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Determinants of liner shipping network configuration: a two-region comparison

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Abstract The worldwide network of container transport services is becoming increasingly diffuse. The different strategies of shipping lines, the balance of power between shipping lines and shippers and constraints related to inland transportation all have a potential impact on the development of maritime shipping networks. Moreover, strategic alliances between the port and the shipping industry, which have both been driven by strong concentration processes and vertical integration, have a profound influence on the maritime network structure and also on the grade of integration of a region in the global maritime transport network. This paper seeks to understand the evolution of maritime networks in and between two differently developed regions. The focus is on the trade route and networks between the West Coast of South America and Northern Europe. The paper analyses the network structures and the behaviour of shipping lines in different economic contexts and port systems. Current and historical developments in the two regions under study have led to their relative position within the global maritime network and illustrate the potential implications of being peripheral or central in this network. The empirical results are compared with known strategies of shipping lines. The authors aim to answer the question of how far the configuration of hinterlands determines calling patterns and if strategic alliances and vertical integration reduce footloose behaviour of shipping lines. Further, we discuss how far, under the current configuration, shipping lines influence port development, and also the reverse situation of how far port accessibility and performance influence maritime network developments. The two region approach provides insights on the constraining factors of maritime network development between two differently developed regions and the associated implications for trade development.

Keywords Container liner networks · Europe · South America · Shipping lines · WCSA

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Introduction and conceptual framework

Port systems and their related hinterlands are configured diversely. These diverse regional configurations have to be embedded in global strategies. Literature on port development has elaborated greatly on the role of port-hinterland relations in shaping concentration patterns in port systems (see e.g. Taaffe et al. 1963; Hayuth 1981; Notteboom and Rodrigue 2005). While these models acknowledge a trend towards an

increasing concentration of maritime services in a limited number of load centres, the specific underlying dynamics and determinants of liner service network configuration are poorly addressed. Notteboom (2004) analysed the interdependency between liner service networks and hinterland networks from an operational perspective. While this analysis provided insight into the strong linkages between concentration patterns in shipping, ports and inland services, the pure operational focus of the paper does not allow for the full explanation of observed differences among regions in the world.

The worldwide network of container transport services is becoming increasingly diffuse. The different strategies of shipping lines, the balance of power between shipping lines and shippers and constraints related to inland transportation have a potential impact on the development of maritime shipping networks. Moreover, strategic alliances between the port and the shipping industry, which have both been driven by strong concentration processes and vertical integration, have a profound influence on maritime network structure and also on the grade of integration of a region in the global maritime transport network. These developments have to a certain extent made port development dependent on network strategies of global players.

Liner shipping network configuration is not only important to shipping lines. The structure of liner shipping networks and thus the relative position on the network of a port has a significant impact on the level of transport costs (Wilmsmeier and Hoffmann 2008; Márquez Ramos et al. 2006). Therefore the location of a port within the network becomes strategic for the competitiveness of trade through that port and subsequently raises important questions of what determinants lead to the configuration of current networks and how these could be influenced. In the past we have seen two strings of converging trends and processes in developing regions, one driven by shipping lines and the other by port development.

Thus, liner shipping networks between two regions are embedded in a wider context. The authors argue that these strategies depend on a complex set of determinants which result in an evolutionary development. In many cases such an explanation can only be provided in full by a thorough analysis of qualitative elements and market circumstances in the observed port system. The literature on port competitiveness, port competition and port selection offers more insights into the determinants of cargo shifts between ports; see e.g. Huybrechts et al. (2002). The literature on shipping networks and vessel operating considerations (including scale increases in vessel size) offers insights into additional factors influencing port system concentration levels, see e.g. Cullinane and Khanna (2000). The derived combination of determinants is presented in Table 1.

The paper seeks to understand the evolution of maritime networks in and between two differently developed regions. The decision to compare the trade route and networks between the emerging market of the West Coast of South America (WCSA) and the mature market of Northern Europe is based on the differences between the two regions in each of the four categories of determinants of liner service network configurations. Such differences require variable strategies from the liner shipping companies in order to maximise gains and efficiency in each region. Further, for a number of factors, e.g. draught, the least developed port of the network does determine the type of deployable equipment. The WCSA also lies outside the major trade lanes of the triade, so that the comparison allows for the consideration of the differences between peripheral and central regions in world trade.

The development of liner shipping networks

The development of liner shipping networks is primarily driven by the demand for containerised transport. The routing of containerised trade flows depends on the strategies of shipping companies and the demand of the shippers for specific service characteristics. As such, the location of a port or a region within the global liner shipping network is determined by the density of trade flows to and from a specific port or region. Shipping lines will determine their calling patterns and services structures in a region based on trade and port specific characteristics. The determinants taken into account are the number and dispersion of origins and final destinations, the density of cargo flows to andfrom these inland destinations and the existence of trade imbalances.

Based on these determinants, the service frequency (including the fixed days/hours of the week for departure/arrival), loading capacity of the transport

Table 1 Determinants for liner service network configuration

Port	Policies	Organisational/institutional	Hinterland specific
Port-hinterland access	Regional maritime policies (e.g. cabotage)	Port devolution and port operator model	Land accessibility as a function of infrastructures, transport services and logistics control
Port infrastructure endowment	Ease of border-crossings (e.g. customs formalities, free trade agreements, etc.)	Terminal awarding system	Cargo dispersion in hinterland
Port superstructure endowment	Policies regarding externalities (e.g. internalisation through road pricing systems)	Alliances with port operators	Market size and development potential
Accessibility (water)	Policies regarding intermodal corridors and dry ports	Vertical integration strategies of shipping lines and other market players	Quality/reliability of hinterland transport
Costs	(National) port policy (decentralised vs. centralised)	Economies of scale/scope in vessels/fleets and terminal operations	Hinterland transport costs and transport time
Productivity		Market strategy of liner shipping company (cf. with respect to market entry)	
Level of competition		Liner service strategies of strategic alliances	
Geographical spread of terminals			

Source Own elaboration

equipment used, number of port calls per roundtrip and stops at intermediate terminals (transhipment/relay) are all determined (see Fagerholt 2004). Bundling is one of the key driving forces of container service network dynamics (Notteboom 2004). Different types of complex bundling networks (i.e. line-bundling, hub-and-spoke, triangular, pendulum, butterfly, etc.) are used as an alternative to direct point-to-point container services. The advantages of complex bundling are higher load factors and/or the use of larger vessels in terms of TEU capacity and/or higher frequencies and/or more destinations served. The main disadvantages of complex bundling networks are the need for extra container handlings at intermediate terminals, longer transport distances and a higher dependency on service quality and synchronisation. These elements incur additional costs and as such could counterbalance the cost advantages linked to higher load factors or the use of larger vessels.

Once the shipping line has decided on the type of network structure, a port selection stage takes place. An abundant literature has addressed the issue of port selection (Barros and Athanassiou 2004; Chou et al. 2003; Guy and Urli 2006; Lirn et al. 2004; Malchow and Kanafani 2001; Murphy and Daley 1994; Murphy et al. 1992; Nir et al. 2006; Song and Yeo 2004; Tiwari et al. 2003; Chang et al. 2008; Wiegmans et al. 2008; Notteboom 2009). Typical port selection criteria relate to (a) the port's physical and technical infrastructure (e.g. nautical access, terminal infrastructure and equipment, hinterland accessibility profile); (b) geographical location; (c) port efficiency (e.g. port turnaround time, cost efficiency); (d) interconnectivity of the port (e.g. sailing frequency of deep-sea and feeder shipping services); (e) reliability, capacity, frequency and costs of inland transport services; (f) efficiency and costs of port management and administration; (g) availability, quality and costs of logistic value-added activities; and (h) strategic considerations of the shipping line concerned (e.g. market entry, strategies of alliance structure). The need for more of a supply chain oriented approach to port selection is echoed in recent work. Magala and Sammons (2008) argue that port choice is to be considered as a by-product of a choice of a logistics pathway. Port choice becomes more a function of the overall network cost and performance.

The design of individual liner services is often linked to other liner services of the same shipping line. Hence, shipping lines can have operational incentives to concentrate several calls in one or more hubs in a region. Cullinane and Khanna (2000) and Frémont and Soppé (2007) referred to the concentration of cargo at the level of liner networks of individual carriers. From a shipping line's perspective, the economies of scale in shipping, port operations and inland operations would favour a very limited number of load centres in a region. The advantages of concentrating cargo in only one or a few ports of call would be stronger at the level of a shipping line than at the port level, simply because

not all carriers will choose the same load centres in their liner service networks.

Container lines operate in an increasingly competitive and market-driven environment driven by global tendencies of market concentration in the maritime industry. Therefore, besides lowering shipping costs, container carriers enhance services to increase quality. Such factors for service enhancement include high sailing frequencies, reduction of shipping time, and a high level of reliability. This aims to satisfy shippers' interests in the minimisation of shipping and inventory costs and high reliability. The trade-off between customer demands and strategies of shipping lines has led to the development of a variety of calling pattern such as hub-and-spoke, relay, feedering, and direct services, including point-to point and line bundling services.

A profile of shipping networks in Northern Europe and South America

Connectivity in the global container liner network

This paper particularly focuses on liner shipping networks serving Northern Europe and the West Coast of South America. The two regions under study display different levels of integration on the global liner shipping network scene.

The countries in Northern Europe are among the most interconnected at a global level. A distinction should be made between, on the one hand, the Le Havre-Hamburg range ports and the ports in the southeast of England which are directly connected to global maritime networks (direct calls) and, on the other hand, the ports in the northern part of the UK, the Baltic and in Scandinavia which primarily rely on feeder services to the major container ports in the Le Havre-Hamburg range (i.e. Hamburg, Bremerhaven, Rotterdam, and to a lesser extent also Antwerp, Zeebrugge and Le Havre) to get access to the major trade routes. The countries on the three main markets in South America: North Coast South America (NCSA), East Coast South America (ECSA) and West Coast South America (WCSA) take significantly lower rankings in the level of connectivity (see Fig. 1). The WCSA is the least connected region in South America. In the period 2004–2008 the level of connectivity of the European countries remained rather stable, while the level of connectedness of the South American countries in comparison to other countries varies significantly.

Shipping lines' involvement in terminal operations

In an effort better to control costs and operational performance and as a measure to remedy against the effects of ever-decreasing schedule integrity, container shipping lines have been very active in securing (semi-)dedicated terminal capacity in strategic locations in recent years.

The growing involvement of shipping lines in European terminal operations is well documented in recent literature (see e.g. Parola and Musso 2007; Soppé et al. 2009). A substantial number of container terminals in North and South Europe feature a shipping line among their shareholders (in most cases as a minority shareholder). In particular MSC and CMA CGM, the world's second and third biggest container shipping lines, are very active in this field (Table 2). It has to be noted that Maersk Line's parent company, AP Moller-Maersk, operates a large number of container terminals in Europe (and abroad) through its subsidiary APM Terminals. Although this Netherlands-headquartered company advertises itself as 'an independent company within the AP Moller-Maersk Group, with an independent board and operating common user terminals for all container ship lines in Europe', it currently still mainly handles traffic of sister company Maersk Line. It does so in an ever-increasing number of European ports: APM Terminals is currently involved in the management of container terminals in the north-European ports of Aarhus, Bremerhaven, Rotterdam, Zeebrugge, Dunkirk and Le Havre. It has also been awarded a new terminal on the future Maasvlakte-2 in Rotterdam and in the future JadeWeser Port in Wilhelmshaven (the latter one in a 30/70 joint-venture with Eurogate).

The involvement of shipping lines in ports on the WCSA is significantly different. A number of ports (see Table 2) in Chile are operated by SAAM who belongs to CSAV, which grants CSAV significant influence in its Chilean home market. AP Moller-Maersk has been active in the region with the plan to develop a new terminal in Posorja, Ecuador.

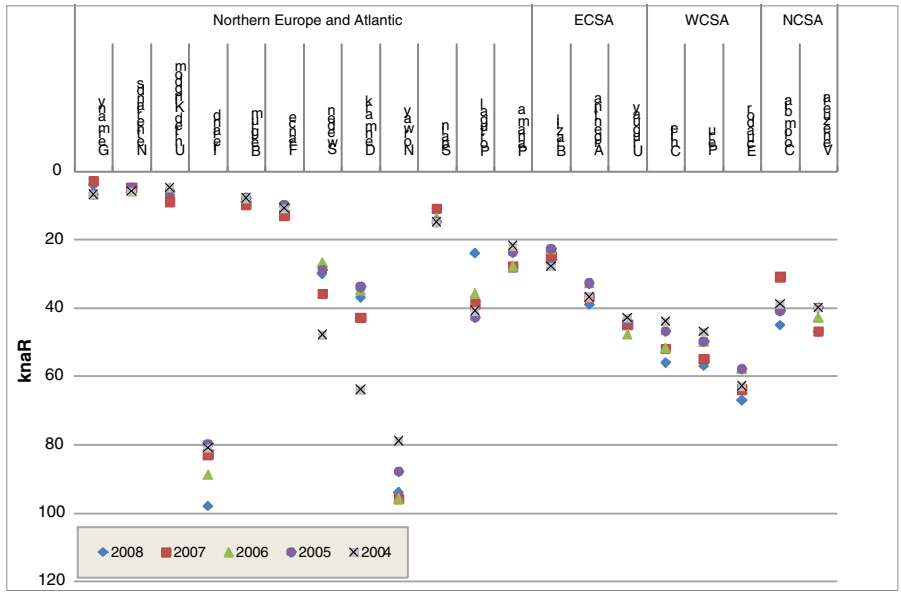

Fig. 1 Level of direct connectivity in global container liner shipping network, 2004–2008. *Source* Own elaboration based on LSCI, UNCTAD, various years

The influx of global terminal operators

Both regions have witnessed an influx of international terminal operator groups.

In Northern Europe, this influx commenced in the second half of the 1990s (see also Notteboom 2002). Global terminal operators such as Hutchison Port Holdings, PSA and DP World initially focused their entry strategies on the main load centres in the Le Havre-Hamburg range and the UK Southeast Coast (mainly Thamesport, Southampton and Felixstowe). In the last couple of years, however, the investment strategies have extended to secondary seaports in the system and inland terminals. The current European portfolio of leading container terminal operators is presented in Fig. 2. The financial involvement varies between full ownership to minority shareholdings.

In South America, international terminal operator groups slowly started to appear at the beginning of the 1990s. This development is closely linked to the port reform processes in the region, as these offered good possibilities for entry (see also Sánchez and Wilmsmeier 2005). In contrast to Northern Europe, a number of regional terminal operator groups compete with the known global terminal operators. Companies such as Hutchison Port Holdings, PSA initially focused on Panama as the main strategic point in Latin America, but not on the WCSA ports. Until the end of the 1990 Valparaiso, Chile, was the only port with an international terminal operator, HHLA, as a shareholder. All other Chilean ports were operated by regional terminal operators (SAAM, SSA, and Dragados). However, with a continuously growing market throughout the 1990s and after the turn of the millennium, global terminal operators competed strongly over concessions for the main ports, when the opportunities arose. Today, DP World is involved in Callao, Peru. In the Ecuadorian market ICTSI are active in Guayaquil and Hutchison in Manta. Buenaventura, Colombia, is operated by TCB. The current WCSA portfolio of leading container terminal operators is presented in Fig. 3. The financial involvement varies between full ownership to minority shareholdings.

Calling patterns and hinterland structures

Port development and the structure of hinterlands are important determinants for shipping line strategies. Shipping lines will tailor their calling patterns depending on a region's hinterland structure especially since door-to-door services play an increasing role in the competitiveness of services. Figure 4 provides a generic representation of liner services and hinterland configuration using the classification presented by Notteboom (2004).

Intercontinental shipping services in relation to Northern Europe typically take the form of line-bundling container services with three to five ports of

Table 2 Container terminals in Northern Europe and West Coast South America in which shipping lines currently hold, or will hold, a (minority) share, 2008

Shipping line	Terminal	Port	Country
MSC	Northern Europe		
	MSC Home Terminal	Antwerp	Belgium
	Terminal de l'Océan, Bougainville Quay	Le Havre	France
	Port 2000	Le Havre	France
	MSC Gate Bremerhaven	Bremerhaven	Germany
CMA CGM	Northern Europe		
	Antwerp Gateway	Antwerp	Belgium
	Container Handling Zeebrugge	Zeebrugge	Belgium
	Nord France Terminal International	Dunkirk	France
	Terminal de France	Le Havre	France
	Europe Terminal	Le Havre	France
	Americas Terminal	Le Havre	France
	Rotterdam World Gateway (planned)	Rotterdam	The Netherlands
(C)YKH-consortium	Northern Europe		
	Deurganckdock Terminal (JV with PSA HNN)	Antwerp	Belgium
	Euromax terminal (JV with ECT)	Rotterdam	The Netherlands
NYK	Northern Europe		
	Minority shareholding in ECT terminals (Hutchison group)	Rotterdam/Amsterdam	The Netherlands
	West Coast South America		
Hapag Lloyd	Northern Europe		
	Container Terminal Altenwerder	Hamburg	Germany
SAAM (CSAV Group)	West Coast of South America		
	San Antonio Terminal Internacional (STI)	San Antonio	Chile
	San Vicente Terminal Internacional S.A.	San Vicente	Chile
	Terminal Puerto Arica S.A.	Arica	Chile
	Iquique Terminal Internacional S.A.	Iquique	Chile

Source Specialised press and company websites

call per loop. The most common calling patterns involve: (a) one call in the Benelux, one call on the UK East Coast and one call in a German port; (b) two calls in the Benelux, one call on the UK East Coast and one call in a German port; (c) one call in the Benelux, one call on the UK East Coast, one call in northern France and one call in a German port; (d) two calls in the Benelux, one call on the UK East Coast, one call in northern France and one call in a German port. This implies that the alleged footloose behaviour of shipping lines is limited in space. Carriers do not select one north-European mega-hub but select three to five regional load centres per loop with partly overlapping hinterlands.

Sea-sea transhipment volumes in the Le Havre-Hamburg range do not exceed 40% of any port's throughput. The existing transhipment volumes in the ports of Hamburg, Bremerhaven, Rotterdam, Zeebrugge, Antwerp and Le Havre are mainly oriented towards the Baltic States, Scandinavia, the United Kingdom and the Iberian Peninsula. Thus, the main load centres primarily function as gateways between deep-sea liner shipping networks and extensive intermodal hinterland networks. The competitiveness of the load centres in the northern range is largely determined by the ports' capabilities in dealing with container flows to the immediate and more distant hinterland regions (see inland corridors

Fig. 2 Presence of global terminal operators in container ports of Northern Europe, 2008. *Source* ITMMA, based on company websites

to overlapping hinterlands in Fig. 4). The future spatial development of liner schedules to and from northern Europe will largely depend on the balance of power between shipping lines and shippers. The higher the bargaining power of shippers vis-à-vis shipping lines the more pressure for direct calls as this will shift the 'cargo follows ship' principle to the 'ship follows cargo' principle. For example, shipping lines are massively prepared to call at the upstream ports of Antwerp and Hamburg in large part because of their high cargo generating performance and the savings they can make in onward inland transportation distances. The optimal liner network design is not only a function of carrier-specific operational factors, but more and more of shippers' needs (for transit time and other service elements) and of shippers' willingness to pay for a better service.

The calling patterns in South America are organised in a clearly different manner, partly as a result of the limited overlap among the hinterland capture areas of the respective ports. Transhipment between main lines is almost exclusively realised in the Panamanian ports. Along the WCSA transhipment is realised to serve secondary ports in the respective country, but a relatively low density of bi- or multilateral feeder services exists. Competition between the load centres on the WCSA is limited due to isolated hinterlands. Competition between ports over a similar hinterland can only be found in the Central Chile port range, where Valparaiso and San Antonio compete for the same market (for details see Sánchez et al. 2008). The current situation is a result of (a) relatively long distances between economic centres, (b) lack of hinterland and cross border infrastructure development for road and rail; and (c) barriers to regional trade e.g. customs inefficiency, which contributes to high overland transport costs (see also Sánchez and Wilmsmeier 2005). Consequently, port choice on the WCSA is basically restricted to Chile. The other countries only have one "point of entry" thus creating "obligatory" port calls for shipping lines.

Fig. 3 Presence of global terminal operators in container ports of South America, 2008. *Source* updated, based on Sánchez and Wilmsmeier (2005)

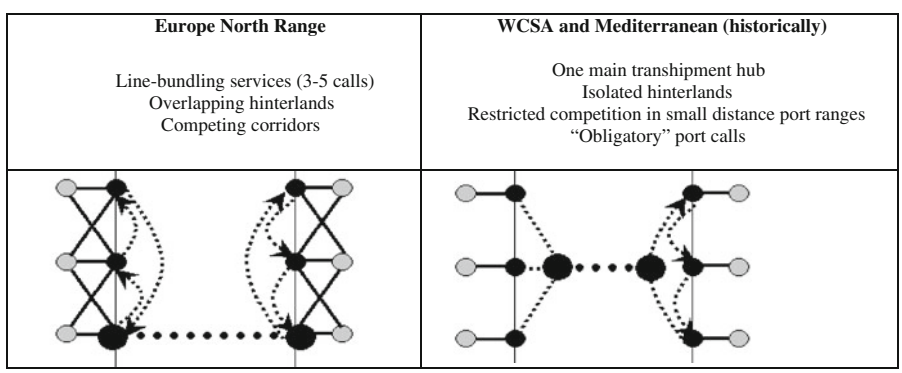

Fig. 4 Hinterland access and calling patterns. *Source* based on classification presented by Notteboom (2004)

Recently, new strategies can be observed which in the medium and long term may lead to a significant shift in the port hierarchy on the WCSA. In 2006 Maersk altered the strategy for the WCSA. With the appearance of a direct WCSA- Europe service the company terminates the WCCA/Peru loop calls in

WCSA, eliminating 884 TEUs per week in the WCSA—North America trades. The capacity expansion using the direct WCSA-Europe service thus allows Maersk to use this service to feeder to its Asia and North America services using Panama as a hub port and economies of densities by consolidating traffic along the WCSA and consequently reaching for economies of scale on the transpacific voyage leg.

The evolution of container liner shipping networks between Northern Europe and South America

The previous sections have highlighted that the port systems in Northern Europe and South America show differences with respect to connectivity, the involvement of shipping lines and global terminal operators in the container scene, the existing calling patterns and the structure of hinterlands. While the previous sections dealt with each of the port systems individually, this section particularly analyses the liner shipping networks in place to connect the North-European and South-American port systems.

The investigation of container liner shipping networks between Northern Europe and South America is based on direct information published by shipping lines and secondary information from Containerisation International and World Liner Supply - ComPair Data. The aim was to depict the development and evolution of the container liner services between Europe and the West and East Coast of South America in the period from 2001 to 2007. The authors evaluated the data on evidences for a number of key restrictive factors for network evolution and calling patterns that reach beyond pure market size.

The configuration of ports and hinterlands can create very different environments. Hinterlands with high accessibility from more than one port are drivers to inter-port competition (e.g. Le Havre—Hamburg port range or Central Chilean Port range). Ports with isolated hinterlands potentially create 'obligatory' port calls (e.g. Guayaquil). While obligatory port calls are not, per se, barriers to liner shipping network development, they can infringe on developments if they help to cause or are concomitant with a lack of development in port infrastructure and superstructures. For example, the fact that the ports of Callao, Peru, and Guayaquil, Ecuador, to this day do not have gantry cranes in operation has had direct implications on all services along the WCSA which called in these ports. Hence, service is only possible with geared ships, which can be referred to as an impediment to efficiency beyond a certain threshold of container movement per hour.

We found indications that failed port development not only infringes on local development and trade facilitation, but also constrains efficiency in the destination/origin regions. A strong indicator for the restrictions in achieving economies of scale is the evolution of ship size in trades between WCSA and Europe. This is driven by the size restrictions given by the Panama Canal crossing, low draft levels (i.e. Guayaquil: 10 m) and restrictions on the ship type as mentioned before (see Figs. 5, 6). As such, the weakest part in the network determines the potential efficiency on a trade route. The regions at each end of the trade route under comparison present integrated and highly connected hinterlands on one end of the route and partly isolated and disconnected hinterlands at the other end of the route. Since shipping lines are seeking new solutions beyond the factor of volume, especially factors such as reliability are gaining as a response to customer orientations. In this environment, low productivity, delays and ineffective and inefficient handling can create significant feedback effects along a whole trade route. According to Drewry (2006), observed schedule reliability of services scored only 59% for services between Europe/Med and WCSA. Thus shipping lines try to maximise their efficiency in these markets based on different strategies. One strategy is trying to avoid unreliable ports and as such reduce the overall impacts on the network.

This contributes to the development of hub-and-spoke networks in which the shipping lines, next to using economies of scale and density, seek to increase the overall efficiency on main routes (see Maersk example for WCSA above. For further reading see also Sánchez and Wilmsmeier 2005). By leaving less developed ports on the periphery of the network, the hub ports can be used as buffer zones which protect the main routes from the negative feedback effects described above.

Further, such a setup also allows for a more adequate material input and in return reduces operating costs. These developments create repercussions at the level of connectivity, especially in developing regions. Data on the evolution of deployed capacity by route reveals the turn towards hub-and-spoke

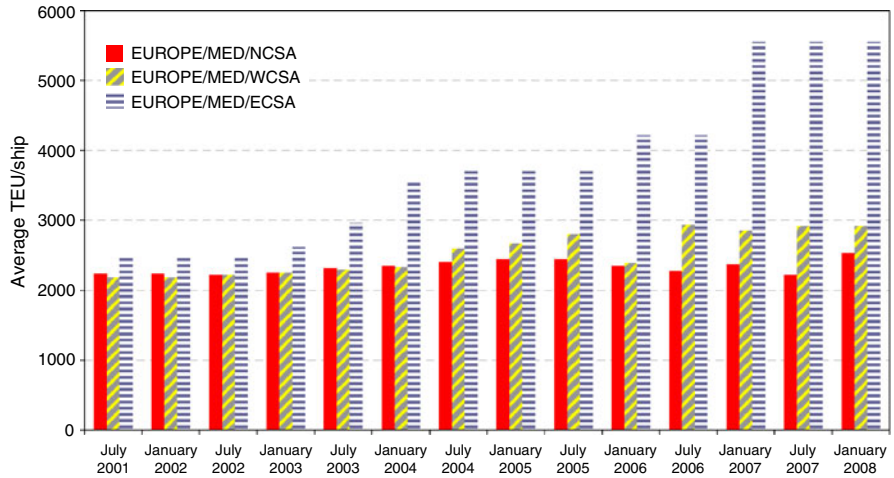

Fig. 5 Ship size development WCSA—ECSA—Europe Trade routes. *Source* Authors, based on Containerisation International various years

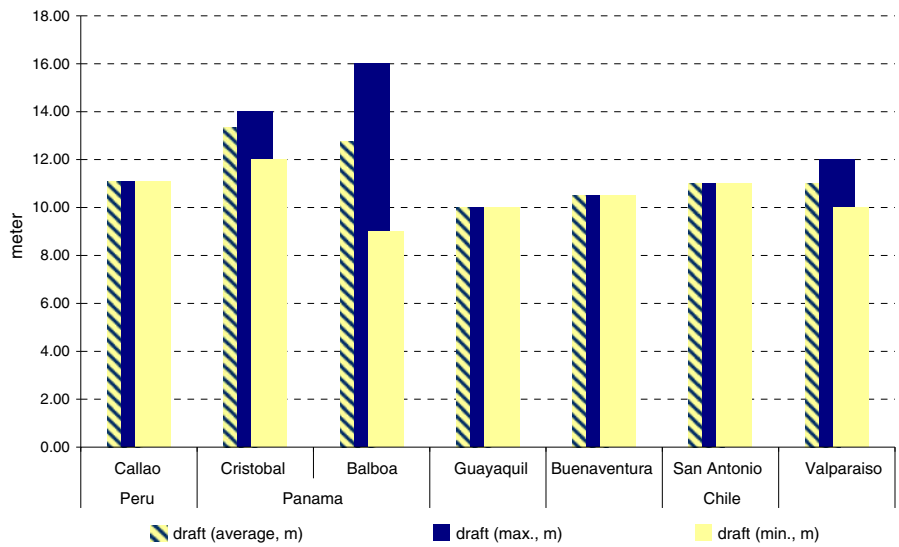

Fig. 6 Draft restrictions along the WCSA. *Source* Authors, based on port websites

strategies in the trade between WCSA and Europe (see Fig. 7). Between January and July 2006 the capacity between the Mediterranean and the NCSA as well as for Europe- NCSA suddenly increased, while at the same time the capacity deployed in direct services between the WCSA and Europe and the Mediterranean dropped. This development was counterbalanced by a significant capacity increase between NCSA and WCSA. Such a development depicts the rise of the NCSA as a hub region for trades for the Europe-WCSA trade route. There seems to be significant evidence that the port infrastructure situation and its effects on liner services contributed to this development.

The authors argue that hub port development in a region can, from a global perspective, reduce the levels of port hierarchy. Additionally, a gateway port might evolve to have less direct services in a hub-and-spoke network, but the number of destinations that can be reached, with only one transhipment, can increase significantly.

Being peripheral in a network, limited market size and lack of port development potentially leads to a reduced level of competition in the liner market, since the market, even under growth conditions, lacks attractiveness for new entrants, or entrance to the market is restricted due to quasi monopolistic market structures. For a detailed discussion on developments

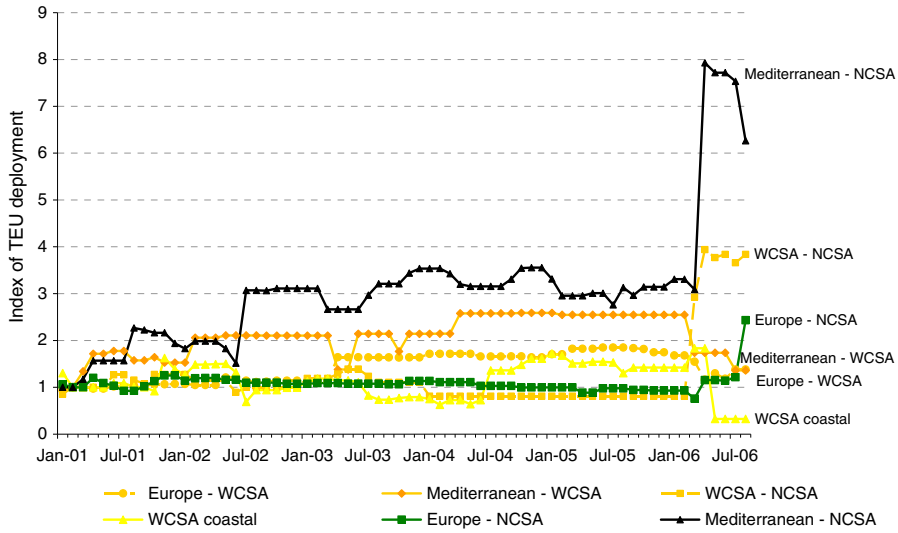

Fig. 7 TEU deployment evolution by route, 2001–2006. *Source* Authors based on Containerisation International-online various years

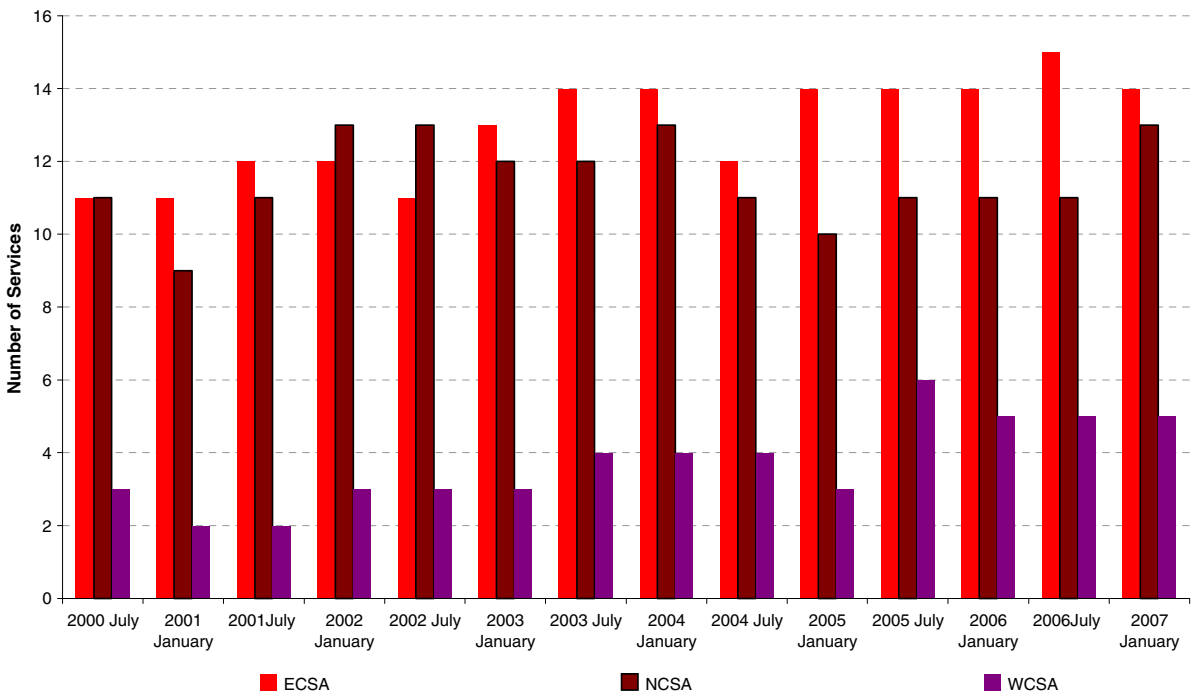

Fig. 8 Container liner services evolution between South America's coasts and Europe. *Source* Authors based on Data from World Liner Supply various years

in WCSA we refer to Wilmsmeier and Sánchez (2008a, b). The analysis of the number of services and shipping lines that serve the region underlines the suspicion towards this direction. In the period under study, the supply of services to Europe on the trade route grew, while the number of service providers underwent a strong concentration process (Fig. 8).

The liner shipping market has experienced strong concentration. Besides the effect of global mergers and acquisitions, small service providers were forced out of the market. This has led to the situation that the Europe—WCSA trade routes are dominated by only six shipping lines. Interestingly, Chilean CCNI, a niche carrier, was able to sustain a significant market

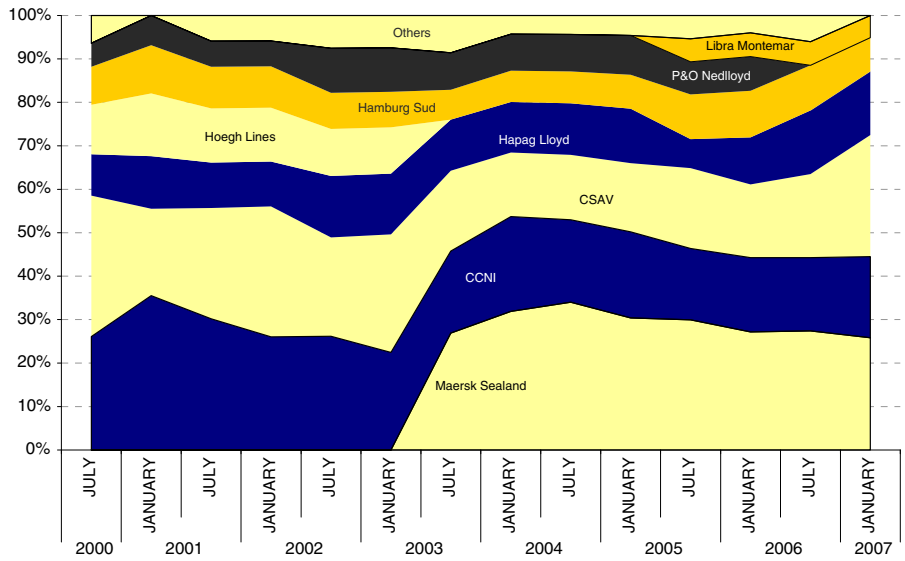

Fig. 9 Development of market shares in terms of ship capacity supply, WCSA - Europe, 2000–2007. *Source* Authors based on Data from World Liner Supply various years

share even against the market entrance of Maersk in 2003 and after a short period was able to make up for the prior lost shares (Fig. 9).

Finally, an analysis of connectivity shows that connectivity and shipping options vary significantly for the ports on the WCSA in relation to the ports that can directly be reached in Northern Europe. Figure 10 illustrates the restrictiveness in terms of direct connectivity between the regions. Thus, shippers on a significant number of relations face at least one transhipment. It can also be argued that the need for transhipment potentially increased with the shift towards a more hub-and-spoke like structure for traffic between Europe and WCSA. This effect increases with geographical closeness, leaving the pacific ports Buenaventura and Guayaquil as the most affected by this development.

Discussion: The evolutionary patterns of liner shipping network configuration

Based on the presented evidence, the last section of the paper presents a mind map of determinants to show how the trends in the liner shipping industry and port development shape liner shipping network configurations (see Fig. 11). Empirical evidence suggests that shipping network evolution and port development go hand in hand with the development of a trade route and historically have developed in a somehow parallel way. These developments are converging through vertical integration in the maritime and port industry. The specific trade route analysis also shows that in a 'penetration period' shipping lines try to develop new markets and aim for a global coverage. This is especially observable for small and medium-sized markets see e.g. Guy (2003) for South America.

The authors find further evidence that shipping lines move towards consolidation in those markets, as the market size is not sufficient to allow the realisation of economies of scale and density in a highly competitive environment. It can therefore be observed that shipping companies tend to create alliances or other forms of agreements to maintain market presence, but at the same time reduce risk levels and competition.

Changes in market organisation have clear implications on the network level. Figure 12 points out that liner shipping networks seem to follow a specific evolutionary pattern on trade routes between differently developed regions. We identify four phases in this evolutionary pattern:

- During the first phase, the liner shipping network is determined by point-to-point direct services with a strong local or regional orientation. The liner service network is highly regional in

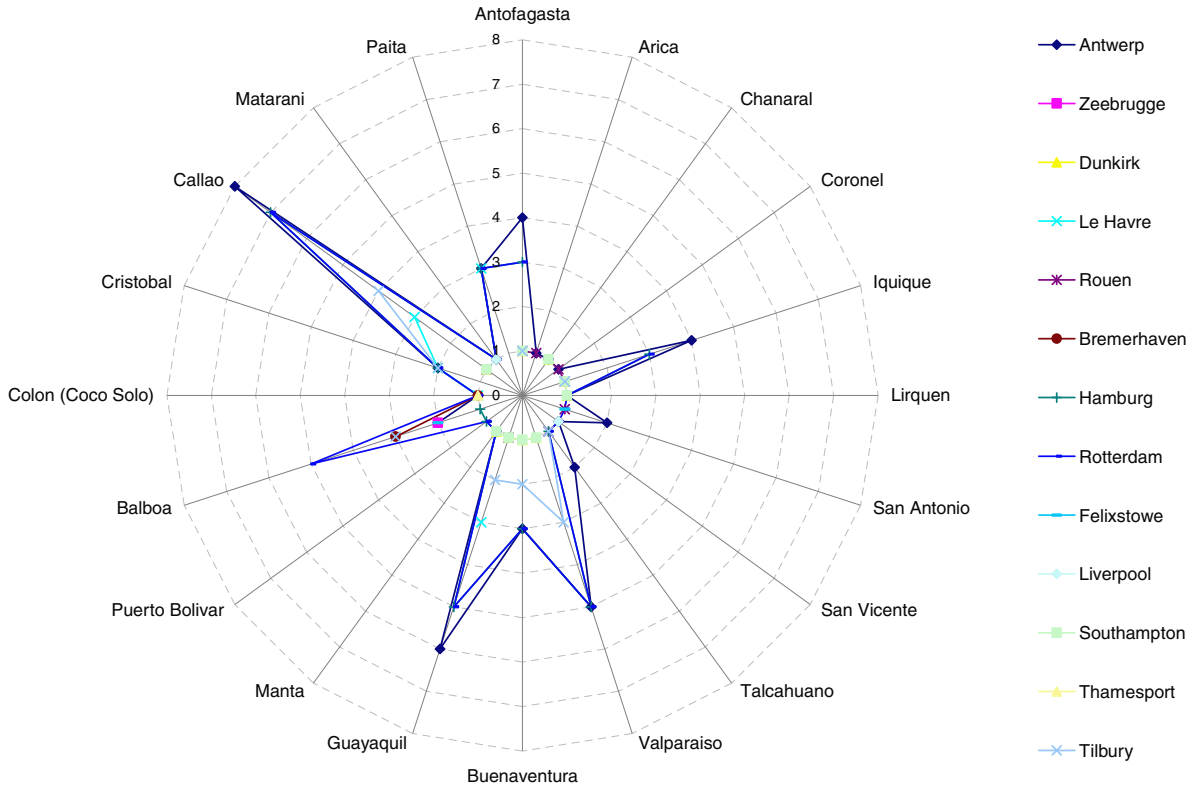

Fig. 10 Number of services connecting ports in WCSA and Europe. *Source* Authors, based on Containerisations Online, November 2006

orientation and interconnectivity to the overseas markets is poor. Government involvement in the port sector is typically high while at the same time international market players (shipping lines and terminal operators) face limited possibilities to enter the region;

- In the second phase, the region and the market players seek a higher connectivity to overseas markets by consolidating cargo in an intermediate hub. The first tendencies towards a hub-and-spoke network emerge. The evolving liner service network configuration increases the dependency of the port system on indirect services via the hub, while direct regional services start to lose their importance. The growing connectivity of the port system to overseas markets increases the region's attractiveness to shipping lines and international port operators. The rising pressure on port infrastructures and the need for a professional and commercial approach to market dynamics urges government bodies to revise their port policy. Often, the local/regional/national government will seek the start-up of a port devolution process to face the mounting infrastructural and operational port challenges linked to the opening up of the region to the world market. The resulting changes in the port governance and policy framework enable international stevedoring groups and shipping lines to access key assets in the local ports and to seek control over terminal operations;
- In the third phase, port traffic growth leads to a further outreach of the hub-and-spoke network and the inclusion of new ports in this pattern. International port operators further penetrate into the market and state intervention in ports is strongly reduced. Main lines are growing and smaller regional services start to develop again in a secondary network;
- In the fourth phase, the market size of specific ports has grown to such an extent that shipping lines can now offer direct services from these ports to overseas regions. The hub sees its functional position undermined. In view of maintaining its role in the network, the hub will seek liner service

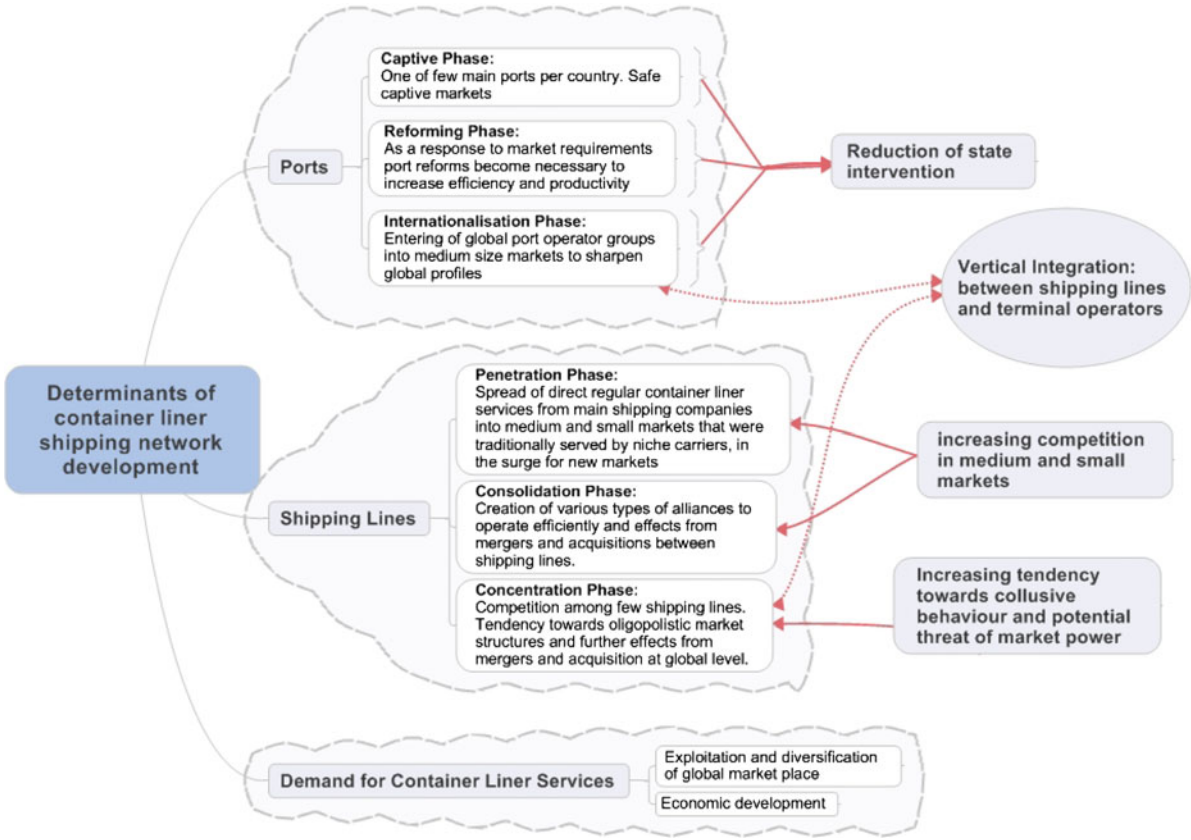

Fig. 11 Shaping container liner network configurations. *Source* own elaboration

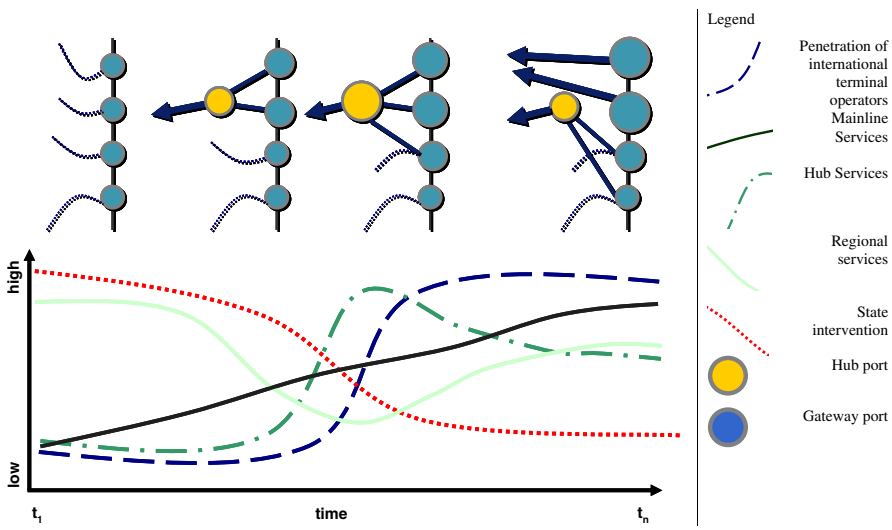

Fig. 12 A generic model for the evolution of liner shipping networks between two trade regions. *Source* own elaboration

connections to smaller ports in the region which still lack connectivity to overseas market. Consequently, the terminal activity in the hub shifts in geographical terms and a new secondary hub-and-spoke network emerges involving other gateway ports.

The port system in the West Coast of South America is slowly shifting from phase 2 to phase 3, while the Baltic port system in Europe displays a pattern closely resembling phase three. As container volumes in the region are growing strongly, major Baltic ports such as Saint-Petersburg (1.66 million TEU in 2007), Kotka in Finland (570,000 TEU) and Gdynia in Poland (614,000 TEU) are among the ports aiming for direct calls of deep-sea vessels (shift to phase four). However, up to now, the market continues to rely on the hub-and-spoke solution centred on the intermediate hubs in the Le Havre-Hamburg range. The latter port range is a clear example of phase four, with some of the gateway ports acting as hubs to smaller ports in the region.

Conclusion

This paper aimed at providing a deeper understanding of the factors that influence liner service network configuration. Liner service network development is not only the result of exogenous factors related to trade developments and the dispersion of economic activity in the hinterland. Endogenous factors linked to the local port environment, access to the hinterland, the strategies of market players and government policy have a clear impact on how regions will connect. Liner networks remain highly complex in nature as they are an outcome of the interplay between many factors and actors.

The focus in the paper was on the trade route and networks between the West Coast of South America and Northern Europe. It was demonstrated that current and historical developments in the two regions result in a different relative position within the global maritime network. The two region approach provided insight on the constraining factors for maritime network development between two differently developed regions and the attached implications for trade development. We derive the following main conclusions:

- The liner shipping network reflects the strategic tradeoffs between market size and market coverage. Hub ports develop especially where economies of scale in port calls to individual ports cannot be realised by calling at individual ports. In regions with 'disconnected' hinterlands an interconnected network is formed;
- The development of the hinterland can impede or undermine the development of hub-and-spoke networks. This is especially true in the case of South America where the discontinuous hinterlands (Notteboom and Rodrigue 2005) are only connected to one port;
- Port infrastructure endowment plays a strategic role in the development of liner shipping networks. Lagged port development moves ports towards the periphery of the liner shipping network;
- Vertical integration in the maritime sector leads to changes in the strategies of liner shipping networks.

The identification of four phases in liner shipping network development between two regions contributes to the literature and regional shipping market analysis because it allows for the classification of the current market situation and can potentially hint towards future development of the liner shipping network in a specific region. Consequently, the generic model can help to develop strategies and policies in order to mitigate the potential negative effects of market concentration.

Further research should look into the effect of market concentration in more detail, especially for medium and smaller sized markets. Further potential effects on transport costs should be analysed in this context as presented for the case of the Caribbean by Wilmsmeier and Hoffmann 2008, who find strong evidence of monopolistic behaviour in the Caribbean and excessive costs on transhipment routes where no competition takes place. In a global economy, such potential market failures may pose significant barriers to the competitiveness of these more peripheral regions and as such may hinder economic development.

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