The adaptive capacity of container ports in an era of mega vessels : the case of upstream seaports Antwerp and Hamburg

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The adaptive capacity of container ports in an era of mega vessels: the case of upstream seaports Antwerp and Hamburg

Theo Notteboom

Transportation Management College, Dalian Maritime University

1 Linghai Road, 116026 Dalian, China, theo.notteboom@gmail.com

And

Faculty of Applied Economics, University of Antwerp, Belgium

And

Maritime Institute, Faculty of Law, Ghent University, Belgium

And

Antwerp Maritime Academy, Belgium

ABSTRACT

Port system development is a key theme in port geography literature. Recent decades have brought a rise in container terminal development at estuarine, coastal and offshore port locations, in part driven by scale increases in vessel size. This paper examines how container ports located upstream on rivers use processes of adaptive capacity building in an attempt to remain competitive in port systems. We link the development path of upstream seaports to a range of economic, technological, social and political factors. When combined, these factors shape the willingness and capacity of an upstream seaport to adapt to changing conditions such as an increasing demand for nautical accessibility. The case study results on Antwerp and Hamburg show that the discussion on the future of these upstream seaports cannot be detached from broader public policy and stakeholder management concerns and the influences of retention mechanisms, power, politics and collective action by the port community.

Keywords: port system, adaptation, upstream, Hamburg, Antwerp

1. Introduction

A seaport is a logistic and industrial node accommodating seagoing vessels and characterised by a functional and spatial clustering of cargo transport, storage and transformation processes linked to global supply chains. The handling of maritime cargo at specialised terminals remains a core function of seaports. Seaports and their maritime freight terminals can be located on an island or an offshore location, along a coastline, in a natural bay, a delta or a river estuary, or upstream along a river. Antwerp in Belgium and Hamburg in Germany can be categorized as upstream seaports. Their terminal infrastructures have been developed entirely alongside a river, at docks directly accessible from a river and, in the case of Antwerp, also partly at dock systems connected to a river via large sea locks. Furthermore, they are located inland with a one-way diversion distance from the main coastline of 40 and 60 nautical miles respectively (1 nm equals 1.852 km). Reaching these ports by seagoing vessel requires the use of pilots to navigate long and narrow tide-dependent access channels on the rivers Scheldt and Elbe respectively. Despite their inland locations, Antwerp and Hamburg are seaports as they receive a large number of seagoing vessels and are home to a large logistic and industrial cluster focused on maritime cargo flows. Container ships are handled at state-of-the-art container terminal facilities spread out in the port area and operated by global terminal operating companies DP World and PSA in Antwerp and Eurogate and HHLA in Hamburg. Both seaports differ from river ports located further upstream along major European rivers (e.g. Rhine, Scheldt, Rhône, Elbe, Danube or Weser) as the latter only receive inland barges and occasionally small coasters.

Baird (1996) argued that scale increases in vessel size negatively affect the competitive position of upstream seaports Antwerp and Hamburg compared to neighbouring seaports located along the coastline or in river estuaries. In a reaction, Notteboom et al. (1997) pointed out that the container market shares of these ports in the so-called Hamburg-Le Havre seaport range actually increased throughout the 1980s and 1990s at the expense of coastal and estuarine rivals. In a rejoinder, Baird (1997) added that political motivation and local forces have artificially extended the lifecycle of these upstream urban seaports, thereby suggesting that the competitive position of these ports cannot be explained by looking at market logic only: “there is now less need for the largest container ships to continue to transit long and narrow inland waterways in order to call at an upstream urban port [..] such vessels are unlikely to continue this practice in the long term” (Baird, 1997, p. 301).

The mentioned papers were published some 20 years ago at a time when Maersk Line introduced the Regina Maersk, the first post-Panamax container vessel with a capacity of about 7,500 TEU. Ship sizes now reach about 20,000 TEU while alliance formation among shipping lines and the strong development of coastal and estuarine ports in northern but also southern Europe intensified competition.

This paper focuses on the adaptive capacity of upstream container ports in dealing with the stress resulting from the increase in container ship size. We apply conceptual insights on adaptive capacity building by port authorities to Antwerp and Hamburg. The central

proposition in this paper is that in the past decades these two upstream container ports have been able to remain competitive vis-à-vis rival ports (despite the significant nautical access challenges both ports are exposed to) by developing strong adaptive capacities combining technological, financial and human resources and a strong political and institutional setting.

The paper is structured as follows. In the first section, we analyse the evolution of container port systems through the lens of the extant traditional port development literature and more recent conceptualizations in economic geography. Then, we discuss the process of adaptive capacity building by port authorities which in the third section is applied to Antwerp and Hamburg. The last part presents conclusions and avenues for further research.

2. Insights from port system development literature

2.1. Forces of port migration away from upstream urban port/terminal locations

A port system is a system of two or more ports, located in proximity within a given area (Ducruet, 2009). They can relate to a complete coastline (e.g. the West coast of North America), a 'range' (Vigarié, 1964) such as the Hamburg-Le Havre range, and a 'multi-port gateway region' such as the Rhine-Scheldt Delta or the Yangtze River Delta (Notteboom, 2010). The development of port systems is a key theme in port geography literature (Ng et al., 2014). Early works on port system development, such as Taaffe et al. (1963), mainly focused on hinterland network development as major forces of port concentration and the degradation of minor ports. Later works pointed to processes of cargo deconcentration resulting from port activities leaving the urban core for less congested suburban or peripheral port sites (Barke, 1986). For urban ports this typically implied a development away from the obsolete facilities near the urban core to less urban locations with ample space and a better nautical accessibility (see the Anyport-model of Bird, 1971). In a number of cases the development took place further down a river as was the case in Antwerp and Hamburg. In other cases, port development moved from river sections to the coastline.

In a more extreme form, Hayuth (1981) introduced a trend towards deconcentration in port systems as a result of the 'challenge of the periphery', a concept which was empirically tested by Notteboom (2005) for Europe and Slack and Wang (2002) for Asia.

The traditional port system development literature discussed above points to underlying reasons that support a spatial shift of container port and terminal development from urban river locations to less urban locations in an estuary or along the coast:

Nautical accessibility (C1). The need for deep water access to accommodate ever larger vessels is one of the prime reasons to look for deepwater locations, typically in an estuary or along a coastline, bay or deep-water inlet. While also many coastal and estuarine ports are challenged to dredge access channels, investments in the nautical accessibility of upstream seaports typically require larger budgets and come with more complex issues revolving around river morphology and ecology, flood protection and the disposal of (contaminated) dredged

material. Puig et al. (2015) concluded that compared to coastal seaports and locations at inlets and bays, European ports located on rivers and in river estuaries rank dredging challenges (e.g. operations, disposal of sediments and sediment contamination) very high on the environmental priority list.

Location vis-à-vis maritime networks (C2). The need for locations that offer a better 'intermediacy' in liner shipping networks (Fleming and Hayuth, 1994) can push port development to estuarine and coastal locations, or even offshore. The g*rowing sea-sea transhipment markets* (hub-feeder) put additional pressure on ports. De Monie (1997) and Baird (2003) argued that the largest vessels would primarily serve offshore transhipment mega-hubs, avoiding many physically constrained traditional container ports. Much-quoted requirements for transhipment terminals include short diversion distances and costs for mainline vessels, fast turnaround times, low feeder ship cost and a smooth and easy nautical access (see e.g. Lirn et al., 2004; Baird, 2006).

Diseconomies of scale and land availability issues at established ports (C3). These concerns are echoed in the work of Bird (1971). In more recent times, the discussions also revolve around finding enough space to create new large-scale logistics zones in the framework of port-centric logistics (Mangan et al., 2008; Monios and Wilmsmeier, 2012;) and free trade and economic development zones (Tiefenbrun, 2012). Moreover, port development away from urban areas might facilitate the creation of (new) congestion-free intermodal corridors to the hinterland which, particularly in the start-up phase, typically face difficulties in finding the necessary base cargo.

Port/city dynamics (C4). In an urban setting, strong tensions between port development and urban/city development can result in a move away from upstream urban locations. The matrix on port-city relations as presented by Ducruet (2005) and modified in Ducruet and Lee (2006) provides a framework to assess the risk of incurring increasing tensions between city and port. Wiegmans and Louw (2011) present a model that adds to the Anyport-model of Bird by referring to zones where conflicts between the existing land use as a port and proposed city land uses takes place. Such city-port tensions can eventually result in port migration.

Cost differentials in production factors capital, labour and or land (C5). This argument is related to C3 and C4, but specifically focuses on the role of production factors in location behaviour. High factor costs at more urban upstream locations can drive port developers and market players to look for new less urban estuarine or coastal locations.

Stronger environmental restrictions (C6) at established ports, particularly those located in urban areas or near vulnerable ecological systems, can trigger a search for other terminal locations. Given the proximity of urban cores and the associated local communities, issues of noise, air quality, energy consumption, waste management and dredging are typically scrutinized much more than in remote offshore or coastal port sites.

2.2. Forces favouring port/terminal development at upstream urban port/terminal locations

The list of forces presented in the previous section points to a decreasing attractiveness of urban container ports located in upstream river locations. Traditional port system development literature provides less clues on the processes that might favour a further development of ports in upstream urban locations. We present five forces that help to explain why upstream seaports can still have a significant role to play in port systems. These forces are based on the application of economic geography concepts to port systems and insights on market-related dynamics.

First, market players typically value some of the supply chain related characteristics of upstream urban ports, such as a closer proximity and better connectivity to inland markets provided by road, rail and or barge networks, high cluster and scale effects in cargo generation and savings in environmental costs of land transport. Port economics literature captures some of these factors driving port competiveness and port selection through port competition models, efficiency analysis, multi-criteria analysis, factor analysis and other qualitative and quantitative methods (see Pallis et al., 2011 for an extensive literature overview). Many of these studies point to generalized transport costs, transit times and service quality elements of ports in a supply chain perspective as key determinants of port competitiveness, see e.g. the Logit model results in Veldman and Bückmann (2003) and Nir et al. (2003). As seaports have evolved towards nodes in value-driven supply chains, their competitive positions are largely determined by their effective integration in these supply chains and logistics pathways (Robinson, 2002; Mangan et al., 2008). Song and Panayides (2008) conceptualized how such integration can be measured and quantified. Upstream urban ports can play a role in a competitive environment centred around supply chain integration.

Second, using an Evolutionary Economic Geography (EEG) approach, Hall and Jacobs (2012) show that the proximity to urban areas provides urban ports with dynamic tangible and less tangibles advantages which cannot be found in non-urban environments, e.g. superior infrastructure, knowledge, innovation and decision-making capacities. The role of human agency and institutional structures on the port-city interface is underrepresented in the older models of port system development.

Third, while congestion and environmental challenges negatively affect more urban ports, they can be a major source of innovative power with positive impacts on competitiveness. For example, Hall et al. (2013) illustrated how environmental innovation took place in the ports of Vancouver and LA/Long Beach, partly because of the pressures on environmental performance as exerted by lead firms, local communities and organizations, and governments. These insights are relevant to the discussion on upstream seaports as the latter ports typically are located adjacent to major urban agglomerations.

Fourth, Ng et al. (2014) state that very few port geographers have used the economic geography concepts of path dependence, embeddedness and convergence to explain how social, cultural and institutional factors produce spatial differences in economic activity (Amin,

1999). Path dependence implies that port systems evolve by building on previous phases and 'memory effects'. Path dependence in port system development can be reinforced by so-called retention mechanisms (see Nelson and Winter, 2002 and Glückler, 2007 for the terminology used). Retention refers to the structural mechanisms that cause new developments to reinforce the existing hierarchy in a port system, and thus favour established ports. One of these mechanisms is preferential attachment. The actors in a specific port system with many ties are more likely to receive new ties in the future. Embedding is another mechanism strengthening path dependency. The mechanism of embedding assumes that future ties form around existing strong ties by processes of trust. Preferential attachment and embedding can lead to self-reinforcing effects whereby established seaports become even more dominant in a port system. The existence of strong retention mechanisms in an upstream seaport can dramatically weaken the push for port/terminal migration to coastal or estuarine locations and undermine the competitiveness of rival ports.

Fifth, power, politics and collective action by the port community have a role to play in port development and port competitiveness. Ports are territorially vested and institutionally articulated entities where power plays a strong role in shaping interactions. Therefore, the position of upstream seaports is influenced by power exerted by dominant groups, but also by a sense of collective action by the local port community. Port performance requires collective action, i.e. joint efforts of various actors in the port cluster or community, in areas such as knowledge development, hinterland accessibility and human resources (De Langen and Visser, 2005). Some actors or stakeholders will use their power and sense for collective action, including mobilizing institutional resources or alternative discourses, in order to constrain or enable the development of an upstream seaport. Jacobs (2007) and Jacobs and Notteboom (2011) demonstrated how strategic or collective action can affect the development path of ports. Also politics can play a major role. For instance, Ng and Pallis (2007) noted that variations of political traditions and culture could result in the embeddedness of strategies within the institutional frameworks concerned.

3. The adaptive capacity of seaports

3.1. The notion of adaptive capacity

The previous section introduced forces that could weaken or strengthen the position of upstream urban seaports in port systems. The balance between the factors in favour and the factors against upstream urban seaport development is case-specific and can thus not be generalized across ports.

In order to provide a balanced discussion on the development path of upstream seaports and to add to extant port development models and ideas, we use the notion of adaptive capacity. Brooks (2003, p. 8) describes adaptation as ''adjustments in a system's behaviour and characteristics that enhance its ability to cope with external stress''. Adaptation in the context of seaports refers to a process, action or outcome in order for the port to better cope with,

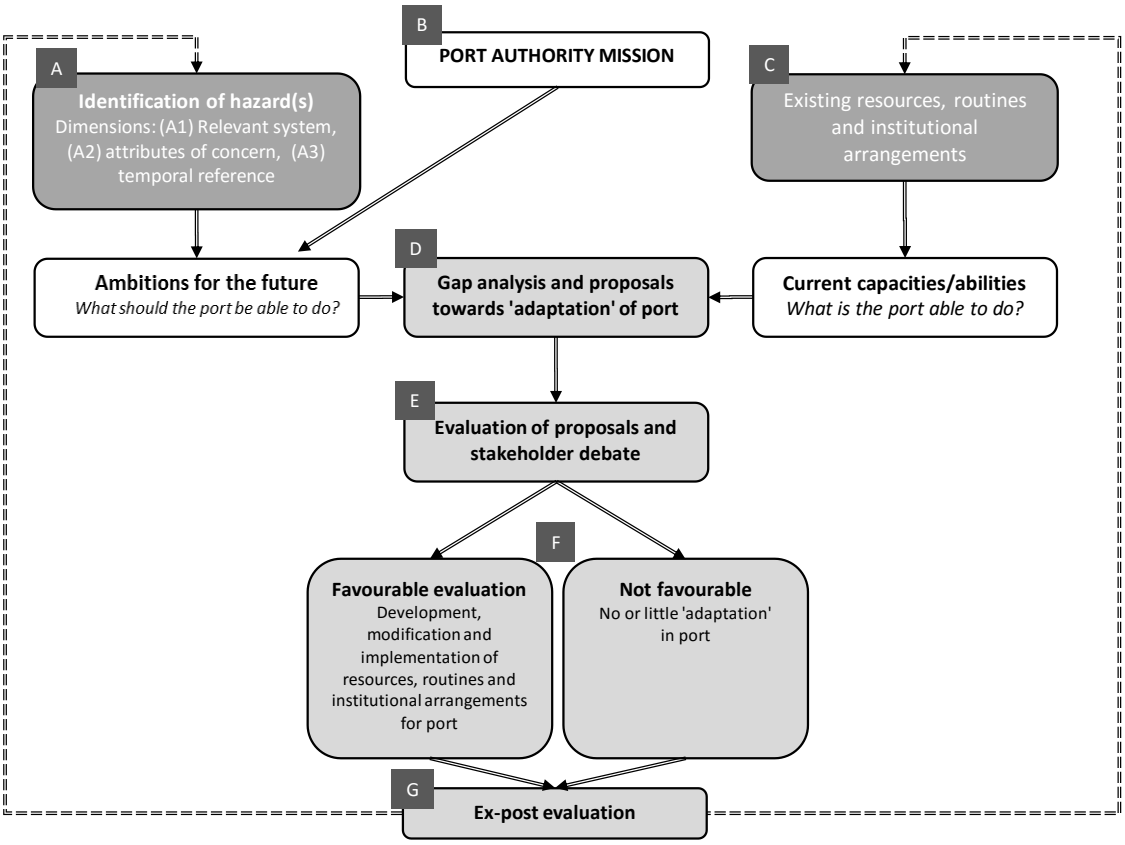
manage or adjust to some changing condition, stress, hazard, risk or opportunity. Turner et al. (2003) make an explicit distinction between perturbations which are hazards that are short-lived and discrete, and stress which refers to a hazard with a long-lasting or even continuous nature. Many of the hazards container ports are confronted with can be categorized as stress. For example, the upscaling of container vessels is not of a temporary nature, but is a continuous hazard.

A port which does not have adequate methods of coping with external changes and associated stress will not be able to remain competitive in its port development path. When borrowing the terminology introduced by Denevan (1983), one could argue that seaports which are able to respond to or cope with change quickly and easily are considered to have a high adaptability or capacity to adapt. These adaptive capacities rely on the ability to develop anticipatory and mitigative adaptations (Goklany, 2007).

We use the notion of 'adaptive capacity' in the context of container port development. Changing conditions, such as an increase in container vessel size, require the development and use of processes of adaptive capacity building to enable a port development path that is able to meet the many challenges.

3.2. The process of adaptive capacity building

Figure 1. The process of adaptive capacity building by a port authority



Source: own compilation

Figure 1 provides an overview of the process of adaptive capacity building by port authorities. The figure is not self-explanatory as it serves as a guide for the detailed discussion on all aspects and factors as presented in the following sub-sections.

3.2.1. Hazard identification and dimensions

The starting point of the process is the identification of one or more hazard(s) in most cases manifesting itself as stress (box A in figure 1). The hazards and changing conditions container ports typically face relate to changes in the economic geography of trade flows (e.g. the rise of Asia or changing distribution patterns), changes in container shipping networks (e.g. larger vessels), changes in productivity standards and requirements for container terminals, changes in institutional arrangements and public policy, and changes in industry structure through consolidation and alliance formation. In the remainder of this paper we will focus on one specific hazard, i.e. scale increases in container vessel size. A hazard is generally but not always external to the system under consideration.

Based on the terminology used in Fuessel (2007), we identify three dimensions to describe a hazard that needs to be addressed by a seaport.

A first dimension of a hazard is the '*system'* that is potentially threatened by the hazard (*A1* in figure 1). This can be an individual seaport, a terminal or set of terminals, or a seaport system (e.g. multi-port gateway region, national port system, port range). When it comes to the dimension 'system', port authorities have a natural reflex to consider their proper port as the relevant 'system'. A port authority typically tries to enhance retention mechanisms that lead to a further successful development of its port.

The second dimension relates to the '*attribute of concern*' (*A2*) which refers to the attribute(s) of the system that is/are threatened by exposure to a hazard. A hazard, when not being addressed properly through adaptation, can negatively affect a range of possible attributes of concern: container traffic flows handled by the terminal(s) or port, port authority revenues (port dues and concessions fees), the economic impact of the port (employment and value-added creation), the generalized costs linked to supply chains, the cost of doing business with the country, environmental effects and costs, the social cost/benefit balance of the port, etc.. .

The third and last dimension is the '*temporal reference*' or the point in time or time period of interest (*A3*). It is important to have a temporal reference particularly when the risk to a system is expected to change significantly during the time horizon.

Hazards feed a need for 'adaptation' through the setting of ambitions as often captured by the mission or strategic intent of the port authority (*box B* in figure 1). A strategic intent reflects the long-term objective of a port. It is the starting point of any strategic port planning process. A well-formulated strategic intent explicitly refers to the main attributes of concern

of the port authority, e.g. maximisation of maritime traffic handled, maximisation of economic value-added for the local community, etc.

3.2.2. Ambitions vs. current abilities

The second building block in the process of adaptive capacity building consists of the resources available in order to cope with the hazards or stress. The starting position is described by the existing resources, routines and institutional arrangements which shape the current abilities and capacities of the upstream port (*C* in figure 1).

A gap analysis might reveal that the current resources are insufficient to allow 'adaptation' to a new environment shaped by stress or continuous hazards (such as scale increases in container vessel size). The port authority will make proposals on how to close the gap between ambitions and current capacities and abilities (*D* in figure 1). This can involve the development of new resources and capacities such as the dredging of a navigation channel or the construction of new quay walls. However, it might also involve changes in institutional arrangements (e.g. related to vessel traffic management, terminal concession policy, port pricing, etc..) or port authority routines.

3.2.3. Evaluation and stakeholder debate

The process of adaptive capacity building by a port authority is strongly entwined with the availability and deployment of sound structures and procedures on stakeholder dialogue/participation and project evaluation/management (Notteboom and Winkelmans, 2003; Dooms et al., 2013). Stakeholder management has gained importance in view of ensuring the convergence of potential conflicting interests held by diverse stakeholder groups (Parola and Maugeri, 2013). Together with a sound project management, it should allow the port authority to prepare for changing conditions through projects (dredging, terminal developments, etc.) or institutional changes in a timely and well-researched way and with active stakeholder involvement. Notteboom et al. (2015) made a distinction between 10 stakeholder groups from a port authority perspective: shareholders of the port authority, the financial community, employees and labour unions, terminal operators, port users (such as freight forwarders, ship agents, transport operators, etc..), shipping lines, passengers, port services providers (e.g. pilots, towage operators), local community and societal groups of interest, and regulators/public institutions.

During the evaluation phase, stakeholders will critically reflect on a range of issues (*box E* in figure 1). First, they will scrutinize the *hazards (A)* as identified by the port authority and the related ambitions. For example, a stakeholder might argue that the future scale increases in vessel size as forecasted by the port authority are exaggerated and that therefore the port needs no or only little adaptation.

Second, while the port authority sees the individual port as *the relevant 'system' (A1)*, stakeholders might have another view on the relevant geographical or functional scale of the system. For example, a terminal operator will consider its global terminal network as forming a system that needs adaptation, while a national government might deal with a hazard by looking at a system consisting of all seaports within the national territory. The different views on the relevant 'system' of analysis can lead to discussions and tensions during the phase of proposal evaluation and stakeholder debate. For example, the managing body of an established upstream seaport might consider a capital dredging project as the optimal solution to deal with larger container vessels, while the national or regional government might see the further development of a coastal port as a better 'port system'-based solution.

Third, stakeholders might also have critique on *the attributes of concern (A2)* advocated by the port authority. For example, logistics service providers favour port development at locations that best suit their interests in terms of minimization of costs, transit times and other quality aspects related to entire transport and logistics chains. National governments are often driven by the direct and indirect economic impacts ports generate for the national economy. Municipal landlord port authorities also use the economic impact argument but underline the local nature of these effects. They are also interested in safeguarding maritime cargo flows and revenue streams (mainly port dues and concession fees). They understand that these revenues can only be generated when the port offers a strong and valuable logistics service to the customers (see discussion on port competitiveness in section 2.2).

Fourth, stakeholders could argue that the *current resources* have not been optimally used and therefore no new resources are needed to adapt the port to the new environment. For example, stakeholders might claim that existing nautical accessibility challenges can be addressed by efficiency gains in vessel traffic management and therefore do not require expensive dredging works.

3.2.4. Evaluation outcome: new resources, routines and institutional arrangements?

Once the evaluation and stakeholder debate phase has been closed, a decision needs to be taken by the relevant actor, mostly the port authority or a public body such as a national or regional government (*box F* in figure 1). Even if the decision is not favourable, an ex-post evaluation phase will be needed at some point in time by going back to the top of figure 1 (*box G*). As such, adaptive capacity building is a continuous process. Hazards and existing resources need to be monitored on a continuous basis to provide input for the formulation of proposals aimed at closing the gap between ambitions and current abilities.

3.3. Factors influencing the development of adaptive capacity

We theorize that the success of a seaport in building and implementing adaptive capacity to deal with the changing conditions is largely influenced by a number of factors.

First, there are some hard economic factors and resources in relation to building adaptive capacity. This includes the availability of and feasibility to deploy technological resources and solutions to prepare for changing conditions. Examples are the technological and process-oriented advances made in dredging techniques, ship propulsion and steering technology and vessel traffic management systems which provide seaports with more and better possibilities to stretch or improve nautical accessibility. It also includes the access to and feasibility of deploying sufficient economic resources (capital, land and human resources) to prepare for changing conditions.

Second, the outcome can be affected by the availability and competitive profile of existing or potential future port facilities which can act as a substitute to the seaport. A lack of (national/regional) alternative ports creates a stronger incentive to find solutions within the existing established seaport. In other words, having alternatives in close proximity pushes the decision-makers and relevant actors towards adaptive measures at the level of a (national) port system, not the established seaport.

Third, the adaptive capacity is influenced by more process-oriented and stakeholder-related factors embedded in an institutional and policy context. The availability and deployment of sound structures and procedures on stakeholder dialogue/participation and project evaluation/management are crucial in view of adaptation. Also the presence of a joint mission, a sense of collective action and preparedness in the port community and among public bodies and policy makers (local, regional and or national) is crucial to continue working towards adaptation of a seaport. A strong sense of joint mission and ambition, a common sense of urgency and a strong focus on collective action by the local port community can help to enhance retention mechanisms that support a further prosperous development of a seaport. A lack of a joint mission threatens the port's future development potential.

The factors mentioned above are inter-related. If a sense of collective action is absent it will be very difficult to secure enough resources. Also, a poor stakeholder management can seriously jeopardize the realization of projects with a clear net social benefit to the region or country, even if there are enough resources available and the port community shows a strong joint mission to keep investing in the competitiveness of the seaport. All factors need to be in place to realize a virtuous cycle of adaptive capacity building.

In the next section, we adopt the case study method to analyse the adaptive capacity of Antwerp and Hamburg and its impact on the ports' competitive positions and development paths in the container market.

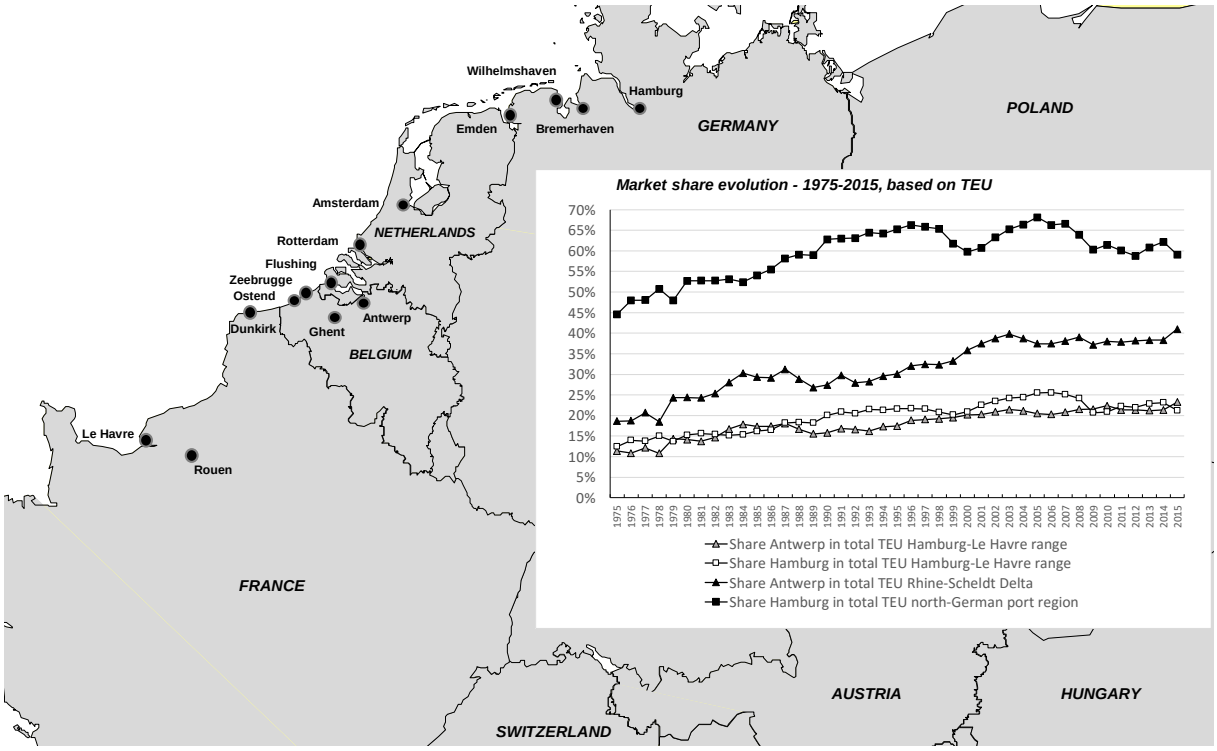
4. Empirical application to the ports of Antwerp and Hamburg

We follow the case study method which is appropriate for "why" and "how" research questions (Yin, 2009). We analyse why and how upstream seaports Antwerp and Hamburg remain competitive in the deepsea container market, despite the significant nautical access challenges and the intense competitive pressures both ports are exposed to. To answer these questions, we analyse the processes of adaptive capacity building by the respective port authorities with a particular focus on the ports' responses to the increases in container vessel size. Figure 1 serves as a structured basis for the analysis. Data and information for the case studies was obtained from direct observation, formal and informal interaction with directly involved actors, and source material including reports, documents and archival records and project evaluation studies. While we focus on two cases, the conceptual approach on the processes of adaptive capacity building as presented in Figure 1 can also be applied to other seaports. The choice for Antwerp and Hamburg as case studies is based on the existence of previous work about these upstream seaports (see introduction), the fierce competitive environment these ports are operating in and their scale and profile as outlined in the next section.

4.1. Profile of Antwerp and Hamburg

This section presents a short profile of the container activities in the two ports before analysing their adaptive capacities. Figures 2 to 4 provide situation maps for Antwerp, Hamburg and the Hamburg-Le Havre range. The deep sea container terminals in Hamburg are located along the Elbe and in open tidal docks connected to the river. After the completion in 2016 of the move of MSC/PSA from the Delwaidedock behind locks to the open tidal Deurganckdock, all major container terminals in Antwerp will be accessible without the use of sea locks, including the planned open tidal Saeftinghedock. Antwerp and Hamburg are among the largest container ports in the world with a total container throughput in 2015 of 9.65 mio TEU and 8.82 mio TEU respectively. In Europe, only Rotterdam realized a higher container volume, i.e. 12.23 mio TEU.

Figure 2. Port Location in Hamburg-Le Havre range and container throughput share of Hamburg and Antwerp



Note: Container ports per region are as follows: Rhine-Scheldt Delta = Rotterdam, Antwerp, Amsterdam, Zeebrugge, Ghent, Zeeland Seaports and Ostend; North-German port region = Hamburg, Bremerhaven/Bremen, Wilhelmshaven, Cuxhaven and Emden; Hamburg-Le Havre range = Rhine-Scheldt Delta, North German port region and the French ports of Le Havre, Dunkirk and Rouen

Source: own compilation based on data individual port authorities

Figure 3. Situation map - port of Antwerp

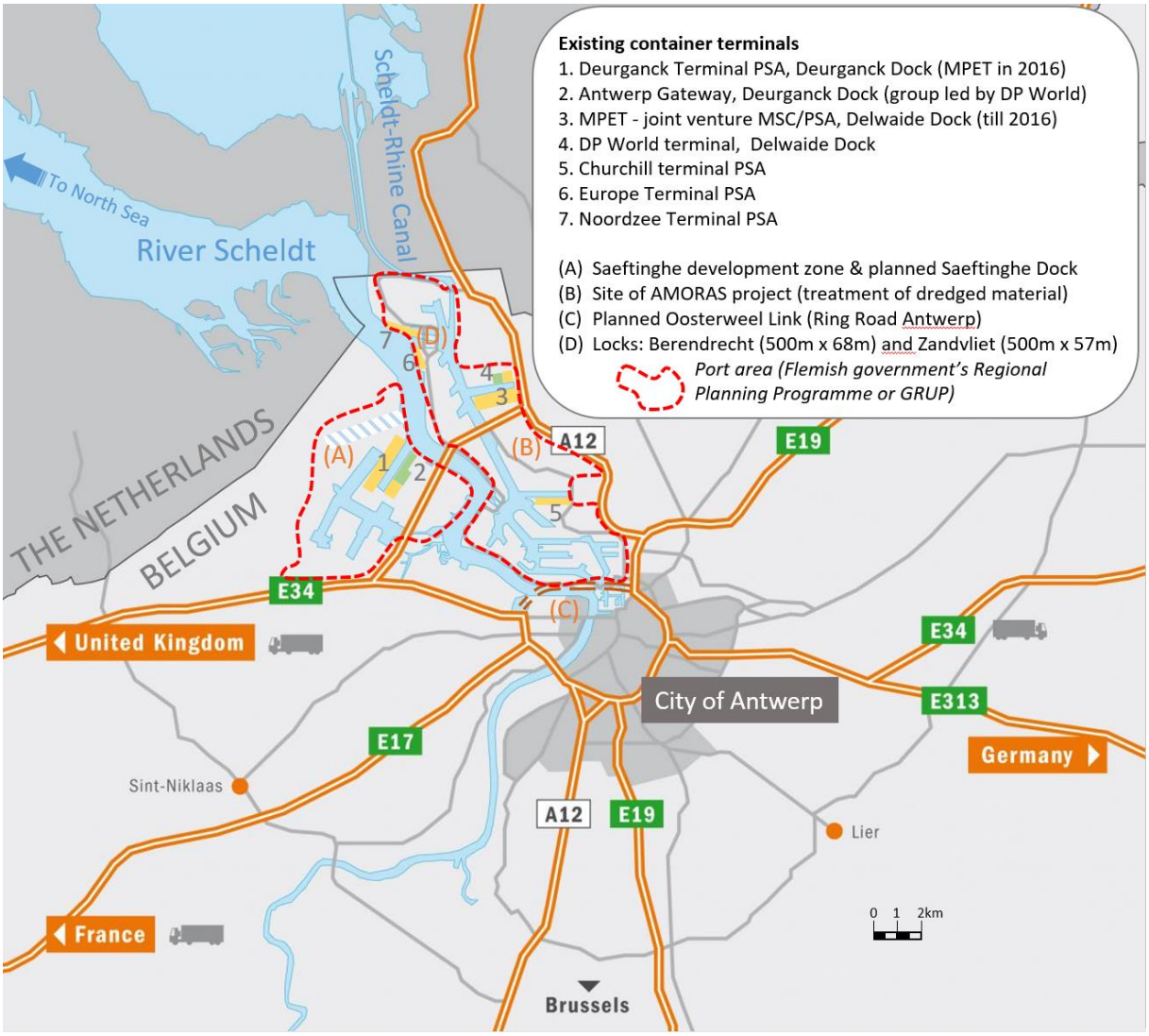


Figure 4. Situation map of port of Hamburg

Antwerp and Hamburg are included in a number of direct liner services between Asia and Europe, the trade route were the largest container vessels are deployed. At the time of writing, the MSC Zoe of 19,224 TEU was the largest ship in the world and also the largest ship that has ever called both ports. The number of container ships of over 10,000 TEU calling at Antwerp amounted to 266 in 2014. Among these 82 vessel arrivals involved ships of more than 13,000 TEU (Port of Antwerp, 2015). In 2014, 507 ships with slot capacities in excess of 10,000 TEU called in Hamburg of which 182 vessels of over 13,300 TEU (Port of Hamburg website).

Hamburg and Antwerp are actively competing with coastal and estuarine ports in close vicinity, i.e. Rotterdam, Zeebrugge, Bremerhaven and Wilhelmshaven. There is also competition with UK ports such as Felixstowe, London Gateway and Southampton for UK transhipment cargo, with a number of Baltic ports such as Gdansk for the Baltic region and

increasingly also with Mediterranean ports for cargo flows to southern, central and eastern parts of Europe.

Despite fierce competition, Antwerp and Hamburg have been able to avoid a systematic loss in container market share vis-à-vis estuarine and coastal rivals (figure 2). The market share of Antwerp shows a long-term gradual increase. In recent years, Antwerp's TEU volume grew by 7.5% in 2015 and 4.6% in the first quarter of 2016, while its nearest rival Rotterdam saw a decrease of 0.5% in 2015 and 3.9% in Q1 2016. Hamburg's market share evolution shows more volatility: a strong upward trend till the mid-2000s partly as a result of the rise of China and the opening up of new hinterland regions in Eastern and Central Europe triggered by the fall of the Iron Curtain, followed by a market share stabilization after a volume drop during crisis year 2009. The drop in Hamburg's market share in 2009 was mainly caused by price competition with Rotterdam and the resulting shift of about 0.5 mio TEU of transhipment volumes to the Dutch port. After a throughput recovery from 7 mio TEU in 2009 to 9.7 mio TEU in 2014, the port's container volume shrank by 9.3% in 2015 and a further 3.4% in Q1 2016, making its container throughput go below the 2006 figure. Also Bremerhaven is confronted with a gradual volume decline since 2012. In 2014 and 2015, Hamburg's volumes suffered from the economic slowdown in China and Russia, two key markets for the Elbe port.

These market shares relate to all container trade routes and might therefore not reveal the ports' competitive positions on the routes where the largest vessels are deployed. Tables 1 and 2 refer to port call patterns on the North Europe-Asia trade. Despite the enormous scale increase in vessel size (see top of table 1) and major changes in alliance structure in container shipping (leading to 2M, Ocean Three, CKHYE and G6), the share of liner services calling at Antwerp increased from 30.8% in 2012 to 38.1% in 2015. While Rotterdam remains the undisputed market leader, quite a few shipping lines call at Rotterdam and Antwerp in the same liner service (or to a lesser extent Zeebrugge), indicating that shipping lines prefer to use a range of ports instead of concentrating all volume in one mega-port, i.e. Rotterdam. Compared to Antwerp, Hamburg has always had a much stronger position on the Europe – Far East trade. The port's market position became stronger in recent years with 81% of all North Europe-Asia services calling the port. In most cases, Hamburg is the only port of call in Germany on the North Europe – Asia trade. Only the 2M alliance also sends ships to Bremerhaven and Wilhelmshaven (table 2).

Table 1. Evolution of the calling patterns of the Asia-North Europe services for the multi-port gateway regions of the Rhine-Scheldt Delta (top) and North Germany (bottom)

	March 1989	Oct 1998	Feb 2006	April 2012	July 2015
Number of liner services on North Europe-Asia trade	16	27	35	26	21
Average ship size (in TEU)	-	4250	6164	9444	13600
Largest ship on trade route (in TEU)	4538	6418	14770	15550 (*)	19224
RHINE-SCHELDT DELTA					
Antwerp only port of call in RSD	6.7%	21.0%	14.3%	4.2%	9.5%
Rotterdam only port of call in RSD	46.7%	38.0%	45.7%	45.8%	47.6%
Zeebrugge only port of call in RSD	0.0%	0.0%	0.0%	0.0%	0.0%
Amsterdam only port of call in RSD	0.0%	0.0%	2.9%	0.0%	0.0%
Calls in Rotterdam and Antwerp	46.7%	34.0%	20.0%	25.0%	28.6%
Calls in Rotterdam and Zeebrugge	0.0%	7.0%	14.3%	20.8%	14.3%
Calls in Antwerp and Zeebrugge	0.0%	0.0%	0.0%	0.0%	0.0%
Calls in Antwerp and Amsterdam	0.0%	0.0%	2.9%	0.0%	0.0%
Calls in Rot., Antw. and Zeebr.	0.0%	0.0%	0.0%	4.2%	0.0%
TOTAL (services calling RSD only)	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
% of NE-Asia services calling in Rhine-Scheldt Delta (RSD	*93.8%*	*95.0%*	*100.0%*	*92.3%*	*100.0%*
% of NE-Asia services calling at Antwerp	*50.0%*	*52.3%*	*37.1%*	*30.8%*	*38.1%*
% of NE-Asia services calling at Rotterdam	*87.5%*	*75.0%*	*80.0%*	*88.5%*	*90.5%*
Number of services with double calls in an RSD port	*0*	*0*	*1*	*2*	*4*
NORTH-GERMANY					
Hamburg only port of call	31.3%	83.9%	78.8%	65.2%	75.0%
Bremerhaven only port of call	12.5%	16.1%	15.2%	21.7%	5.0%
Wilhelmshaven - JadeWeserPort (**) only port of call	0.0%	0.0%	0.0%	0.0%	0.0%
Calls in Hamburg and Bremerhaven	56.3%	6.5%	6.1%	13.0%	10.0%
Calls in Hamburg and Wilhelmshaven	0.0%	0.0%	0.0%	0.0%	0.0%
Calls in Bremerhaven and Wilhemshaven	0.0%	0.0%	0.0%	0.0%	10.0%
Calls in Ham., Brem. and Wilh.	0.0%	0.0%	0.0%	0.0%	0.0%
TOTAL (services calling North-Germany only)	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
% of NE-Asia services calling in North Germany	*100.0%*	*75.0%*	*94.3%*	*88.5%*	*95.2%*
% of NE-Asia services calling at Hamburg	*87.5%*	*63.6%*	*80.0%*	*69.2%*	*81.0%*
% of NE-Asia services calling at Bremerhaven	*68.8%*	*15.9%*	*22.9%*	*30.8%*	*23.8%*
Number of services with double calls in North Germany	*0*	*0*	*1*	*0*	*2*

Notes: (*) The first in a series of 'triple E' class ships of Maersk (18,340 TEU) were put in operation in July 2013 ; (**) JadeWeserPort opened in the Summer of 2012

Source: own compilation based on current (online) and historic liner service schedules of respective shipping lines

Table 2. Antwerp and Hamburg as ports of call on the Asia-North Europe services of the four big shipping line alliances (situation in July 2015, 21 regular liner services in total)

		No. of services	Rhine-Scheldt Delta			North Germany			Other continental ports		
ALLIANCE	**MEMBERS**	**TOTAL**	**Antwerp**	**Rotterdam**	**Zeebrugge**	**Hamburg**	**Bremerhaven**	**Wilhelmshaven**	**Le Havre**	**Dunkirk**	**Gdansk**
2M	Maersk Line MSC	6	3 (*)	4 (*)	0	2	5 (**)	2	3 (*)	0	1
Ocean 3	CMA CGM CSCL UASC	4	1	4 (**)	3	4	0	0	2 (*)	1	0
CKHYE	Cosco K-Line Yang Ming Hanjin Evergreen	6	3	6	0	6	0	0	2	0	0
G6	APL/NOL MOL HMM Hapag-Lloyd NYK OOCL	5	1	5	0	5	0	0	2	0	1
Total no. of services		**21**	**8**	**19**	**3**	**17**	**5**	**2**	**9**	**1**	**1**

Notes: (*) = of which oneservice with a double vessel call, (**) = of which two services with double calls

Source: own compilation based on online liner service schedules of respective shipping lines

The sea-sea transhipment incidences of Antwerp and Hamburg in 2014 amounted to 29% and 40% respectively and are comparable to the transhipment shares in coastal and estuarine rivals : 36% in Rotterdam, 45% in Bremerhaven, 25% in Zeebrugge and 17% in Le Havre. The fact that significant transhipment activities take place in these upstream river locations largely goes against force C2 in section 2.1, but at the same time is confirmed by the survey-based analysis of Ng (2006) which points to Hamburg and Rotterdam as the most attractive options for transhipment activity in Northern Europe, with Antwerp and Bremerhaven closely behind. It further demonstrates that consideration should be given to the geographical factors of the region (Russo and Musolino, 2013). The morphology of the sea basins in north Europe, with the Baltic Sea and the British Isles and a large continental European market, partly explains the combination of gateway and transhipment cargo in mainland ports (even in upstream locations) and the absence of pure transhipment hubs.

In summary, both Antwerp and Hamburg are large upstream urban container ports, receiving the largest container vessels, able to withstand the intense competitive pressure from coastal and estuarine rivals and handling considerable volumes of transhipment flows.

4.2. Processes of adaptive capacity building in Antwerp and Hamburg

4.2.1. Hazard identification and its dimensions

We follow the structure of figure 1 as a basis for the analysis of processes of adaptive capacity building by the port authorities of Antwerp and Hamburg. We first focus on the hazards both ports are exposed to (*box A* in figure 1). Antwerp and Hamburg regard scale increases in vessel size as one of the key hazards in the container market. Both port authorities are aware of the importance of a range of other issues in the area of inland transport, terminals, the environment, port-city relations and the cost and availability of production factors.

As regards *box B* in figure 1, the mission of the port of Antwerp reads "To assure maximum sustainable added value of the port area entrusted to us. To this end, Antwerp Port Authority plays active roles, both within the port area and outside it" (Port of Antwerp, 2014, p. 4). This mission underlines the economic importance of the port is a major attribute of concern (*A2* in figure 1) for the port authority. The port generates a direct and indirect employment of 145,000 people and a direct and indirect added value of around 20 billion euro or 8.9% of Flemish GDP and 5.1% of Belgian GDP (National Bank of Belgium, 2014). The port authority clearly focuses on the individual port as the relevant system of analysis (*A1* in figure 1) to address any hazards. In the 2014-2018 Business Plan, the Antwerp Port Authority insists that "all stakeholders must help to ensure that the port of Antwerp remains competitive" (Port of Antwerp, 2014, p. 5) and underlines the need for legitimacy by an intensive process of testing, both internal and external.

The same kind of drive for retention can be found in Hamburg's Port Development Plan to 2025 (Free and Hanseatic City of Hamburg and Hamburg Port Authority, 2012). The plan clearly aims at utilising the growth potential of the port of Hamburg. In a foreword, Senator of Hamburg Frank Horch (President of the State Ministry of Economic Affairs, Innovation and Transport) states "I believe that the foremost aim of port development should be to secure the manifold jobs in the port and increase value creation in Hamburg", thereby implicitly confirming that, just like in Antwerp, the economic impact of the port is the key attribute of concern (*A2*) and the individual port is the relevant system of analysis (*A1*). In 2010, the port was responsible for 155,000 jobs in the entire metropolitan region (i.e. 11.8% of the labour force). Jobs supported by the port employ an estimated 261,000 people in Germany. The added value of the port amounted to 12.6 billion euro or 14% of overall gross value creation in Hamburg. Also Hamburg strongly believes in a dialogue process involving the relevant stakeholders to gather ideas to develop a market-oriented port strategy. Through stakeholder involvement, both port authorities try to enhance retention mechanisms and a sense of collective action by the port community which should guarantee continued support for the port and its further development.

The sense of retention is further reinforced by the specific (local) institutional and governance setting in both ports. Antwerp and Hamburg can be categorised as Hanseatic landlord port authorities. In the Hanseatic tradition the local government/municipality has a strong influence on ports (ESPO, 2011). Following rather recent port reforms the port authorities now have a high level of autonomy vis-à-vis the local city council or senate:

- In 1997, the former municipal Antwerp port authority was transformed into an autonomous municipal port authority with only one shareholder, i.e. the municipality of Antwerp. The new port authority gained financial independence. The port authority was changed into a public limited company on January 1, 2016. This coincided with the entry of more business people in the board of directors. The main revenues for APA come from land fees (concessions) and port dues on ships and cargo arriving in the port and income related to towage operations in the docks behind the locks;

- In Hamburg, the city state "Free and Hanseatic City of Hamburg" is responsible for port affairs. The federal German government is responsible for maritime access and hinterland connections such as national roads, railways and inland waterways. The Port Authority of Hamburg (HPA) was created in 2005 when port-related authorities of the City State were unified. The City State and HPA invest in the infrastructure, while private operators invest in superstructure (cranes, warehouses, etc.). HPA has to present a budget and bears responsibility for resources. Next to land rents and port dues, HPA also gets revenues from its involvement in the port railway.

Despite the acquired autonomy, both port authorities face formal and informal political influence via the appointment of top management executives and the composition of supervisory bodies. We argue that the power of these (local) politicians in the decentralized port management setting leads to strong retention mechanisms favouring the established upstream seaport as the relevant system of analysis (*A1*). The earlier quote of Senator Horch underlined the local political commitment to secure the future of the port of Hamburg. Similar statements can be found in the 2013-2018 coalition agreement for the City of Antwerp. In other words, the local political level is a major force in facilitating processes of adaptive capacity building in both ports. A more centralised port policy and management system at a higher geographical scale, such as in most Latin countries in Europe, would result in weaker political retention mechanisms at the local level.

4.2.2. Evaluation and stakeholder debate: the forces for and against building adaptive capacity in Antwerp and Hamburg

The aim of the port authorities of Hamburg and Antwerp to build adaptive capacity is shaped by the interaction between stakeholders' interpretation of the dimensions of hazards and the resources, routines and institutional arrangements.

Draught limitations remain one of the worst threats to the container positions of Antwerp and Hamburg, mainly on the Europe-Far East trade. We focus the discussion on the way Antwerp and Hamburg have responded or are planning to respond to this hazard, although we are aware that both ports also face a lot of other hazards of an economic, technological, environmental and institutional nature. Both ports have completed or are embarking on capital dredging programs to ensure a better nautical accessibility (*boxes D and E* in figure 1, see next section).

< insert table 3 about here >

The first column of table 3 summarizes the main arguments used by APA and HPA in the evaluation phase (*box E* in figure 1) to justify investments in nautical accessibility to allow the largest vessel to call at the port. The arguments are linked to business and supply chain factors (such as the proximity to markets and cargo generating effect), macro-economic significance

and the potential environmental benefits compared to more coastal locations. These arguments all relate to specific attributes of concern and consider the individual port as the relevant system and not a wider port system including other (national) ports.

At the level of market demand, both ports understand that calls at upstream seaports are only justified if the benefits more than compensate the additional (time) costs for the vessel and the cargo. Both ports underline that shipping lines and shippers are attracted by their high cargo availability (and thus a higher call size and better vessel utilization), a high maritime and inland connectivity, a high terminal productivity and potential savings in onward inland transportation. The ports also stress that they are strategically located in relation to the main economic centres in Europe.

In phase *E* of figure 1, opponents of port development in Antwerp or Hamburg typically contest many of the arguments by referring to the issues raised in the last column of table 3. Strings of arguments emerge during the formal project evaluation phase (*F in figure 1*) and the associated (public) debate on investments in the accessibility of Antwerp and Hamburg. The public debate and decision making processes receive formal inputs via project evaluation studies (social cost-benefit analyses, economic impact studies, mobility studies, environmental impact studies, etc..) and second opinions of such studies. Community and environmentalist groups and the media exert major influence on the public discourse and final decision.

The evaluation and stakeholder debate phase is typically lengthy. Improving the nautical accessibility within a reasonable timeframe has become a major competitive factor in port systems. Hamburg and Antwerp have built up a rich experience in dealing with project planning issues. The experience level in terms of stakeholder relations management can serve as a retention mechanism in favour of these ports.

4.2.3. Closing the gap between ambitions and current abilities

HPA and APA have initiated, coordinated or supported actions to ensure the adaptive capacity is in place to secure the ports' continued competitiveness (*box D* in figure 1). The first two columns in table 4 reiterate the six main forces pushing port development towards coastal or estuarine locations (see section 2) and some related arguments used by opponents of upstream port development (see table 3). Both port authorities are actively engaged with the broader port community to monitor and solve any problems that might occur in these areas. As a detailed discussion of each of these actions falls beyond the scope of this paper, we concentrate the discussion again on the nautical accessibility for the largest container vessels.

< insert table 4 about here >

Large container vessels that sail up or down the bendy River Scheldt are subject to a tidal window. The market share model on West-European container hubs presented by Veldman et al. (2005) statistically proves that tidal windows play a role in the competitive position of Antwerp. As a result of three capital dredging programs on the river and the estuary, completed in the periods 1970-1975, 1997-1998 and 2010-2011, Antwerp can now accommodate container vessels with a draught up to 16m travelling up-river and 15.2m down-river on a tide-dependent basis. The tide-independent draught is 13.1m. The record draught inbound for a container vessel is 15.65m and the record draught outbound 14.9m (figures Antwerp Port Authority).

The deepening programs faced political and institutional complexity as most of the Scheldt River runs on the territory of the Netherlands. The 1997-1998 deepening program was enshrined in a convention signed by the governments of Flanders and the Netherlands on 17 January 1995. The decision on the 2010-2011 deepening program was embedded in a 'Long-Term Vision for the Scheldt Estuary' covering three dimensions, i.e. nautical accessibility, nature/ecology and safety/flood protection. The explicit link with ecology and safety was made in order to ensure that the deepening project went beyond a pure socio-economic evaluation. The project organisation was entrusted to the Dutch-Flemish partnership ProSes and led to a 'Development outline 2010' (Ontwikkelingsschets 2010). The Flemish and Dutch parliaments signed four Scheldt Treaties in 2007 including the deepening program. Dredging eventually started in February 2010 and was completed in 2011. Throughout the process it was clear that the Flemish government showed a strong dedication to overcome any political, economic and technical obstacles.

Next to capital and maintenance dredging, the Flemish government and APA innovate in the area of vessel traffic management, the maximisation of ship draught and manoeuvrability and the minimisation of underkeel clearance in silty river beds. Shipping on the Scheldt river is based on the integrated chain concept from pilot pick-up to berth using the Antwerp Port Information and Control System application (APICS). Before a new size of ultra-large container vessel is allowed on the River Scheldt, the Flemish government in coordination with Harbour Captain's and pilotage services performs tests using computer models and ship simulators. The nautical authority only gives the green light for the ship's arrival if the tests are positive.

The River Elbe is the most frequently used route to approach the port of Hamburg. HPA and the Federal Waterways and Shipping Administration both manage a section of the river. Incoming large container vessels require close cooperation and coordination between the different vessel traffic centres along the Elbe and the pilot service. Pilots practice on ship simulators at the Marine Training Center (MTC) to prepare for the arrival of new ship types.

The river Elbe was deepened for the last time in 1999. At present, existing channel depths are not sufficient to accommodate a fully loaded container ship of the latest generation. HPA argues that this situation is only tolerated by shipping lines because they are confident that a planned deepening program will be completed soon. The Senate of Hamburg has applied for approval of a deepening program with the Federal Ministry of Transport, Building & Urban

Development. This program involves deepening the river by one metre to 13.5m on a tide-independent basis. Container vessels with a draught of 14.5m will be able to navigate the Elbe at high tide within a substantially wider time window. Furthermore, a widening of the river channel is planned to allow the largest container ships to be able to pass each other on the river section from Glückstadt to the port. The dredging and widening work would take about 21 months with the first improvements visible after 6 months.

While HHLA and Eurogate have already invested in terminals capable of handling the largest vessels, the patience and loyalty of carriers is being tested as the planned deepening program is still awaiting approval. In 2014, German environmental groups NABU and BUND (Friends of the Earth Germany) went to court to appeal against the plans to deepen the Weser and Elbe rivers as these plans would not meet the aims of the EU Water Framework Directive (2000/60/EC). The associated ruling from the European Court of Justice in early 2015 has made it more difficult for Hamburg and Bremerhaven to start dredging unless they make provisions to ensure the quality of marine life and are able to demonstrate the projects' overriding public interest. German courts have to use this new judgement to make a decision on dredging project applications. HPA hopes on the approval for the deepening and widening project by the Federal Administrative Court in Leipzig, so that implementation can start soon after.

Dredging projects are sensitive in political, port and community circles given the investments involved and the associated economic and environmental impacts, leading to a difficult and complex evaluation of such investments (*block E* in figure 1). The capital and maintenance dredging costs on the river Scheldt are funded by the Flemish Government, while the German central government and the Hamburg State pay for the maintenance and deepening of the Elbe River. The 1999 Elbe deepening program costed about 150 mio euro. The latest estimate on the costs of the planned Elbe deepening and widening program (including environmental measures) amounts to nearly 400 mio euro. The 2010-2011 deepening program of the river Scheldt amounted to 250 mio euro including environmental and flood protection measures, of which 45 mio euro was paid by the Dutch government. These figures exclude recurrent additional maintenance dredging costs. Depending on water depth and coastal morphology, also coastal and estuarine ports can face substantial costs to remain accessible. Moreover, dredging costs cannot be treated in isolation as there are also public investments in port and inland transport infrastructures.

There is a noticeable difference between Antwerp and Hamburg when it comes to accommodating container vessels of the latest generation. While Antwerp has secured its nautical accessibility for the largest container vessels (*box F* in figure 1: favourable evaluation), Hamburg is struggling to get the deepening plans for the Elbe River approved (*box F*: decision pending). The question is how long carriers are willing to stretch their willingness to adapt vessel utilization levels and port of call sequences to match the nautical limits of Hamburg. The uncertainty regarding the completion of the deepening program puts Hamburg in a danger zone and increases the attractiveness of coastal and estuarine rivals. Antwerp went

through a similar phase during the lengthy decision-making trajectory prior to the realization of the 2010-2011 deepening program.

4.2.4. Coastal and estuarine rivals

The future development potential of a seaport can be affected by existing or planned rival ports (see second factor in section 3.3). Having national alternatives in close proximity pushes decision-makers and relevant actors towards adaptive measures at the level of a port system, not an individual port. The respective port authorities typically try to convince policy-makers and the broader community that the national coastal ports cannot not act as alternatives for the upstream seaport. At the same time, they use the set of arguments presented in table 4 to justify further investments in and support for the upstream seaport.

Rotterdam will undisputedly continue to exert strong competitive pressure on Hamburg and Antwerp, given its deep-water access, terminal capacity expansions at Maasvlakte I and II and its extensive intermodal network to reach the hinterland. The competitive position of the other coastal and estuarine ports is less certain. A decade ago, Flushing had well-advanced plans to construct the Westerscheldt Container Terminal with a capacity of 2.5 mio TEU. However, the lengthy planning phase and the start of the economic crisis closed the window of opportunity and the project was shelved (Jacobs and Notteboom, 2011). Amsterdam opened its Ceres Paragon terminal in 2001, but the terminal remained unused for years. Its last owner, Hutchison Port Holdings, closed the terminal in 2012. The Belgian coastal port of Zeebrugge saw healthy growth in the past decade, but the tide turned in 2014. After a stagnation of volumes in 2014, container throughput in Zeebrugge recorded a year-on-year decrease of 23.8% in 2015. Zeebrugge is now undergoing a major rationalisation of its container terminal capacity. Zeebrugge has low cargo handling charges, a good water depth and a good nautical location, but suffers from a limited cargo generating power and poor barge connectivity.

Bremerhaven, Europe's fourth largest container port, continues to be a rival of Hamburg. Still, Hamburg and Bremerhaven are complementary with respect to container routes (Merk and Hesse, 2012). Hamburg is specialised in Asia while Bremerhaven has a much stronger position on the trans-Atlantic trade. The early 2000s brought a discussion on the development of a new deepwater port in the region. A proposed project in Cuxhaven at the mouth of the Elbe river was shelved partly because Wilhelmshaven has superior nautical qualities. In the end JadeWeserPort was developed in Wilhelmshaven with a capacity of 2.7 mio TEU and a draught of up to 16.5 m. The terminal was opened in the summer of 2012 and handled only 67,076 TEU in 2014. The arrival of some services of 2M resulted in a volume of 426,751 TEU in 2015. Wilhelmshaven is actively pursuing transhipment business as the development of intermodal services for gateway cargo takes time. Despite the current nautical restrictions in Hamburg, Wilhelmshaven has not (yet) succeeded in substantially undermining the position of Hamburg.

The strong reputation and market power of Hamburg, Antwerp, but also Rotterdam, lead to market-based retention mechanisms in the form of preferential attachment and embedding among market players. Newer ports and terminals offer an excellent nautical accessibility, but have to overcome major issues such as securing hinterland services and a weaker cargo-generating and cargo-binding potential. Moreover, terminal operators clearly follow a strategy of not putting all eggs in one basket. Eurogate has terminals in Hamburg, Bremerhaven and Wilhelmshaven, APM Terminals has terminals in Bremerhaven, Rotterdam and Zeebrugge, DP World is active in Rotterdam and Antwerp and PSA operates in Antwerp and Zeebrugge. By doing so, they offer customers a more differentiated product range. Tables 1 and 2 already indicated that also shipping lines do not concentrate all their volumes in one port to spread commercial risks and best serve the customer base.

4.3. Adaptive capacity building and regional port cooperation

In recent years, cooperation between port authorities has received a lot of attention in academic and policy circles. European examples include the HAROPA cooperation scheme in the Seine basin between coastal port Le Havre, river port Rouen and inland barge port Paris (Deiss, 2012), and the North Adriatic Ports Association (NAPA) between the ports of Venice, Trieste, Koper and Rijeka (Costa and Maresca, 2013). In some cases, different ports in proximity are brought under one port management entity, e.g. the creation of Copenhagen-Malmo Port (CMP) (De Langen and Nijdam, 2009).

Co-operation between (national) ports is a hot topic in North Germany and Flanders. We discuss the relationship between the increased pressure for port cooperation and the process of adaptive capacity building in these upstream seaports.

Port policy of the Flemish government is aimed at creating a level playing field among the Flemish ports (Antwerp, Zeebrugge, Ghent and Ostend) and at providing the necessary policy and regulatory framework for ports to excel. Via the 'Flanders Port Area' partnership, the Flemish government tries to encourage commercial cooperation among ports, for example in the area of hinterland strategy. The government also insists on better cooperation and coordination between Antwerp and Zeebrugge to improve the utilisation of all container terminal capacity.

APA and the City of Antwerp cannot get around the fact that port cooperation is high on the political agenda and attracts a lot of interest in port business circles. In its 'Bestuursakkoord 2013-2018' (coalition agreement), the City considers the strong local roots of the port as of vital importance to its success. While the City and APA are not against port cooperation, they follow a more restrictive approach than the Flemish government. Starting from the strong brand name of the port of Antwerp, APA fosters an open dialogue with the other Flemish ports. APA and MBZ (port authority of Zeebrugge) set up an economic cooperation entity ("Economisch Samenwerkingsverband") in November 2015 focusing on joint capacity development and marketing efforts in the container business. Up to now, there are no

tangible results of this cooperation, partly because APA claims that Antwerp is a better market-oriented option for deep-sea container shipping than Zeebrugge and uses recent container growth figures to support this statement.

In Germany, the ninth National Port Concept, which was approved by the federal cabinet in 2015, contains a strategic framework to improve the international competitiveness of seaports and inland ports. The Free and Hanseatic City of Hamburg actively participates in its implementation. The Senate of Hamburg believes cooperation between ports can help to increase a port's competitiveness in selected fields. However, it also believes that no other German port can form a fully-fledged alternative for Hamburg. Discussions on planning issues and technical knowhow are gaining in importance. Once a year Bremen, Lower Saxony and Hamburg hold a port development dialogue where the ministers in charge of ports, the Senate of Hamburg and the managers of the port authorities meet to discuss current port planning practised in each port and other key topics. These forms of port-related political cooperation are not meant to eliminate competition between the ports. Competition is and remains the basis and major driver of innovations and sustainable growth of ports and port-related businesses.

We conclude that further public investments in the development and accessibility of Antwerp and Hamburg are increasingly made subject to cooperation schemes with coastal or estuarine rivals located in the same country. In response to this increased pressure towards cooperation, APA and HPA have developed a pragmatic approach combining an open attitude towards dialogue on port cooperation without embracing far-reaching cooperation schemes. In this way they hope to retain political support for their accessibility and terminal projects and thus to maximize their adaptive capacity building potential.

5. Conclusions

The central proposition in this paper is that Antwerp and Hamburg have been able to remain competitive vis-à-vis rival ports (despite the significant nautical access challenges both ports are exposed to) by developing strong adaptive capacities combining technological, financial and human resources and a strong political and institutional setting. We specifically zoomed in on one of the key hazards, i.e. the scale increases in vessel size.

The analysis shows that the discussion on the future of these upstream seaports cannot be detached from broader public policy and stakeholder management concerns and the influences of power, politics, and collective action by the port community. Part of the success of Hamburg and Antwerp results from decades of strong retention mechanisms at the level of public bodies (supported by an institutional setup of strongly locally embedded port governance structures) and preferential attachment and embedding processes at the level of the market players. These mechanisms support a strong believe in the future growth potential and help to mobilize investments from public authorities and private port players, despite a growing call for closer cooperation with (domestic) coastal or estuarine rivals.

While political and other non-market related retention mechanisms undeniably play a role in the building of adaptive capacity, we do not support the claim made by Baird (1997) that political motivation and local forces have artificially extended the lifecycle of Hamburg and Antwerp (see quote in introduction). The market demand for these upstream seaports remains high despite severe nautical limitations in Hamburg and the existence of coastal alternatives. Antwerp and Hamburg have been able to avoid a structural weakening of their respective positions in the container market in part because of their supply chain integration strategies, the scale of the existing logistics cluster and self-reinforcing processes of cargo consolidation via a high maritime and land connectivity. Without a clear and proven market demand, any political or non-market related initiative to support upstream ports would be in vain.

Still, the future brings challenges and potential (new) hazards for Antwerp and Hamburg. First, there exist some upper limits in how far these upstream seaports can adapt to changing conditions. These upper limits can be economic (e.g. when the costs of keeping a port accessible far exceed socio-economic benefits), physical (e.g. when a river is dredged to a level at which its morphology or ecological balance is at risk) or social (e.g. when fierce and broad local community protest *de facto* makes an urban upstream port lose its licence to operate). Defining these upper limits in itself is a key point of discussion between stakeholders, knowing that also coastal and estuarine ports face upper limits.

Second, the current buyers' market gives shippers a lot of market power which incentivizes carriers to follow the cargo, even upstream (i.e. 'ships follow cargo' principle). Shipping lines such as MSC and Maersk Line gradually develop hinterland networks based on high-volume intermodal shuttles between seaports and inland terminal locations (Van den Berg and De Langen, 2015) and thus try to direct cargo flows to best suit their vessel schedules (i.e. 'cargo follows ship' principle). These carrier haulage solutions might in the longer term somewhat undermine the strong position of merchant haulage in continental Europe and render the strong profile of upstream seaports for shippers and other cargo interests somewhat less relevant. Even if this trend materializes, the extensive intermodal offer of Hamburg and Antwerp can help shipping lines to venture into the hinterland and thus potentially serve as a retention mechanism favouring these ports.

Third, it remains to be seen how in the longer term the call for port cooperation will affect the traffic distribution between these upstream seaports and other domestic ports. We demonstrated that further public investments in the development and accessibility of Antwerp and Hamburg are increasingly made subject to cooperation schemes with rival ports located in the same country. APA and HPA follow a prudent approach in dealing with port cooperation issues as they want to avoid a scenario of far-reaching cooperation or even merger with other ports. By keeping the cooperation dialogue going, they hope to retain political and business support for further adaptive capacity building without giving up their strong focus on the individual port as the relevant system of analysis.

This paper contributes to existing literature on port system development by introducing processes of adaptive capacity building in upstream seaports. Existing traditional port system development literature identifies quite a few factors supporting a decreasing attractiveness of upstream container ports. The application of the adaptive capacity notion supports a more balanced discussion on the position of upstream seaports in port systems by linking their development paths and competitiveness to a range of economic, technological, social and political factors. When combined, these factors shape the willingness and capacity of a port to adapt to changing conditions. The role of collective action, retention mechanisms and politics in the process of adaptive capacity building and in shaping the development path of seaports has been largely overlooked in existing literature on port system development. The inclusion of these dimensions can also be regarded as a response to the call in Ng et al. (2014) for a new narrative in port geography research that emphasizes the spatial politics of port development. Furthermore, the conceptual insights presented in this research can constitute valuable inputs for a further extension and refinement of existing port competition models that typically only focus on costs, transit times and service quality elements when assessing a port's competitive position.

The presented study opens avenues for further research on port system development dynamics. Similar studies on ports embedded in other political, governance or market-related settings could add additional insights on how the building blocks and factors of adaptive capacity interact and result in specific actions and reactions in a multi-stakeholder environment. Another item for further study relates to the impact of port governance models on the enhancement of retention mechanisms in favour of specific ports. There is room for research on the contribution of coordination and the balance in financial strength among port authorities, market players and the government in building adaptive capacity. The latter is particularly relevant taking into account declining government funds in many countries, a greater autonomy and market-orientation of landlord port authorities (Verhoeven, 2010) and a strong market consolidation at the level of terminal operators, shipping lines and logistics service providers.

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Table 3. Arguments for and against (public) investments in upstream ports Antwerp and Hamburg (vs. coastal or estuarine alternatives)

Arguments used to keep investing in the competitiveness of upstream seaports	**Relevant to which stakeholders?**	**Counter arguments or comments used by opponents of the further development of upstream seaports**
U1. Closer proximity to inland markets and lower inland transport costs U2. '*Ship follows cargo*' argument => Strong cargo generating power due to location vis-à-vis hinterland U3. Benefits of combining gateway cargo and transhipment cargo (see also U7)	Market players (shippers, carriers, terminal operators, logistic companies, etc..)	NU1. Keeping upstream ports accessible for ever larger ships comes at increasingly high capital and maintenance dredging costs, often paid with tax payer money (see also argument C1 in section 2.1) . NU2. '*Cargo follows ship*' argument => Cargo is pulled to coastal locations as sailing upstream generates time costs for ship and cargo (see also C2). NU3. Relationship between inland transport costs, transit time and inland transport distance is often not linear, so proximity should be measured in terms of cost distance and transit time, not physical distance. NU4. Inland accessibility problems and diseconomies of scale in inland access in upstream urban ports (see also C3). NU5. Specific needs of growing transhipment market (see C2).
U4. Savings in environmental/ external costs of land transport	Community Environmentalist groups Policy-makers Market players	NU4. The external costs depend a lot on the modal split of the port and the 'ecologies of scale' in inland transport operations. NU5. Ships are big polluters when sailing or idling near urban areas. NU6. Using an upstream port for sea-sea transhipment generates higher external costs than when relying on coastal alternatives (see C6) NU7. The needed dredging works can negatively affect the morphology and ecology of river systems and can increase flood risks (see C1) NU8. Market players do not take into account external costs as they are not (yet) an integral part of the freight cost.
U5. Inland transport is becoming more expensive due to policies aimed at internalisation of external costs (emissions, congestion). So proximity to inland markets matters.	Market players Policy-makers	NU9. Ship operations are also becoming more expensive due to compulsory use of cleaner fuels (see Marpol Annex VI of IMO) and other environmental pressures, rules and measures. NU10. Depends again on the modal split of the port and the 'ecologies of scale' in inland transport operations.
U6. Economic significance of the port for the region (jobs, value-added and tax revenues) U7. Need to keep cluster, scale and connectivity effects and benefits of the existing upstream port and valorise earlier investments made. U8. Newer coastal ports lack cluster/scale effects in cargo generation and foreland and hinterland connectivity. U9. Avoid a doom scenario: a lack of investments in (nautical) accessibility and terminals will lead to a vicious cycle towards decline of the port and a decrease of its economic effects.	Policy-makers Community Market players	NU11. It is wrong to have a very local focus on the economic significance of a port. Coastal ports also create jobs and value-added and these effects go far inland (see C4). NU12. Earlier investments done in the upstream port should be considered as sunk costs in the discussion coastal vs. upstream port. Any investment in an upstream port should be evaluated against the development of downstream/coastal alternatives. NU13. Terminals are not the main sources of the economic significance of a port. Jobs and value-added creation will still exist even when large vessels cannot reach the port, e.g. via logistics or industrial activities in the port area. NU14. A bad scenario is to stubbornly support an upstream port which is doomed anyway. It is better to support the development of a deep-water coastal port which can act as a satellite for the logistic and industrial activities in the upstream port. NU15. Encourage/force intense cooperation between an upstream port and one or more adjacent coastal alternatives. This would help to benefit from port complementarity and to bring the discussion on macro-economic and cluster/connectivity issues to another (geographical) level.

Note: the numbering of arguments uses a U for 'upstream' and NU for 'not upstream'

Source: own compilation

Table 4. Main initiatives and actions initiated, coordinated or supported by the port authorities of Antwerp and Hamburg

Forces threatening upstream port development	Also	Action in Antwerp	Actions in Hamburg
C1. Nautical accessibility	NU1. NU7.	• Dredging programs (1970-1975, 1997-1998, 2010-2011) on Scheldt River to increase tide-independent draught and widen tidal windows • Balanced approach of accessibility, ecology and safety (cf. PROSES) • AMORAS-program for the processing of contaminated dredged material • Advances in vessel traffic management (VTS) & underkeel clearance • Scheldt terminals and Deurganckdock are ULCV ready. Delwaidedock terminals behind the locks pose increasing challenges for ULCV.	• Capital dredging program for upper and lower Elbe (decision phase) • Widening of navigation channel to allow two-way traffic along the entire river • Adjustment of turning circles in port area • Terminals are ULCV ready • Advanced VTS system • Vessel simulation and pilot training to prepare for new types of vessels
C2. Location vis-à-vis maritime networks	NU2. NU5.	• Port pricing incentives for feeder ships • Underlining advantages of combining gateway and transhipment traffic and cargo-generating power of port • Underlining of Antwerp as best option to reach core hinterland regions in EU when following a total logistics cost approach (sea-port-hinterland costs)	• Port pricing incentives for feeder ships • Underlining advantages of combining gateway and transhipment traffic and cargo-generating power of port • Most easterly located large container port in Northern Europe + hub for Baltic • Use of total logistics cost approach in marketing efforts to shippers
C3. Diseconomies of scale and land availability issues at established ports	NU4.	• Mobility plan to reach modal split target in containers of maximum 40% by road, minimum 40% by barge and minimum 20% by rail • Promotion of increased use of barge and railways through infrastructure development (e.g. new railway tunnel in port area, the rising of bridges on Albert Canal), intermodal and IT initiatives to bundle cargo, develop inland terminal network and set-up new intermodal services, pricing (e.g. kilometre fee for trucks using in highways in Flanders), etc.. • Completing the ring road around Antwerp via Oosterweel link (decision phase) • Significant land reserves: Flemish government defined port borders in GRUP (Gewestelijk Ruimtelijk Uitvoeringsplan) in 2013: ample space (> 1,000 ha) at Saeftinghe zone • Move of MSC terminal (joint-venture with PSA) from Delwaidedock (5 mio TEU capacity) to MPET terminal Deurganck dock (9 mio) to be completed in 2016. Re-orientation of Delwaidedock towards non-container activities. • Planning of a new Saeftinghe dock with first terminals to be ready by 2021 • Active port regionalisation strategy of APA (see Notteboom, 2006)	• Strong focus on and active involvement of HPA in rail network to serve hinterland regions in Germany, Alpine countries and East and Central Europe • Development of barge transport on Elbe River (to Czech Republic) • Cargo bundling platforms for intermodal transport • Hamburg Port Development Act (1982) defines the borders of the port area: limited land reserves in Altenwerder and Moorburg • Initiatives towards increased land productivity of terminals (innovation in handling equipment, terminal software, shorter dwell times, etc..): planned maximum capacities: CT Altenwerder 4 mio TEU, CT Burchardkai 6 mio TEU, CT Hamburg (Waltershof) 6 million TEU, CT Tollerort 4 mio TEU • Re-use of older port areas for new terminal function (e.g. Steinwerder area) • Active port regionalisation strategy of HPA (see Flämig and Hesse, 2011)
C4. Port/city dynamics	NU11.	• Large-scale waterfront redevelopment in obsolete port area ('Eilandje' zone) • Extensive program to increase public acceptance and image of port: recreation, landscape qualities, heritage, etc.. • Newest container terminal expansion are at least 10km from urban centres • Detailed measurement of economic impact for city and hinterland • Employment programs to attract low- and high-skilled people to work in port	• Large-scale waterfront redevelopment in obsolete port area (Hafencity project) • Extensive program to increase public acceptance and image of port • Detailed measurement of economic impact for city and hinterland • Employment programs to attract low- and high-skilled people to work in port

C5. Cost differentials in production factors capital, labour and or land		• Land rents are comparable to land prices in immediate hinterland • Labour costs are in line with average for Flanders region • Actions to attract (specialised) finance and insurance firms for port investment • Benefit from cluster advantages (chemical industry, commodities, etc..)	• Hamburg is a prominent city in advanced maritime services including finance, (European) headquarters of shipping lines, etc.. (Jacobs et al., 2011) • Strong marketing on attractiveness of city for business and living. • Selective policy in attracting activities combined with port regionalisation.
C6. Environmental restrictions	NU6.	• Incentive schemes to green port and shipping operations (e.g. Environmental Ship Index) • Very active role in ECOPORTS (cooperation among European ports on environmental issues) • Environmental management and reporting system, bi-annual presentation of a sustainability report, stimulate innovation in environmental issues in port area • Initiatives in the area of energy management	• Incentive schemes to green port and shipping operations (e.g. Environmental Ship Index) • Very active role in ECOPORTS (cooperation among European ports on environmental issues) • Environmental management system and energy management

Note: ULCV = ultra-large container vessel

Source: own compilation based on broad range of documents and formal and informal meetings