgogne and Rhône-Alpes.

A number of factors explain the appearance of these combined transport operators. The political context favoured the development of modes other than the road, in particular in response to environmental issues. The European Commission White Book of 2001 opened up the possibility of financial support for combined transport, in particular in the framework of port services. State aid to investment and operation encouraged the development of firms such as LogiSeine, River Shuttle Container (RSC) and the creation of new companies.

The port authorities of Le Havre and Marseille also wanted to catch up with the Rhine ports whose high-capacity inland services, whether by rail or inland waterway, threatened their hinterlands. This is particularly the case for Marseille. Historically, the Lyon Region had been considered as part of the hinterland of Marseille. In the late 1990s Marseille found itself threatened by a possible rail service from Lyon to Rotterdam that was proposed by the European Rail Shuttle (ERS), a private operator set up by Maersk and P&O Nedlloyd. Marseille's response was the setting up inland waterway services to the Lyon region at a price for the shipper that was lower than road transport, was thus in the nature of a defensive measure. It may be noted that the Rotterdam to Lyon link operated by ERS never materialized.

At the same time, the inland terminals, Paris Terminal and Lyon Terminal developed additional services to satisfy the expectations of their shippers. Henceforth, these terminals not only handled, stored, repaired and managed the container fleet but also filled and emptied the containers and offered attractively priced customs clearance services for shippers. Here too, the port authorities played an important role, via the port of Paris in the Paris Region and the direct participation of the port of Marseille in the capital of Lyon Terminal in the case of Lyon.

State involvement provided private combined transport operators with reliable infrastructure on which to set up their services. The first link in the chain, that of creating road links to serve clients in urban areas, faced chronic difficulties as a result of congestion in the major urban areas of Paris and Lyon. However, the role of freight dispatcher, which was taken on by the combined transport operator, involved working with road hauliers in order to rationalize their services, minimizing turnaround times and empty runs.

Last, inland waterway transport in France also benefited indirectly from the problems that affected rail freight, since the SNCF was in the middle of a restructuring crisis. It did not have the confidence of shippers or the other operators in the transport chain which saw inland waterway transport as an alternate high-capacity mode.

This favourable context resulted in major expansion. For example, on the Seine, both the size of barge trains and the frequency of shuttle services have increased since 1994. With regard to services to Le Havre, the frequency of return services between Gennevilliers and Le Havre increased from one a week when the service was set up by LogiSeine in 1994 to three a week in 1998. Services have been running to Bonneuil since 2003. New barges that are able to carry 176 TEUs in four layers have been brought into service.

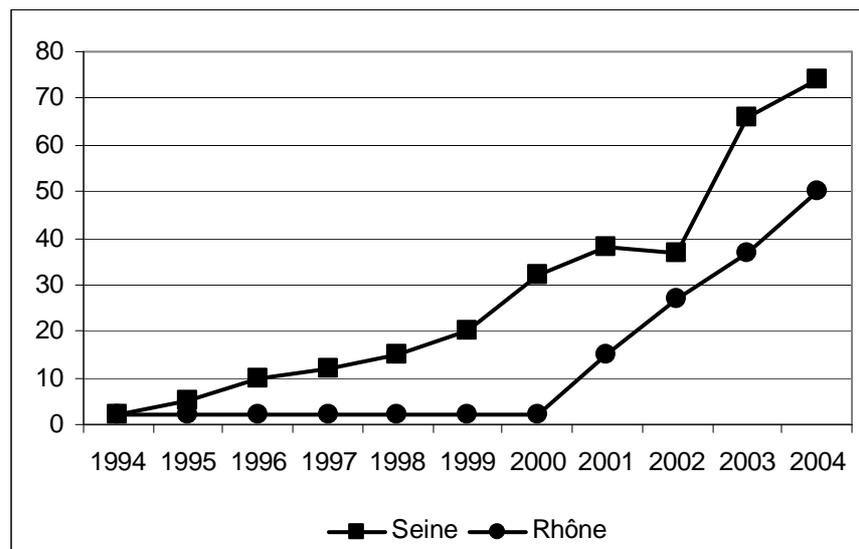
These supplement the existing fleet, made up of barges that can carry 132 TEUs in three layers.

Combined transport operators have appeared on the scene. At the beginning of 2004, the players were as follows:

- On the Seine: LogiSeine and the Société Nogentaise de Transport Combiné which operated services between Nogent-sur-Seine and Le Havre via Gennevilliers;
- On the Rhône: RSC and Alcotrans Container Line which is part of the Imperial Reederei Group and which is also a major player in waterway transport on the Rhine market.

The success of these combined transport operating companies explains the rapid growth in containerized traffic on the Seine and the Rhône. Nevertheless, this traffic is still marginal in scale compared with the enormous volumes achieved on the Rhine.

Figure 1: Container traffic between 1994 and 2004 on the Seine and the Rhône, in thousand TEUs



3.3. Since 2005: the involvement of shipping lines

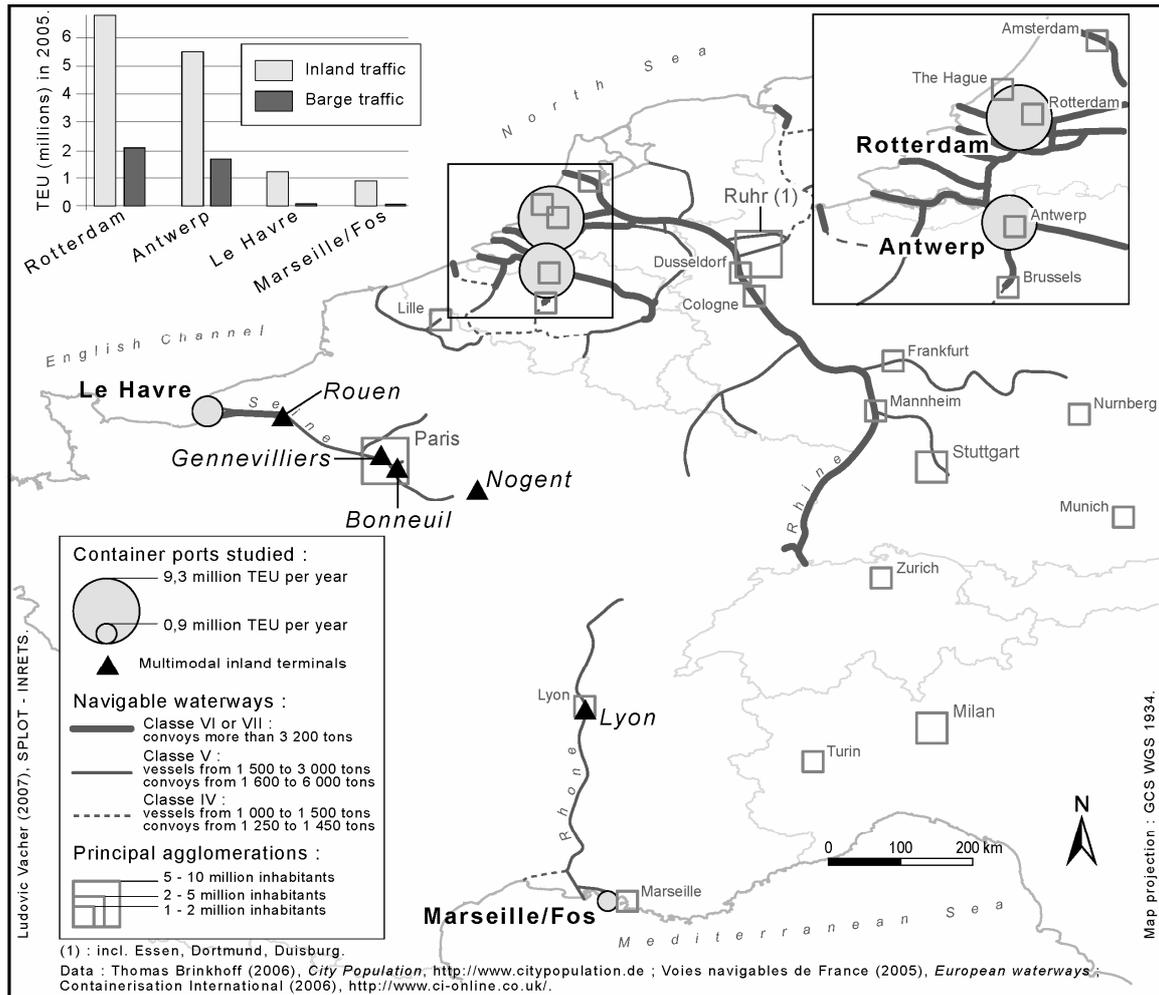
A very recent development is the involvement of maritime shipping lines in containerized barge services. This is particularly marked in the case of Le Havre where the three largest shipping lines in the world, Maersk, MSC and CMA-CGM, are establishing themselves on a large-scale and durable basis by constructing dedicated terminals in the framework of the new Port 2000 project. They are now in a dominant position. MSC is further along in this process as it was the first of the three to have invested in Le Havre. It alone accounts for approximately 30% of Le Havre's traffic flows.

The strategy of these shipping lines is not restricted to the port segment. They are aiming to dominate services to the Greater Paris Region by providing dedicated high-capacity inland services. This region is the port of Le Havre's principal market. It is not served by high-capacity modes from Antwerp and Rotterdam. Rather than continuing to purchase single slots from the combined transport operator LogiSeine, they are now tending to charter one or more barges a week, bearing the commercial and operating risk. In January 2005, MSC was the first maritime shipping line to become a combined waterway-road transport operator on the Seine, chartering barges from LogiSeine, between Le Havre and Gennevilliers (3 return services per week) and between Le Havre and Rouen (2 return services per week). Based on its successful experience in the Rhône basin, in January 2005 RSC launched a regular line operating four times a week on the Seine between Le Havre and Paris/Gennevilliers. Essentially RSC now operates river shuttles for CMA-CGM. This major involvement of shipping lines explains why although the amount of total traffic has only increased slightly since 2005, the growth of combined waterway-road traffic at Le Havre is pretty strong (from 5.8% in 2005 to 8% in 2006).

Similar results may be seen in Marseille, but on a smaller scale as the volume of port and inland waterway traffic is lower. This suggests that the dedicated shuttle services set up by shipping lines are less profitable in the case of Marseille. Nevertheless, CMA-CGM, which is the principal shipping line in the port of Marseille, is already operating dedicated shuttles via its subsidiary RSC. Moreover, the two new Fos 2XL terminals are due to open in 2008. One is to be managed by the Portsnergie Group (CMA-CGM, Egysport, CNC, IFB) and the other by the shipping line MSC. Their effect should be to reinforce this trend towards greater involvement on the part of maritime shipping lines in river transport on the Rhône, as is already the case on the Seine.

There is a difference between the model which is taking shape in France and that on the Rhine. On the Rhine, it is the large international freight forwarders which since 1995 have gained control of combined waterway-road transport. To do this, they have gradually taken control of the inland terminals and waterborne transport undertakings and made them into subsidiaries. In France, it is the shipping lines which have played the principal role.

Figure 2: inland and barge traffics in 2005



4. PORT HINTERLANDS AND INLAND WATERWAY NETWORKS: A THEORETICAL APPROACH

France represents a very specific case in the broader context of Europe. Nevertheless, its position raises theoretical issues which have so far received little attention in the literature. The French example shows that combined waterway-road transport is possible over relatively short distances (less than 200 km between Le Havre and Gennevilliers and 500 km on the Rhône-Saône artery). It indicates that inland waterway transport has developed as a result of competition between transport operators, in particular shipping lines, in order to control the hinterland of the ports they serve. Last, it demonstrates that competition between ports is an important factor. Container barge transport is developing in France in order to respond to the threat posed by the powerful ports of Rotterdam and Antwerp which are competing with Le Havre and Marseille in domestic French market.

4.1. The low importance given to inland waterway transport in port development models

The development of ports along a maritime range has generated a considerable number of models. Very few of these take account of the impact of inland waterway services on port development or competition between ports. While it is true that all ports are not connected to an inland waterway network, which makes it difficult to develop a general model, some of the world's largest ports such as Hong Kong, Shanghai, Rotterdam and Antwerp, inland waterways do play a role in the inland accessibility of the ports and give them a competitive advantage over their competitors with regard to hinterland services.

In order to explain the changes in the port hierarchy, some models emphasize the impetus from the hinterland (Taaffe, Morrill et Gould, 1963). Others, on the other hand, emphasize the role of changes in maritime services but minimize the role of hinterland links (Hayuth, 1981). Today's unprecedented level of port traffic depends on the existence of modes that concentrate the traffic to the hinterland with high-capacity routes and inland hubs (Slack, 1999; Notteboom, 2001). Notteboom thus proposed a model for the spatial development of rail networks (2001) and then applied the same approach, with Konings, to inland waterway networks (2004). These scholars have shown clearly that the operational and geographical conditions are not the same for rail and barges. Complementarity between inland waterway networks and rail networks exists in theory, however this has yet to be demonstrated in practice.

The Notteboom and Konings model shows very clearly how the development of an effective barge transport system is based on the gradual creation of inland waterway terminals. To begin with, this network is undifferentiated. Then inland waterway hubs are set up, concentrating traffic to and from seaports. However, this model does not illustrate the repercussions that the development of a network of this type has on the organization of hinterlands and on interport competition within the port range.

4.2. Proposed three-phase theoretical model

Our model involves three successive phases. In the first phase of containerization, the dominant port A is that with the richest hinterland, which also means that it can attract the largest number of shipping lines. Road transport is sufficient to carry the port's inland traffic. Inland waterway carriers are responsible for the first attempts to use waterways. Each port controls a close hinterland which is captive and in addition a more distant or

secondary hinterland. These secondary hinterlands are shared between the different ports and provide the setting for the greatest competition between them for attracting freight. Because of its higher traffic volumes, the dominant port had the largest secondary hinterland.

In the second phase, high-capacity inland waterway services are set up from port A and inland waterway terminals are set up near the major urban centres. In the context of rising traffic, port A attempts to take advantage of waterborne transport's specific benefits. The market is structured by the waterborne transport operators, supported by the freight forwarders that handle the largest amounts of traffic. Rail services play a complementary role to the inland waterway services on the same corridor and become more intensified where waterway infrastructure is lacking, providing a means, for example, of carrying freight from port B's near hinterland. Port A extended its secondary hinterland and asserted its primacy over the other ports by becoming the principal load port in the range. By this time, this port has considerably increased its market share in the port range.

In the last phase, the two peripheral ports B and C react by also using inland waterways. It is necessary for them to cope with the general increase in volumes. They are going through port A's second phase at a later date. The shipping lines use larger and larger vessels, even for "secondary" markets as they realize that it is possible to cover the entire market area of a port range by serving a single very large port without generating major adverse impacts, particularly in terms of congestion and/or diseconomies of scale. This is Hayuth's "peripheral port challenge" (1981) which leads to the concentration of inland traffic flows from ports B and C in the hinterland, particularly on waterways when the infrastructure exists. Because their hinterland nevertheless remains less rich, the number of inland waterway services and the emergence of inland waterway hubs remains limited compared with the increasingly complex organization from port A, as shown by the Notteboom-Konings model (2004).

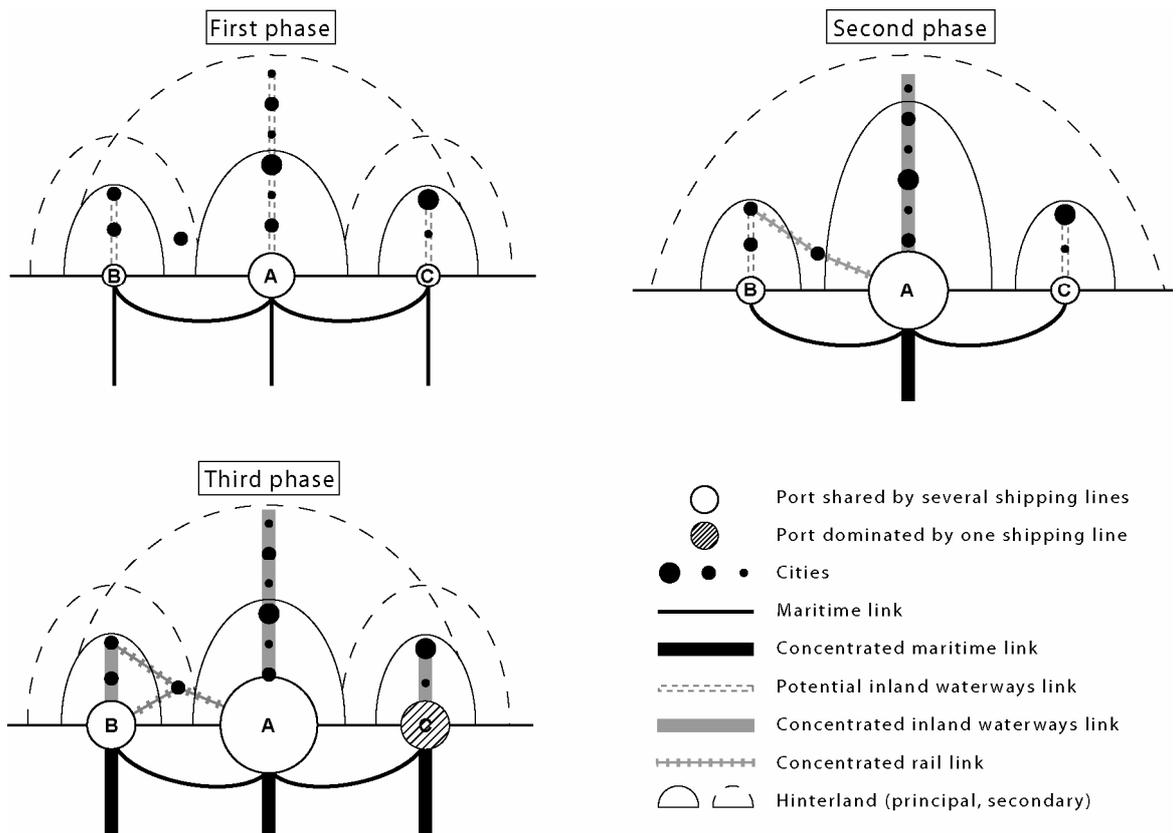
Other factors explain the development of waterway traffic from ports B and C. From phase 2, port B's close hinterland has been under threat from rail services from port A. To reconquer this hinterland, port B must reduce the costs of transport in its close hinterland. Waterway transport provides a way of doing this, even in the case of a short distance. Rail provides an alternative in the case of cities with a waterway connection. The secondary port's transport chains can thus become competitive with those of port A.

Unlike port B, port C does not suffer from the competition of a high-capacity service from port A. Its use of inland waterway services is therefore explained by competition

between shipping lines. If one or two shipping lines make port C their preferred port of call and consequently occupy a dominant position there, it is very much in their interests to increase their market share in the hinterlands in order to be able to fill their vessels. Their objective is in this case to dominate port C's inland market. To achieve this they must reduce costs on the inland leg in order to gain a price advantage over their competitors. This means they need to control the transport chain, including the inland leg, by developing "carrier haulage" and the use of a high-capacity mode in order to reduce costs. In this situation, the existence of an inland waterway network provides shipping lines with a possible alternative to rail.

In this last phase, the market shares of the different ports in the range have become more balanced, while all the ports have experienced a very large increase in their volumes in absolute terms.

Figure 3: Changes in port and inland waterway systems: a theoretical model



5. CONCLUSION

The recent rapid development of container barge services at French ports is explained by a few major factors: the increase in maritime traffic, the deficiencies of rail in France, the setting up of simple point to point waterway services, the appearance of combined transport operators, the strong impetus provided by the public authorities wishing to improve the competitiveness of French ports in their hinterlands and concerned by environmental issues, and last, most recently, the involvement of a few very large shipping lines with a strong presence in the two French ports.

The reasons behind the process have not been exactly the same in Marseille and Le Havre. Marseille initially developed a defensive strategy in order to protect its hinterland against Antwerp and Rotterdam. The large-scale increase in Le Havre's inland waterway traffic is due more to the involvement of the major shipping lines in dedicated inland transport networks in order to capture the largest possible amount of freight to and from the Paris Region. However, the two approaches have now come to resemble each other: achieving better control of their hinterland by using river or canal transport makes the two French ports more competitive in the European context.

Based on lessons drawn from the French case, the theoretical model presented here extends those of Taaffe et al (1963), Hayuth (1981) and Notteboom and Konings (2004). It highlights the interdependence between the setting up of combined waterway-road services, and the competition between ports and the competition between shipping lines. Nevertheless, a new theoretical question is raised, again as a result of empirical observations. Point-to-point services between Le Havre and Gennevilliers and between Marseille and the port of Lyon reduce barge turnaround times and encourage dedicated services with a high container capacity utilization ratio operated by shipping lines. On the Rhine, the large number of inland ports served means that a number of freight forwarders are involved in running the system (Zurbach, 2005), working from inland terminals and loading their barges with containers from several shipping lines that they transport to or from the ports of Antwerp or Rotterdam. Could it be possible to increase the number of inland terminals on the Seine or the Rhône?

The shipping lines that are operating dedicated waterway-road services have not taken on the organization of road pre- and end haulage. This remains the domain of combined transport operators. Vertical integration therefore ceases at the inland terminal. However, road end haul accounts for a substantial part of the cost of the combined transport service. This suggests that additional productivity gains are possible if the road leg can be

integrated in the chain. Future research could investigate the utility and profitability of combined transport in the context of providing services to ports which constitute a link in the shipping lines' container logistics chain.

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