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David Guerrero

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## **Chapter 2. A global analysis of hinterlands from a European perspective**

**David Guerrero**

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### **INTRODUCTION**

This work examines the main determinants of hinterland evolution through a literature review. It explores the possibilities and challenges for inter-regional comparisons, and suggests a tentative common framework. The chapter mainly deals with European issues, though complementing them by integrating studies done on other regions. The literature review covers mainly the last two decades, during which containerization have reached maturity in most world regions.

The chapter is organized as follows. The first section introduces some historical elements to understand the specificity of European hinterlands, mostly shaped during the 16<sup>th</sup>-18<sup>th</sup> century. The next section presents the current situation of European ports compared with the rest of the world. The third section reviews current determinants of hinterland expansion and shrinkage in various regional contexts. The conclusion discusses the need for pushing further the elaboration of a common framework notwithstanding challenges for inter-regional comparison.

### **ON THE HISTORICAL ORIGIN OF EUROPEAN HINTERLANDS**

The current spatial configuration of European hinterlands has been largely prefigured at the early days of capitalism, during the 16<sup>th</sup>-18<sup>th</sup> centuries. Major ports such Antwerp and Rotterdam benefitted from their position within and old-established megalopolis stretching between the South of England to the North of Italy. In the early 16<sup>th</sup> century, with the development of Atlantic trade, Antwerp was preferred over Lisbon by the most important European merchant families, mostly German (Braudel, 1982). In the early 18<sup>th</sup> Century, the Dutch were considered '*the Carriers of the World, the middle Persons in Trade, the Factors and Brokers of Europe*' (Defoe, 1728, quoted by Braudel, 1982, p. 239). At that period, '*a large proportion of colonial produce was bought by the Dutch at*

*the auctions held by the East India Company; they also bought a great deal of tobacco, sugar, sometimes grain, [...] woollen cloths – [...] were stored in warehouses in Rotterdam and Amsterdam before being re-exported, chiefly to Germany*’ (Defoe, 1728, quoted by Braudel, 1982, p. 261).

The later development of inland connections along the Rhine –waterways, during the 16th-18<sup>th</sup> centuries and railways, during the 19<sup>th</sup>- further consolidated the dominance of Northern port cities, to the detriment of Northern Italian urban centers. Hamburg also greatly benefitted from Atlantic trade, rising in the 17<sup>th</sup> century as an important European financial and trading center, connecting England, Germany, the Baltic, Central and Eastern Europe, and the Mediterranean. Its emergence as a global trade center was also tightly connected to the development of an urban hierarchy of commercial cities within Germany (Lindbergh, 2008).

In Rotterdam, Antwerp and Hamburg, historical networks undoubtedly favored early competition for common inland markets, prefiguring the contemporary competitive context of containerization. Regions such as the East of France (Demangeon, 1918), the South of Germany, and many countries in Central and Eastern Europe (Morgan, 1948) historically relied on several ports for their maritime trade. The port orientation of these regions often changed depending not just on market conditions, but also on the economic policies favoring or limiting the development of certain ports. At the end of WW1, Demangeon warned against protectionist policies aiming to promote the development of national ports by introducing special taxes to trade, *‘artificially constraining the movement of foreign cargo trying to reach the sea through the shortest path’* (Demangeon, 1918, 314, translated by the author). Because French manufacturers could not always find the materials they needed within France, they paid surcharges to import them through the port of Antwerp. This put French manufacturers in a position of inferiority with regard to their German competitors (Demangeon, 1918, p. 337).

The importance of political barriers was later confirmed by Morgan (1948), who considered them as one of the main factors shaping hinterlands, together with market conditions. Based on the cases of Hamburg and Bremen, Morgan stressed on the need to analyze separately the regions next to the ports, often captive (*primary or “captive” hinterland*) and those largely disputed between several ports (*secondary or “contested” hinterland*). Eastern France, Southern Germany, and many Central and Eastern European countries are good examples of secondary hinterlands.

Before closing this historical parenthesis, there are two key lessons which can be drawn:

- The spatial organization of hinterlands in mainland Europe has been strongly shaped by commercial and transport networks developed in the 16-18<sup>th</sup> centuries. Although there has been some geographical disconnection between the ports and

the trade centers during the 20<sup>th</sup> century (Ducruet, 2006), hinterlands remain path dependent.

- Despite an early development of liberalism in many sectors, European states have often promoted protectionist port policies. With the end of WW2 and the later development of a common market, internal customs barriers were progressively eliminated. However certain habits remained, as evidenced by the way in which the French trade passing through Antwerp and Rotterdam is still called as “diverted” in many official documents (Court of Auditors, 2006). France is probably not the only country employing this concept.

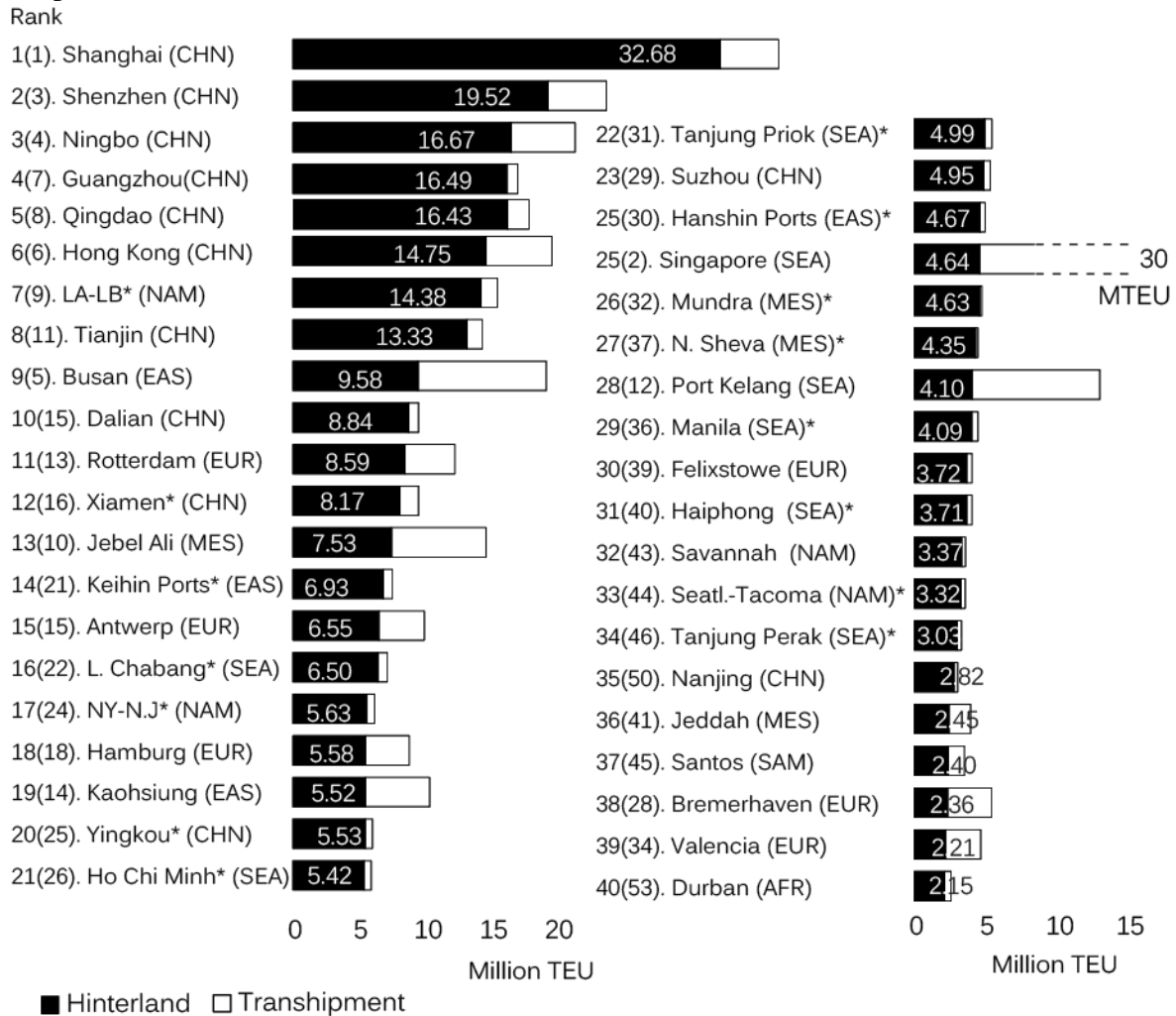
## **ANALYZING GLOBAL HINTERLANDS IN A CONTEMPORARY CONTEXT**

In the last three decades, with an increasing participation of emerging economies to global trade and the spread of containerization, the position of European ports had rapidly weakened (Guerrero and Rodrigue, 2014). In 1985, three European ports were in a global top-10 dominated by Rotterdam. In 2016, the top-10 ranking was dominated by six Chinese ports (Figure 2-1) and the first European port ranked 11<sup>th</sup>.

This ranking (Figure 2-11), based on the hinterland throughput of ports, brings to light a hierarchy of container ports slightly different than the usual one including transshipment traffic (rank in brackets). On the one hand, it relativizes the importance of transshipment hubs in Asia (e.g. Singapore), the Middle-East (e.g. Jebel Ali) and the Mediterranean (e.g. Valencia), with limited inland markets. So-called “pure hubs” such as Tanjung Pelepas (19), Colombo (26), and Algeciras (32) do not even show up, although the latter also serves as a gateway port for the capital region Madrid. On the other hand, it highlights cases where a relatively weak transshipment function is partially offset by large inland markets. Chinese ports, already prominent when including transshipment, are even stronger as gateways. The same happens to top US and Japanese ports, albeit on a lesser scale. Within the top-40, the best represented regions are: China (12), Rest of Asia (12), Europe (6), Middle East & South Asia (4), and North America (4). The minor contributions of South America (1) and Africa (1) reflect the marginal contribution of these regions to the global container market.

Focusing on hinterland throughput doesn't imply to deny the advantages of sea-sea transshipment for ports, which usually facilitate the achievement of scale economies in cargo handling, intra-port competition and so on, eventually contributing to expand their inland markets. However, transshipment throughput is very different from the one generated by imports and exports. Moreover, transshipment throughput implies doubly counting, which artificially increases its importance. In view of these issues, there is a

strong need to separate both types of throughput, in order to enable inter-port comparisons.



In brackets, ranking based on total throughput, including transshipment.

CHN: China, EAS: Rest of East-Asia,  
 SEA: South-East Asia,  
 MES: Middle-East and South Asia,  
 AFR: Africa, EUR: Europe,  
 NAM: North America, SAM: South America.

Sources: Drewry's (2016), World Shipping Council (2016)

\* Transshipment throughput estimated by the author based on the average transshipment rate by region shown in Drewry's (2016)

Figure 2-1. Top global port gateways in 2016

Source: own realization based on Drewry (2017)

## DETERMINANTS OF HINTERLAND EXPANSION AND SHRINKAGE

A number of factors affect the extent and degree of competition of port hinterlands. Understanding these factors is an issue that has been widely studied in the academic literature.

One of the key factors that influence the success of ports is their geographic proximity to inland markets. This was demonstrated in several regional contexts such as Europe (Charlier, 1990; Garcia-Alonso & Sanchez-Soriano, 2010; Guerrero, 2014), Japan (Itoh, 2013; Xu & Ito, 2017), USA (Pitts, 1995; Malchow & Kanafani, 2004), South America (Tiller & Thill, 2017), and China (Wang et al., 2017)). However, the impact of distance on inland flows varies considerably depending on the shape and the geographic character of countries. Some works using gravity models showed that the sensitivity of flows to inland distance is lower in large countries with broad inland regions, such as China (Wang et al., 2017) and USA (Pitts, 1994), compared with much smaller countries such as France (Guerrero, 2014, 2019) or Italy (Ferrari et al., 2011). In these countries the lack of alternatives to road haulage results in relatively high values of inland friction. The theoretical explanation of this parameter is however difficult since an increase or decrease of friction can result from very different factors, which usually go far beyond the sphere of action of port authorities (Anderson et al., 2009).

The aim of this work is not so much to provide theoretical explanation of the effects of distance on hinterlands (an interesting review on this topic has been recently done by Tiller and Thill, 2017) but to draw up a panorama of the factors influencing hinterland expansion or shrinkage in different regions of the world.

## **VARIATIONS IN PORT CHOICE BEHAVIOR**

One of the most studied aspects affecting hinterland development is the different port choice behavior depending on the characteristics of decision-makers, either shippers or freight forwarders. Perceptions are usually analyzed through (a) surveys on declared preferences (Tiwari et al., 2003; Tongzon, 2009; Nir et al., 2003); or (b) data on revealed preferences. The latter can be individual shipment data obtained from bills of lading (Malchow and Kanafani, 2004; Steven and Corsi, 2012; Martinez et al. 2016; Kashiha et al., 2016), or commodity flow surveys (Gouvenal et al., 2010). While the declared preferences approach is better adapted to regions where data is scarce, studies on revealed preferences analyze the real choices of shippers and forwarders. Of course, the two approaches can lead to different results, as discussed by Tongzon (1995). These differences may arise from the respondent's profile, for example top-managers who are not familiar with what happens precisely on the ground. On the other side, quantitative surveys on revealed preferences hardly provide accurate information on key variables like the inland origin or destination of cargo within the hinterland, or the places where the containers are stuffed and unstuffed (Itoh and Tiwari, 2002). Yet, these two variables are essential to define the extent of hinterlands and to understand port choice.

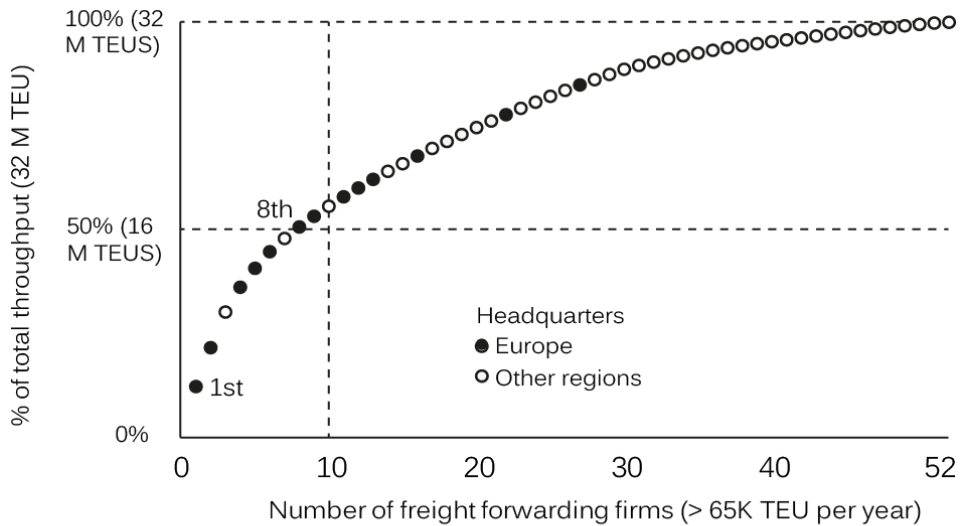
## **Large versus Small Shippers**

The size of the shipper turns to be an important factor affecting hinterlands. While small-size shippers appear to be more concerned by cost factors, larger shippers seem more focused on the speed of delivery. This has been confirmed within the USA (Steven and Corsi, 2012) and Europe (Kashiha et al., 2016), using data from bills of lading of US deep-sea shipments. The main explanation for these differences in port choice behavior rely on the different perceptions of the actors involved in international transport chains. Large shippers would have a broader vision of the costs of end-to-end transport chains than small shippers. The latter better focus on cost reduction only in the inland segment, overlooking factors like port efficiency (Kashiha et al., 2016) or the diversity and frequency of liner services (Tiwari et al., 2003). A significant presence of large shippers in certain regions would then favor larger hinterlands. The gains obtained by choosing most efficient ports and routes would eventually compensate additional costs of longer inland haulage. A high proportion of maritime trade in the USA (Steven and Corsi, 2012), Japan (Itoh et al., 2002), and Europe (Kashiha et al., 2016) is generated by large manufacturing and retail firms. This seems to be less the case in developing regions such as Africa (Pedersen, 2003).

## **Shippers versus Freight Forwarders**

Another source of differences in hinterland structures is the degree of involvement of freight forwarders in the organization of maritime shipments. The results of research surveys in Asia and Europe show that freight forwarders are more focused on cost reduction on the land segment than large shippers (Tiwari et al., 2003, De Langen, 2007, Tongzon, 2009). The latter are less focused on a single segment than on the whole transport chain, being more concerned by indirect costs such as unreliability, damage, and adverse reputation effects (Tongzon, 1995).

However, there may be differences between large and small freight forwarders. Figure 2-2 shows a highly concentrated ocean freight forwarding market, with 8 top firms concentrating more than 50% of the TEU throughput. Obviously, these large firms, mostly European, are in good position to negotiate preferential rates with several shipping companies, eventually being less dependent on specific companies and ports than small freight forwarders. These large freight forwarders can, depending on the needs of their clients, select more efficient door-to-door solutions, even if it does imply not choosing the shortest path. It was also demonstrated that in Europe, the concentration of small and medium-sized freight forwarders in port city-regions was a symptom of supply chain inefficiency in a context of less-liberalized countries such as France and Eastern Europe for instance (Ducruet and Van der Horst, 2009).



1. K&N(EUR) 2. DHL(EUR) 3. Sinotrans (CHN) 4. DB Schenker (EUR)
5. Panalpina (EUR) 6. DSV (EUR) 7. Expeditors (USA) 8. Hellmann Worldwide (EUR)

Figure 2-2. Ocean freight forwarders dealing with more than 65K TEU per year

Source: Author, Data: A&A, 2017

Freight forwarders make most of their business in Europe, Asia and North America (Figure 2-3). Their secondary markets are South America, and, to a much lesser extent, Africa. Their importance can also considerably differ within the same region. For example, South Africa is an exception within Africa, with many international freight forwarders. Despite the importance of the volumes handled by freight forwarders in Asia, their negotiation power against large shippers appears to be lower here than in Europe or the USA (Itoh and Tiwari, 2002). This results from the strong presence of large shippers, usually negotiating freight rates directly with maritime companies, and then reducing the profit opportunities for freight forwarders.

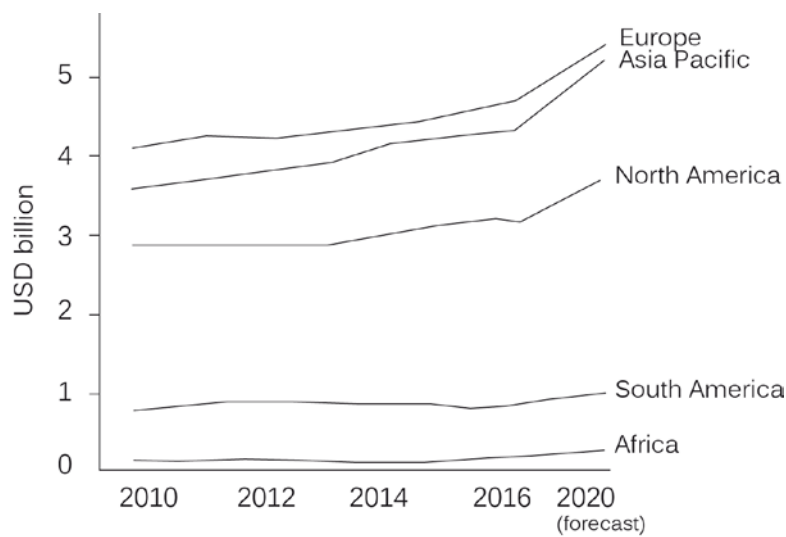


Figure 2-3. Global freight forwarding market, by world region

Source: Transport intelligence (2017)



## **Intermodal Connections**

In Europe, hinterland intermodal connections are relatively well-developed, particularly from Northern Range ports. The setting of strategies such as rail shuttles (Gouveral & Daydou, 2005), barge services (Frémont and Soppé, 2007; Franc & van der Horst, 2010) contributed to expanding the hinterlands of the most efficient container ports. This was demonstrated by De Langen (2007), showing how the port choice of Austrian shippers and freight forwarders substantially changed in favor of Northern Range ports, following an upgrade on connections with the Rhine waterway system. In France as well, it has been shown, through a spatial interaction model of foreign trade flows, that when waterway and rail connections are available the impedance of inland distance is lower (Guerrero, 2019). However, not all types of traffic are equally sensitive to the existence of efficient alternatives to the road. The presence of high capacity waterway connections between a port and inland region impacts flows of all types of cargo, but less on low-value cargo. This result goes against what is expected for a slow mode rather used for low-value added cargo. Inland waterways are also used to convey high value added products to the congested metropolitan areas. It is also a mean to delay deliveries to retailers, to save warehousing costs, and having the possibility to accelerate the flow by shifting from waterway to road if needed (Guerrero, 2019).

North America is probably the region where intermodal connections of ports are most developed, both in terms of distance and modal share of alternative modes. Efficient railway connections are used to connect the West and East coast, creating large areas of competition between ports. Though US railways are old, the development of intermodal services is relatively recent, mainly during the 1980s (Monios and Lambert, 2016). As compared to other regions the world, the conditions of demand (geographically concentrated, long inter-urban distances) and supply (long double-stack trains, competition between rail companies owning their own networks) make rail particularly competitive against road (Douet and Gouveral, 2004). In this context, containers are often carried over long distances by rail to reach their final destinations. However, the international trade of North America is increasingly unbalanced, which makes very difficult to find back haulage cargo for containers. In order to avoid extra-container rental charges, and to improve the efficiency of loading, sometimes containers are unstaffed in warehouses at the vicinity of ports and stuffed in 52' containers. Three 40' containers can be staffed on two 52' containers. According to Rodrigue et Notteboom (2008), about 25% of the rail cargo moved by rail is transferred to domestic containers.

In China, the development of intermodalism varies considerably across the country. Waterway transportation of containers is highly developed along the Yangtze river (over more than 2000 km), with many river container terminals reaching altogether about 9 million TEU/year capacity (Veenstra and Notteboom, 2011). But the capacities and traffic remains highly concentrated on a relatively short segment, namely between

Shanghai and Nanjing, the latter located 350 km from the sea. Beyond the Yangtze, the port of Shanghai also handles a substantial part of the 1200km distant Beijing (between 16 and 24% during 1994-2012 (Yang et al., 2016). But the depth of Shanghai's hinterland is exceptional within the context of China. The hinterlands of ports remain, in general, limited, and very concentrated in coastal regions (Lee et al., 2008; Wang et al., 2017).

In other developing regions, the integration between shipping lines and land transport remains very limited. In the context of South America, competitive hinterlands remain scarce, partly because of the lack of modal alternatives (Tiller and Thill, 2017; Ng et al., 2013). In Africa, the degree of development of intermodalism is slightly higher, with some Est-West (and in a lesser extent North-South) railway lines connecting ports with landlocked countries. The development of intermodalism in Africa has been encouraged by overseas exporters aiming to protect their high-value manufactured goods all over the journey. However, the degree of integration of shipping lines with inland transport remains low, with a majority of containers being unstuffed and stuffed in warehouses at the vicinity of ports. As reported by Pedersen (2003) in Ghana only 5% of the inbound containers continue inland and most of them are imported by a few mining companies, which are the only having the equipment needed to handle them. In East Africa, the situation is slightly better, with a higher proportion of containers going inland (Hoyle and Charlier, 1995; Charlier, 1996). About 28% of Mombasa port's throughput value (Kenya) is generated by landlocked countries (TTCANC, 2017). In South Africa, the level of integration between rail and maritime transport is probably the highest in the region, with several ports serving the wealthy Gauteng province (Fraser and Notteboom, 2014). It is however difficult to obtain accurate data on the number of containers going inland, as compared to those which are stuffed and unstuffed in warehouses surrounding the ports.

### **Borders and Natural Barriers**

The importance of borders and natural barriers have been early recognized by scholars. Sargent, for example, considered that natural characteristics played an important role in the differences between hinterlands in different regions of the world (Sargent, 1938). The case of South America is used to illustrate the strong impedance of elevation to hinterland expansion. The exception are the plains in Argentina where the hinterlands for cereal exports look like the traditional (semi)circular areas organized around the ports (Sargent, 1938). Rivers also matter, since hinterlands are often organized along watersheds, which usually provide good conditions for the development of transport corridors. Even when the rivers are not navigable the valleys provide good conditions for land transportation (Comtois, 2012). More marginally, natural disasters such earthquakes or floods can temporarily obstruct inland connections or block certain ports. They can, in certain cases, accelerate the long-term decline of a port, as showed by Xu and Ito (2017) for Kobe after the 1996 earthquake. In Europe, it was shown that the commodity diversity of ports' traffic was higher at island and peripheral locations such as behind mountains and at

peninsulas, as such ports are “naturally protected” from competition across plains (Ducruet et al., 2010).

Another important factor influencing port hinterlands is the development of infrastructure overcoming physical obstacles. The recent upgrade of the Panama Canal, allowing the transit of larger container vessels (up to 14,000 TEUs) is expected to favor the expansion of US East Coast ports to the detriment of West coast ones, as showed by Martinez et al. (2016). The expected shifts, estimated for shippers located in Pittsburgh (600km inland from the East Coast), are however different depending on the overseas origin of cargo: East Asian shipments would be more affected than Southeast Asian ones.

Borders also play an important role in the configuration of hinterlands, even within Europe, several decades after the introduction of single market. Borders have uneven impacts depending on the geographical position of countries: coastal or landlocked (Kashiha et al, 2016). The former are more constrained by inland distance the latter. While the first are tied to their national logistics networks, the latter have historically expanded their logistics networks to other countries in order to get access to the sea (Kashiha et al., 2016). The impact of borders on hinterland flows would also vary depending on other factors such the ports considered, or the direction of flows, import or export. For example, the effect of the alpine border would be stronger for Italian ports than for those of the Northern Range, both competing for the North Italian market (Ferrari et al., 2011). The latter differences are not just limited to language proficiency but also commercial skills and the ability to cope with different cultures.

### **Traffic Imbalances and Empty Container Repositioning Issues**

Commercial asymmetries are an important obstacle to hinterland expansion. They affect all the regions of the world: mainly on East-West routes, but in North-South ones as well, albeit to a lesser extent. As shown by Figure 2-4, the largest East-West imbalances take place between the Far East and its partners: North America, Europe, and the Middle-East. However, in relative terms, the most imbalanced routes are those where oil economies of the Mid-East are involved: inbound volumes are on average 2 to 3 times larger than outbound ones. Comparatively, North-South trades are less imbalanced (Figure 2-5), and are globally in favor of Northern regions. The largest imbalances (in absolute terms) take place also on the routes involving the Far East: Australasia, Africa, and to a lesser extent Latin America. Important imbalances take place as well on Europe-related trades. In relative terms, the most unbalanced trades are also those involving Australasia, and secondarily Africa, both regions having a limited potential for generating containerized exports.

These imbalances result in large volumes of empty containers and transport inefficiencies impacting from haul rates. In regions with limited potential for exporting containers, shippers and freight forwarders often prefer to unstuffing containers near ports to avoid extra charges for container rental. Moreover, in these areas, shipping companies often prefer to get their empty containers back as soon as possible to maximize their utilization (Notteboom et Rodrigue, 2007).

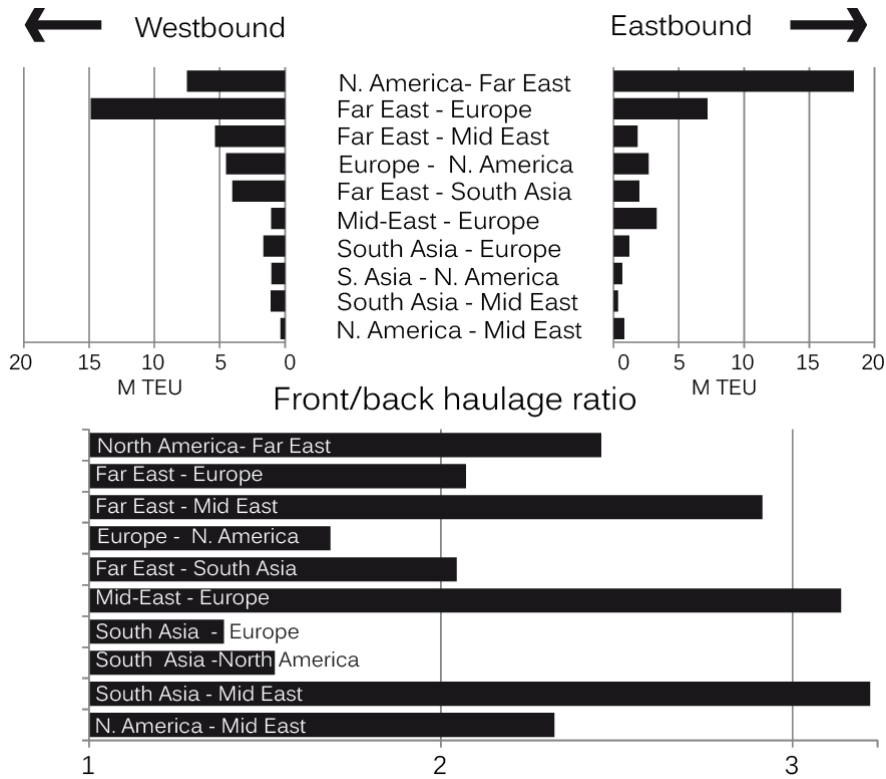


Figure 2-4. Main Est-West containerized flows in 2016

Source: own elaboration based on Drewry (2017)

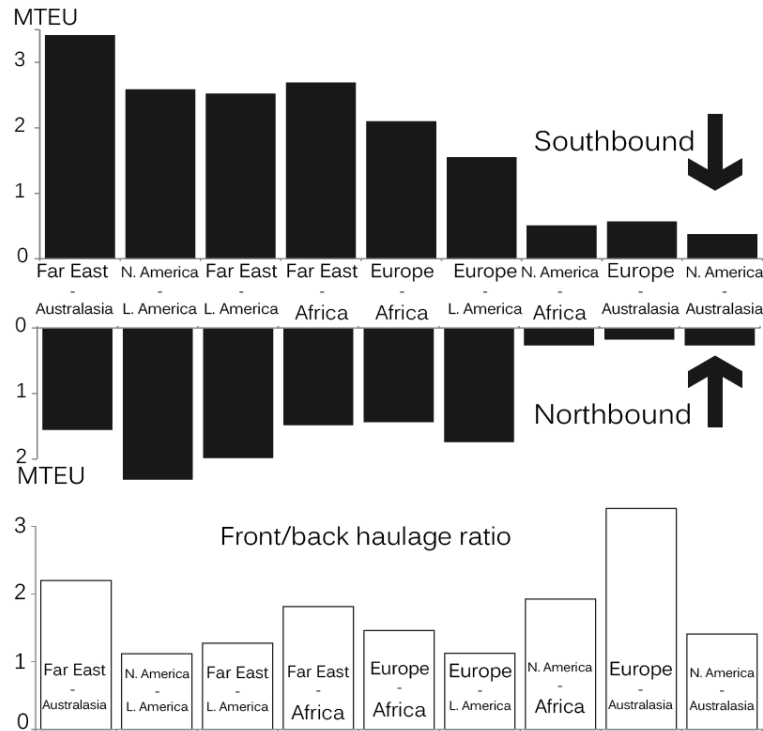


Figure 2-5. Main North-South containerized flows in 2016

Source: own elaboration based on Drewry (2017)

Port-centric logistics facilities are viewed by some as a solution to palliate part of the problems resulting from traffic imbalances. They imply container unstuffing at ports and re-distribution of unpacked goods from port-based distribution centers (DCs). The elimination of empty inland running of containers results in a reduction of inland transport costs (Mangan et al., 2008; Ng and Liu, 2014). However, when the inputs of DCs are sourced not exclusively from overseas, the location at ports, generally at the margins of countries, may not be optimal (Monios and Wilmsmeier, 2012; Acciaro and McKinnon, 2013). In developed regions such Europe, another problem related to port-centric logistics is that the gains obtained with the reduction of empty hauls would be partially offset by the increase of volume of cargo resulting from the use of pallets and individualized packages (Acciaro and McKinnon, 2013).

This list of determinants is not exhaustive. Some other “forces” impacting hinterland shrinkage or expansion are presented in Figure 2-6. This scheme shows that the forces driving hinterland shrinkage such as elevation or border crossing (b1-b3) generally affect more developing regions than developed ones. However, there are factors affecting both types of regions, as for example traffic imbalances or the likely increase in fuel cost or hinterland congestion issues (b4, b5, b6). Forces contributing to hinterland expansion mainly concern developed regions like North America, Europe, and some parts of China,

where economies of scale achieved on maritime transport and port handling can be achieved on the land side as well by efficient intermodal integration (a2-a4, a6). The intermodal issue is probably less important in South America or Africa. The factors inducing more time-based competition (a5, a8) primarily concern developed countries and high value-added cargo. Traffic imbalances affect many regions, both developed and developing ones. America and Europe share the common issue of single market development (a1), which is less relevant in other parts of the world. In some cases, sharing a common language or culture could eventually facilitate hinterland expansion, although counter-examples of this can be found as well (De Langen, 2007, Acciaro et al., 2017).

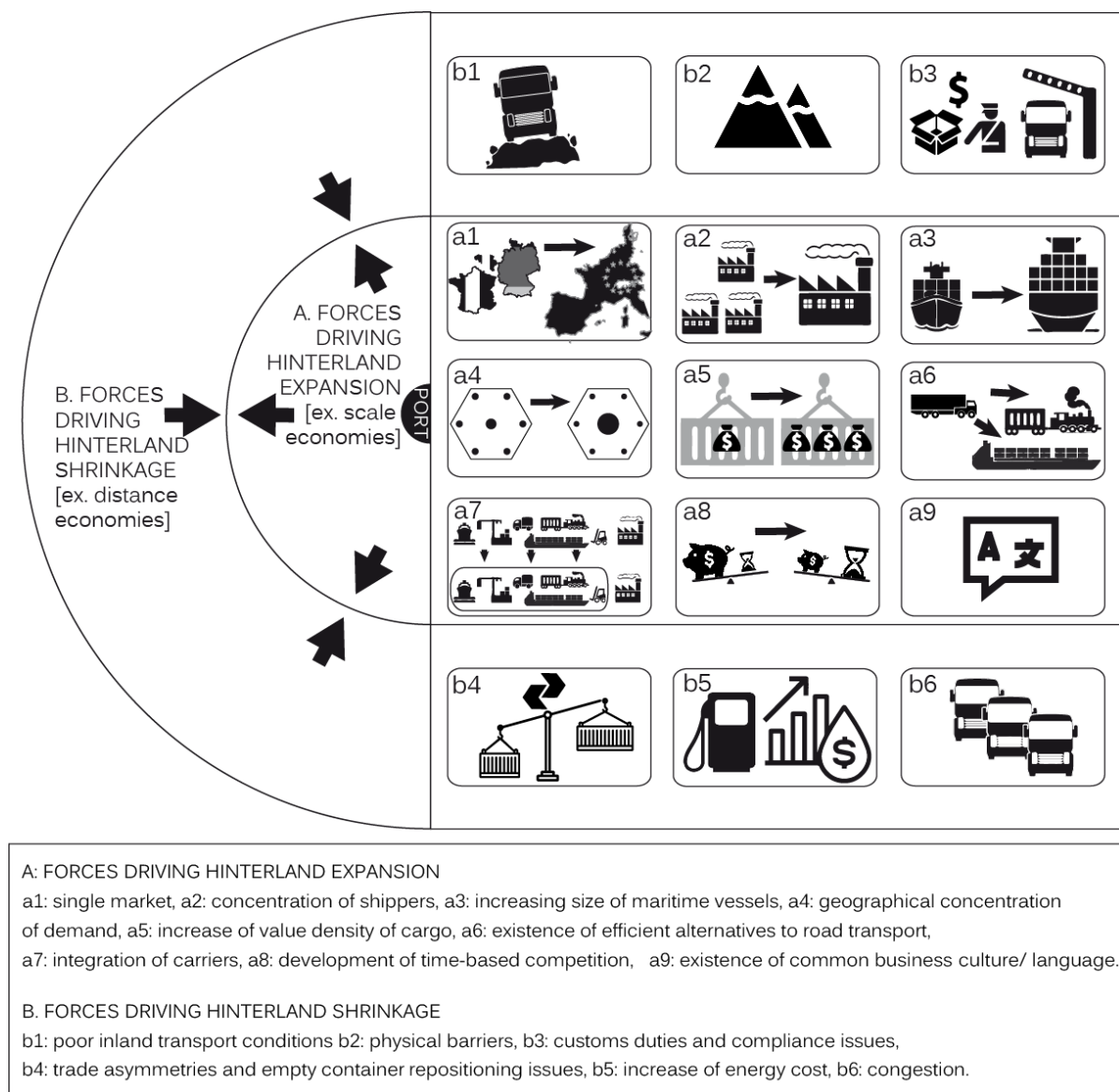


Figure 2-6. An overview of forces driving hinterland shrinkage and expansion.

Source: own elaboration

## **CONCLUSION**

This chapter provided a literature review of hinterland developments in different regions of the world. It identified some factors of hinterland development enabling inter-regional comparisons. The review is not exhaustive and tends to overlook factors such as governance or regulation of competition, which are difficult to measure or to characterize at the global scale. Table 2-1 provides a synthesis of the main factors which have been reviewed. It shows that in most of the regions analyzed, hinterlands change slowly. The main exception is China, where the rapid development of inland urban areas can favor further development of intermodalism.

Traffic imbalances and the places used for stuffing and stuffing containers appear to be important factors in hinterland development, which have been largely overlooked by the literature. Further research on these topics would contribute to a better understanding of the barriers to intermodal integration and hinterland expansion. Another promising avenue for further research is the in-depth analysis of activities generating maritime trade flows, to understand the ways in which shippers and freight forwarders interact with maritime companies in the choice of routes and ports.

Other regions such as South Asia, the Middle-East, Australia, and Central America have not been studied here. Even if the level of integration of land and maritime transport is considered to be low in most of these areas, more research would be needed to understand shippers and forwarders and the ways in which they deal with unbalances.

The lack of reliable data remains a big challenge for the study of port hinterlands. This problem becomes more acute within the context of developing countries where exhaustive and comprehensive surveys on freight flows are extremely rare. Carrying out qualitative surveys from the actors involved in freight entails difficulties, but seems more adapted to this specific context.

Table 2-1. Characteristics of hinterlands in several world regions

	North America	Western Europe	Japan	China	South America	Africa
Inland Competition	+++	++	+	+ / ++	---	--
Intermodalism	+++	++	-	+ / ++	-	+
Large Shippers	+++	++	+++	++	-	---
Large Freight Forwarders	++	+++	+	+ / ++	+	-- / -
Low Inland Barriers	+++	+	-	-	---	--
Throughput Balance	--	+	++	++	+++	---
Related Works	Slack, 1985, Fleming, 1989, Hayuth, 1988, Pitts, 1994, Malchow and Kanafani, 2004, Douet and Gouvernal, 2004, Levine et al., 2009, Steven and Corsi, 2012, Martinez et al., 2016	De Langen, 2007, Garcia Alonso and Sanchez Soriano, 2009, Ferrari et al., 2011, Monios and Wilmsmeier, 2012, Guerrero, 2014, 2018, Grecco et al. 2017	Itoh, Tiwari and Doi, 2002, Itoh, 2013, Xu and Itoh, 2017	Tiwari, Itoh and Doi, 2003, Lee et al., 2008, Monios and Wang, 2013, Yang et al, 2016 Wang et al. 2018,	Padilha and Ng et al, 2013, Wilmsmeier and Monios, 2016, Tiller and Thill, 2017	Hoyle and Charlier, 1995, Charlier, 1996, Pedersen, 2003, Fraser and Notteboom, 2016

Source: own elaboration

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