Inland cities, maritime gateways and international trade

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Abstract

This research focuses on the relationships between inland cities and port gateways. A quantitative analysis of 64 inland capital cities situated in coastal countries is proposed based on indicators that relate to ports, transport, trade and urban factors. The identified trends suggest that there is a trade-off between remoteness and openness to trade which leads us to postulate the existence of three typologies of inland cities: major logistics hubs, constrained metropolises and underdeveloped corridors. We conduct a more quantitative review of y intermodalism and port choice issues with reference to via a selection of six case studies. The observed spatial configurations have implications for logistics and governance.

Keywords: corridor; maritime transport; port hinterland; spatial friction; trade openness; urban system

1. Introduction

"*Paris, Rouen and Le Havre are a single city with the Seine as its main street*"

Jules Michelet, 1870

In a world where more than 80% of international trade volumes are carried by sea, the accessibility of places to maritime networks largely influences their socio-economic vitality (Gallup et al., 1999; Lane and Pretes, 2020). Thus, maritime transport has historically played

an essential role in the emergence and development of cities (Bretagnolle, 2015). The quality of maritime connections fostered the growth of some cities rather than others, as illustrated by Haig (1926) in his work about the development of American cities and notably New York. After lagging behind Boston or Philadelphia on the eve of the Revolutionary War (1775-1783), it grew after the war and maintained its primacy within the US urban hierarchy until today, through strong national and international trade networks, with its gateway functions channelling as much as 50% of US overseas trade in the period between 1812 and 1860, and the rapid expansion of its hinterland permiting the development of canals and railways (Haig, 1926).

But uneven access to maritime transport only provides a partial explanation of why some cities are more successful than others. Some important cities have emerged at considerable distances from the sea, such as, for example, Chicago, where the primary factor of success was not its proximity to Lake Michigan but the productivity of the Middle West (Ullman, 1941, p.855). Some of the most populated cities in the world such as Delhi, Mexico or Johannesburg are more than 400km from the sea. Moreover, it is difficult to establish causal relationships between transport conditions and urban growth, since the demand required to recover large investments in infrastructure like ports, canals or railways is most likely to be strongest in places which are already economically successful (Ahlfeldt and Feddersen, 2018). Good initial freight transport conditions may lead, in the long run, to urban growth differentials even after the initial advantage had become irrelevant (Fujita and Mori, 1996) [Cette reference semble manquer dan la bibli] In addition, transport infrastructures and cities develop through a mutual, dialectical, relationship rather than in one direction only (Banister and Lichfield, 1995).

Today, while freight transport is still regarded as important for urban development, the connection between both is not as close as in the past (Bird, 1963; Hoyle, 1993; Ducruet and Lee, 2006). The development of contemporary logistics and intermodalism, in combination with urban growth, the lack of available land for further expansion, and environmental

constraints have led to the movement of some freight-generating activities, such as manufacturing and wholesaling, away from large urban centers. As highlighted by the OECD (2014), port cities increasingly bear the costs of international trade, while the benefits are concentrated in inland regions. Therefore, remoteness from the sea does not necessarily have a negative impact on the growth of a city. Some scholars have even claimed that an inland location may be advantageous for a region if it is centrally located in terms of trade with truly landlocked regions (Debrie and Steck, 2001). For U.S. cities, it has been shown that "*possessing a port no longer assures a metropolitan area a superior advantage in trade*" (Noponen et al., 1997). Other empirical studies on Australia and the United States (O'Connor, 1987) as well as globally (Jacobs et al., 2011) have confirmed that the advanced services involved in trade and maritime transport preferentially locate in large cities (e.g., Paris and Madrid), but not necessarily in large ports.

By focusing on inland cities and their maritime gateways, this research raises a number of unresolved questions in the fields of port and economic geography. How do inland cities make up for their lack of direct access to maritime transport? What are the consequences of remoteness from the sea on international trade? Are there recurrent configurations across the world? To answer these questions it is necessary to review a wide spectrum of earlier work on ports, cities and hinterlands. The maritime accessibility of inland cities is also closely related to issues such as the relationships between cities, trade openness, transport costs, and spatial structure. By means of an empirical, comparative, analysis of inland cities across the world, we shall supplement earlier research on the accessibility of cities to foreign trade (Guo and Yang, 2018), and the unequal accessibility of the world's cities (Weiss et al., 2018), which did not discuss per se the specific relationship between inland cities and port gateways.

This research also addresses concrete issues of corridor development, as inland city actors (i.e municipalities, shippers and forwarders) have no option but to maintain and improve

their vital sea access to remain competitive. Cost- and time-effective transport solutions are also necessary for the port community: these include the development of intermodalism and inland ports to boost hinterland connectivity. In some cases, the inland city may benefit from multiple gateways, within national borders or stretching across the port rnge, thereby fostering port competition. The severity of transport congestion and environmental impacts vary from one corridor to another.

The remainder of this article is organized as follows. Section 2 reviews three strands of literature on ports, cities and international trade. The third section defines the research framework we have developed in order to conduct an international comparison of inland cities in relation to their coastal gateway(s). Based on this, Section 4 proposes a quantitative analysis and typology of inland capital cities. Section 5 presents the logistical challenges of six selected examples in more detail. Lastly, Section 6 discusses the novelty of this research and draws conclusions about its contribution to transport and economic geography.

2. Literature review

This research has been much influenced by a trend towards the better integration (or reintegration) of freight flows and physical exchanges in the study of cities and regions (Derudder and Witlox, 2010; Hall and Hesse, 2012; Birtchnell et al., 2015; Ducruet and Itoh, 2016). Three main types of studies have helped us gain a better understanding of the relationship between inland cities and maritime transport.

First, spatial models have been proposed to examine the dichotomy between inland and maritime cities. Vance (1970), for instance, compared a mercantile model of coastal urban primacy with a central place model of an upstream city. The first developed by applying a colonial approach that involved expanding linear transport connections towards the hinterland, while the latter strengthened its landward centrality and developed a maritime outport. Bird’s

earlier "Anyport" model (1963) well depicted the successive stages of port growth outside the original upstream city towards a more distant deep-sea location. The "chorotype" of the estuary (Brunet, 1990), which was adapted by Brocard et al. (1995) to the case of Europe, shows a dichotomy between upstream and downstream cities, the second having the advantage of direct, deep-water access but being more specialized in transport and industrial functions (e.g., Le Havre, Saint-Nazaire), and the first having better landward centrality and higher-order urban functions (e.g., Rouen and Nantes). Stern and Hayuth's spatial model (1984) on extended gateways considered the presence of an inland, non-port, core region, which limits the developmental impacts of ports on their local economy despite the emergence of a dense corridor between them and the core region. Nonetheless, as underlined by Bird (1980), "*It is often difficult to distinguish gateway functions from central place functions*" (p. 360). The same author later acknowledged that both functions can foster urban growth, exogenously for gateways (international trade) and endogenously for central places (the 'land around') (Bird, 1983). In his 1970 study, the same scholar set out to improve the status of seaports in the analysis of cities, as location theory had long ignored such non-central gateways.

This inland/coastal dichotomy is a key concern in the framework of the New Economic Geography. Since the seminal work of Krugman (1991), numerous scholars have investigated how international trade increases spatial inequalities. For instance, Venables (2005) discussed the conditions of the emergence of industrial clusters in developing economies depending on the openness of the economy and the number of ports. A useful review of the numerous existing spatial models was provided by Brülhart (2011), with a special focus on the influence of international trade on the concentration or dispersion of activities within countries, between the "interior" and the "border" (which includes the coast). However, the author observed that the different models contradict each other, while empirical studies show very diverse effects, concluding that it is impossible to generalize because it "*depends on each country's specific*

geography" (p. 80). In the model developed by Coşar and Fagelbaum (2016), the dual-economy structure is made up of a commercially integrated coastal region and an autarkic interior region, where the first gains industrial employment at the expense of the second with the advent of international integration and good domestic infrastructure (see also Mansori, 2003). Conversely, it has been found that "*improved access to coastal ports amplifies the welfare gains for inner regions*" (Xu and Yang, 2021).

The second research strand focuses on corridors, linking inland markets and maritime gateways, with numerous monographs (see Hall et al., 2011; Alix, 2012) which all discuss gateways and hinterlands rather than inland cities. Such studies focus on port competition, efficiency, and the development of inland ports through the process of regionalization (Notteboom and Rodrigue, 2005). While scholars have observed that inland ports are becoming increasingly involved in the transport chain (Wiegmans et al., 2020), the underlying urban geography of the corridor is barely discussed. Witte et al. (2019) underlined that inland port research was mainly conducted from a port-related perspective, although some research has investigated the inland port-city relationship (Witte et al., 2014). Other studies have considered port competition for contestable hinterlands, i.e. when a given inland region can be served by multiple gateways, such as the Rhône-Alpes region in France which includes Lyon (Charlier and Thomas, 1983), Austria (de Langen, 2007), and Southern Germany (Acciaro et al., 2017). Such studies deal with the determinants of port choice (e.g. distance, cost and reliability) for different cargoes and different ports, so that port issues dominate the analysis, leaving urban issues aside.

Third, systematic quantitative analyses of the relationship between inland cities and maritime networks have been proposed in recent years, in a way reinvigorating the "triptych" model of foreland-port-hinterland proposed by Vigarié (1979). At the global scale, Weiss et al. (2018) produced a map of travel time to cities resulting from the combination of multiple GIS

layers that included maritime routes. In Europe, Guerrero et al. (2015) found that 43% of general cargo supply and 36% of container transport supply were explained by differences in inland population accessibility,, while such results may differ according to the targeted overseas market. Australian inland and coastal cities were compared by Berli et al. (2018) according to their centrality within single and combined maritime and road networks. As in the case of Europe (Berli et al., 2020), they concluded that the urban population was more significantly correlated with intermodal centrality than with single-mode centrality. Yet, such studies neitherfocused on particular places nor proposed an index that measured the "maritime dependence" of cities. Available databases on cargo origins and destinations were used to provide precise analyses of hinterlands and port connectivity for France (Guerrero and Thill, 2021) and the USA (Shen et al., 2020). Other studies analyzed global and continental multimodal transport networks (Tavasszy et al., 2011; Shibasaki et al., 2020), without, however, discussing the specific role played by inland cities in such systems. The link between inland cities and maritime networks was also considered by Ducruet et al. (2018) in their global study covering the period 1890-2010. In particular, they showed that while the correlation between urban population and vessel traffic declined over time for port cities, on the contrary, it increased for major cities with direct land transport connections to ports[1]. The authors explained this result by the diseconomies of scale in large port cities (e.g., lack of space), the creation of new ports to serve distant hinterlands, and the increasing landward connectivity of transport systems (e.g. trucking).

The reviewed literature represents a very high degree of diversity. The models and case studies differ substantially in terms of theories, methods, geographic scale, and results - to such an extent that it has become difficult to make generalizations about their findings. There is a

[1] This study does not consider all the major cities, but describes, for each port, the largest (port or non-port) city in the outlying region.

need to develop a unified research framework based on two main principles. First, a synthesis of existing spatial models allows us to better capture the geographic diversity of the nexus between inland cities and port gateways. Second, the creation of a global urban and port database will make it possible, for the first time, to make international comparisons and compare the models with empirical data.

3. Research framework

3.1 The diverse nature of spatial configurations

Before discussing the relationship between inland cities and maritime gateways, it is important to note that the boundary between coastal and inland areas is ill-defined, which means estimates of coastal population vary greatly across sources[2]. This problem is presented in Figure 1, in which a distinction is made between a continental city (2a) and a "pseudo port city" (2b). While both locations are non-port cities, 2b is roughly adjacent to a port city, to such an extent that in some cases – depending, for example, on urban morphology – the two may be considered as a single city that contains a port. Examples abound, for example in Latin America (e.g. Lima and Callao) and Asia (e.g. Kuala Lumpur and Port Klang, Seoul and Incheon), but also in Europe (Athens and Piraeus), Africa (Accra and Tema), and the Middle East (Tel-Aviv and Ashdod). Configuration 2a may, depending on the scale of analysis, correspond to an estuary or delta if the continental city is upstream on the river (Paris, London, Constanta) and not easily accessible to modern ships. Ensuring their river remains navigable is another way for inland cities to access maritime trade, as witnessed by the large-scale efforts and expenditure Antwerp and Hamburg have made to dredgee their port entrances of in order to maintain their port function and competitiveness (Notteboom, 2016).

[2] The United Nations adopt the threshold of 100km inland to define coastal areas, which in recent years are home to about 40% of the world's population.

The relationship between inland city and maritime gateway also depends on the on their relative demographic and economic importance, which varies from one case to another. This recalls the aforementioned spatial models, wherea coastal urban primacy prevails in former colonies and/or developing economies (4bi), or an inland centrality is dominant, recalling central place theory (4bii). Based on our own count, 138 of the world's 203 reported coastal countrieshave their capital and most populated city on the coast, 8 have their capital city but not their most populated city inland, and 57 have their capital and most populated city inland. The last group of countries account for only 28% of the total in terms of numberntries, but were responsible for over 50% of world GDP in 2019. In such countries, the core city's access to maritime trade is thus vital, butit is highly influenced by the level of urban and port concentration.

For a single gateway and inland city (1ai), the latter depends completely on the former, for geographic and/or political reasons, as seen with Amman and Aqaba, Nairobi and Mombasa, Vilnius and Klaipeda, Walvis Bay and Windhoek, etc. A wider choice of ports is available for certain dominant cities (1bi), with the presence of multiple gateways on the same port range (e.g. Brussels, Santiago and Cairo) or on different port ranges (e.g. Mexico City, Riyad, Bogota and Madrid). Port choice may also be increased by cross-border transport, in addition to existing national gateways (3b), like for Paris (Le Havre in France, Antwerp in Belgium), Moscow (St. Petersburg in Russia, Baltic ports), and Phnom Penh (Sihanoukville in Cambodia, Ho Chi Minh City in Vietnam), but also the Ruhr area with German ports at the national level and the Benelux ports abroad. Germany, Poland, China and the United States for instance can be considered as multi-city and multi-gateway countries (1bii).

[Figure 1 here]

Spatial configurations have implications for logistics and governance. The further inland a city is located (2a), the wider, in theory, the port choice (1bi), but the higher the

impedance for accessing maritime trade. The narrower the port choice (1ai), the more likely transport congestion and high costs become in a monopoly situation. In the event of a shock or crisis (e.g., natural disaster, war, blockade, congestion, labor unrest), an inland city with only one gateway finds itself much more vulnerable.

3.2 Data and methodology for an international comparison

The empirical analysis proposed in this research focuses on the inland capital cities of coastal countries. The study sample is composed of 64 cities (Table 1) characterized by ten variables (Table 2). Coastal capital cities which are not ports were excluded from the sample (Accra and Tel-Aviv), as were upstream seaports (i.e., London), and capital cities created by decentralization policies (Brasilia and Canberra)[3]. Given that Sao Paulo and Santos are respectively the largest city and the largest port in Brazil, they were kept in the sample under study. A single gateway was attributed to each capital under the criteria of being within the national borders and the nearest in distance by road. We thus hypothesized that a gateway of this type is the capital city's principal access to the sea, although many cases fall into the multiple gateway category. For instance, Busan and Virginia Ports have superseded Incheon and Baltimore to serve Seoul and Washington respectively, due to their superior nautical accessibility (Frémont and Ducruet, 2005; Boquet, 2011).

In terms of demographic size, most of the capital cities in our sample were larger than the port cities (cf. Figure 1, 4bi) Contradictory cases (4bii) were retained in the sample although such cities may not be prime locations in port hinterlands[4]. As emphasized by Gottmann (1977,

[3] Jerusalem is a special case. It was also excluded, as its gateway Ashdod is very close to Tel-Aviv, a coastal non-port city of superior size (economic capital). Brasilia and Canberra share the role of planning tools to temper rivalries between Sao Paulo and Rio de Janeiro in the first case, and Sydney and Melbourne in the second.

[4] Examples include Yamoussoukro, Dodoma, Abuja, Yaoundé, Islamabad, Ankara, Belmopan, Quito, Bandar Seri Begawan, Ottawa, and Washington DC. There has been much debate among urban geographers about the correct definition of capital cities, given their diversity and the distinction between "natural" and "artificial" cities (see Spate, 1942).

1983), the functions of a capital city secure "strong and lasting centrality" and foster the development of ancillary activities and accessibility. This is particularly true under autocratic political regimes, but less so in federal states and ones where a division of power has been made to promote regional balance or for other reasons. Thus, capital cities may not always be economically relevant to study ports. Yet it has the advantage of restricting the study to a single corridor per country as very large economies such as China, India, Russia, Brazil, and the United States (Figure 1, 1bii) contain many more, as do Europe and other transnational markets (Africa, Eurasia). Another advantage is that it avoids defining corridors by selecting ports and cities on the basis of arbitrary population, traffic, and distance criteria, and also avoids the complexity of assigning multiple ports to multiple cities without concrete evidence about the precise distribution of hinterland flows. Consequently, some inland cities may be minor at the global scale, but prime locations nationally, thereby providing a great diversity of cases not only in terms of size but also of levels of socio-economic development.

[Table 1 about here]

In the absence of economic indicators for cities such as GDP, we chose demographic size as a proxy for the economic size of the cities at both ends of each corridor (gateway and inland city). The distance by road between an inland city and its gateway is a simple but crucial variable that expresses of the city's remoteness from maritime trade. While distance is often included in port choice studies as a proxy or component of transport cost (see a useful review by Blonigen and Wilson, 2006), "significant improvements in domestic transportation systems appeared to have lessened the importance of close geographical proximity between ports and their customers in port choice decisions" (Tongzon, 2009). Lacking data on railway traffic and services, and given the fact that the quality of the road link is not documented at a precise level, we complemented the distance by road by the share of paved roads in the nation's network. As the quality of transport infrastructures is of key concern for inland cities and the participation

in trade in general (Clark et al., 2004), indices of port infrastructure quality and logistics performance were added to the database. In order to check the assumptions made by new economic geographers on the relationship between spatial structures and international trade, we included the level of trade openness, which corresponds to the share of imports and exports of goods and services in the total GDP. These national-level indicators allow the analysis to take account of the context in which inland cities and gateways develop and operateSuch cities are characterized by their total air cargo traffic. Although this traffic cannot replace seaborne traffic when a city is far from the coast, it is a useful complement to maritime transport and an indicator of urban vitality. Lastly, port gateways are defined by their total vessel traffic (i.e., the product of vessel capacity and call frequency) and the containerization rate (i.e., share of container traffic in the total vessel traffic).

[Table 2 about here]

These indicators have been used to perform a multivariate statistical analysis, which included principal components analysis (or factor analysis) and hierarchical clustering. The main purpose of these approaches is to unravel the principal main trends at work, by observing the relationships between variables, and the groupings of cities along these relationships, resulting in a typology. Based on the results presented in the next section, two case studies for each type of inland city are examined more thoroughly and qualitatively. This makes it possible to discuss several non-measurable aspects which include cross-border trade, port choice, intermodalism, and the current strategies of actors, and compare them with the outcomes of the data analysis.

4. Towards a typology of inland capital cities

The main tendencies]that characterize inland capital cities can be identified applying Principal Components Analysis (PCA) to our data, as shown in Figure 2. The first four components

account for 75.4% of the total variance, each with eigenvalues greater than 1. The first component (F1) corresponds to a size effect, whereby all variables in component 1 (the horizontal axis) are positive. The most representative variables (highest scores) of this tendency are air and sea traffic, logistics performance, and inland city population. This means that inland capital cities are mainly differentiated (32.7% variance) by their market size and level of transport activity, in a hierarchical manner. It also suggests that the traffic passing through the nearest port gateway reflects the size of the inland city, although the correlation coefficient (Pearson) is only moderately significant (R^2=0.35)[5]. In comparison, air traffic is much more correlated with inland city size (R^2=0.54).

The tendency that best answers our research questions is that observed in component 2 (vertical axis). The strong inverse relationship between road distance and trade openness (20.2% variance) confirms that remoteness from maritime transport is detrimental to international trade. The spatial friction caused by distance is also inversely related to the quality of transport infrastructure (port and paved roads), suggesting that the effect of remoteness is aggravated by poor transport. Another interesting aspect is the association between distance and population, especially gateway population. This is in accordance with the model developed by Fujita and Mori (1996), where the growth of port cities is constrained by the "shadow effect" exerted by the core (here, the inland city) on the periphery (the port city). Our results show that the size of the gateway increases with its distance from the inland city, due to a "self-agglomeration and hub effect" (Fujita and Mori, 1996). Although the inverse relationship between trade openness and gateway population seems to contradict the economic geography literature, it can be explained by the fact that large gateways benefit from both market size and direct sea access, thus reducing their need to serve hinterlands. Thus, there is a trade-off among

[5] Total vessel traffic is more correlated with inland city size than with port city size (R^2=0.23) but slightly more correlated with total corridor population (inland city + port city) (R^2=0.38).

inland cities between trade openness and land transport costs, whereas certain gateways have developed as economic capitals. The inverse relationship between inland city size and transport infrastructure quality confirms the model of Behrens et al. (2006), where high transport costs act as a barrier to competition from abroad (e.g., other cities) and make the "landlocked" region attractive for firms (and workers – i.e., population) despite its remoteness. In a more recent study, Behrens et al. (2017) showed that spatial frictions between cities (known as *trade* frictions) are responsible for the agglomeration of firms and workers in larger cities, to such an extent that eliminating such frictions promotes the growth of smaller urban centers. As the existing research deals only with landward relationships, we have added a new dompension, that of the port, or the fact that poor quality port infrastructure generates spatial frictions that tend to increaseg urban concentration in the interior. The crossing of components 3 and 4, which is not shown in Figure 2, confirms these tendencies, with the very close ties between gateway population and road distance on the one hand, and inland city population and air cargo on the other.

[Figure 2 here]

Hierarchical clustering was applied to the results of the PCA (four components) so as to classify inland capital cities and check the geographic distribution of the identified typologies (Figure 3). Given the exploratory nature of this study, it is important to assess the robustness of the clusters to avoid misinterpretations. Figure 4 provides a box plot, showing how the values within each cluster deviate from the central values. In each box, the lower and upper limits are the first and third quartiles, respectively. The black crosses indicate the averages and the horizontal bars the medians. The upper and lower dots designate the maximum and the minimum respectively. Any points that arehigher than the upper bounds or lower than the lower bounds of the whiskerscan be considered as outliers.

Three clusters were obtained. *Major logistics hubs* stand out by their proximity to the coast (150km on average), their high sea and air traffic, and their possession of the best transport infrastructure. They also rank high in terms of average inland city population (over 5 million inhabitants)[6], average containerization rate (41.8%), and average degree of trade openness (80.4%). This profile confirms the main tendency identified by the PCA which we have previously named the "size effect". The geographic distribution of these cities is far from random, as most of them are in the northern hemisphere or the "Triad" (USA, Western Europe, and Northeast Asia), with the only exception being Kuala Lumpur.

The second cluster, the *constrained metropolises* is, conversely, defined by remoteness from the coast (500km on average). Of the three clusters it is this which has the largest inland city and gateway city in terms of population (over 8 million inhabitants) and over 3 million inhabitants respectively, and the highest containerization rate (42.7%). However it has the lowest trade openness (57.7%) of the three clusters. This group is typical of the second tendency$/pattern observed in the PCA, namely the inverse relationship between road distance and trade openness, and the link between distance and city size. In addition, the cluster suffers from the worst port infrastructure quality index (3.6 on average), and although it is in second place among the three clusters for percentage of paved roads (37.5%) and logistics performance (2.8), it lags far behind the *major logistics hubs* in this regard The geographic distribution of this cluster is also not random, as the cities in question are mainly concentrated in West Asia, followed by Latin America (with Mexico), and Africa. A common feature is for them to be located in very large countries, often with major natural barriers such as mountainous regions.

Lastly, we have called the third cluster ed *underdeveloped corridors* as it has the lowest scores in nearly every sphere, except the degree of trade openness, where it has the highest (86.5%). It ranks second for port infrastructure quality (3.7) and distance to the coast (188km),

[6] For a comparison, the average population of the world's 173 coastal capitals is just under 1.4 million.

although the two values remain fairly low. This cluster therefore belongs to the first tendency we identified in the PCA, namely the size effect, as such cities stand at the opposite of *major logistics hubs*. While absolute inland city size is much smaller than in the other clusters, the capital cities here are, on average, 35 times larger than their maritime gateway, compared to 14 for constrained metropolises and 13 for major logistics hubs. The geographic distribution of the cluster includes Central America / Caribbean, Eastern Europe, Southeast Asia, and Africa, notwithstanding the special case of Pyongyang in North Korea. Many of these countries have faced political instability and crisis in recent decades, which has worsenedthe already poor state of their transport systems. The high level of urban concentration inland, combined with poor transport infrastructure and logistics performance, is exacerbated by the relatively small land area of most countries in this cluster[7].

[Figure 3 here]

[Figure 4 here]

5. The role of port choice and intermodalism in the selected cities

5.1 Paris: between the Seine axis and Benelux

The Greater Paris Region[8] (GPR) brings together 18.5% of the French population and accounts for 31% of the nation's GDP. It also generates 21% of the exports and 26% of the imports (in

[7] For the Latin American locations in this cluster, altitude is responsible for major friction, gold mining and the presence of an indigenous population with agriculture, buildings, wood and water were prime factors when selecting the location of most capitals in the colonial period (Hardoy, 1993). For former (or present-day) socialist states as well as autocratic regimes, the prevalence of political over economic imperatives has often led to the moving of the capital cityinland in order to achieve better control of the territory, with a preference for land transport over maritime trade (Vigarié, 1995). In contrast, "most traditional Asian cities were located inland and primarily performed administrative and cultural functions" prior to European colonial rule (Murphey, 1969). In the greater part of Africa, the capital (like the nation state) is a relatively recent concept that originated in Europe, exceptions being theArab area and the ancient empires) (Hamdan, 1964).

[8] Région Ile-de-France

value). Most of the maritime trade is containerized, and the retail sector, the automotive industry, aeronautics, and luxury sector play important roles.

The port of Le Havre is by far the main gateway for the GPR, with about 50-55% of the regional tonnage, followed by the Benelux ports with about 20% (Guerrero, 2019). However, the dominance of Le Havre is less clear when it comes to Asian trade. For this, the Benelux ports to the East and the North dominate, as this is where most of the groupage transport terminals are located (Heitz et al., 2019). The marked reorientation of French international trade towards China during the past two decades has been to the benefit of the Benelux ports (Guerrero and Pais-Montes, 2021).

Most of the GPR's maritime trade is carried by road (85%). During the past two decades, the modal transfer policies implemented by successive governments have failed to alter this situation. Currently, the GPR is involved in two corridor projects. The first, supported by the French State and the Normandy region, is the development of the Seine Valley, including several rail and waterway infrastructure projects and the merger of the ports of Le Havre, Rouen and Paris under a single port authority (Haropa). The other is the Seine-Nord-Europe canal project, heavily funded by the French State, the European Commission and the Nord region[9]. These two corridors are not only competing to attract public investments, but also to attract the GPR's maritime trade. From the perspective of the GPR this could be positive, since it enhances competition between Le Havre and the Benelux ports. However, there is also a real risk of overcapacity, given the GPR's limited demand compared to core European regions such as the Randstad or the Ruhr.

5.2 Seoul: reorientating trade through West coast ports

[9] Région Hauts-de-France.

In South Korea, the capital region includes Incheon, Seoul, andGyeonggi province, which together account for about half of the nation's population and GDP. Seoul is the manufacturing hub of this export-oriented economy. Two major changes have occurred in the past three decades: the amount of high-value exports has increased rapidly (semi-conductors, mobile telephones, automobiles and vessels), and the reorientation of trade towards China, both of which have increasedthe importance of the country's West Coast ports, which include Incheon, Pyeongtaek, and Gunsan. Cargo flows between Incheon and Seoul are mainly by road, and suffer from severe congestion due to their volume and the presence of passenger cars on the roads. While this 30km corridor is too short for rail to be a viable option, the canal's limited capacity does not permit river-road cargo transfers. Despite the initial intention for the canal to allow direct sea-river container shipping between China and Seoul, the canal is in fact too narrow for two-way barge navigation.

The modernization of Incheon port since 2007 aims to sustain Incheon's gateway role, especially given its proximity with growing China, and to counterbalance the domination of Busan and Gwangyang for containers. This dominance is explained by several factors, which include the proximity to global shipping lines and Japan for transshipment. Busan New Port has a direct rail link to Seoul Uiwang Inland Container Depot (25km to the south); however, rail freight accounts for only 2-3% of Busan's throughput, and for 10.5% of its Seoul-bound volume, as road dominates due to its geographically limited hinterland[10]. As underlined by Lee and Rodrigue (2006), "*Using Busan instead of Inchon* [to reach China from Seoul] *involves additional inland transport costs of about $681 per TEU and delays of at least two days*".

Another way to strengthen Incheon's position has been the development of free-trade zones through foreign investment and the attraction of capital functions such as the international

[10] More than 60% of Busan's container throughput comes from transhipment. The Seoul-Busan Grand Korean Waterway project conceived in 2008 was abandoned for environmental and economic reasons.

airport (which also carries air-sea freight), R&D facilities, universities, and top-level residential amenities, through the efforts of central and municipal government as well as major private investments (Ducruet et al., 2012). As a result, the port had become relatively self-contained, with nearly 35% of its container traffic serving Incheon city itself, followed by Seoul (17%) and Gyeonggi province (37%), namely about 90%. In comparison, Seoul and Gyeonggi province only account for about 9% and 0.5% of Busan and Gwangyang ports' container traffic respectively (Li et al., 2018).

5.3 Mexico City: complementarity between the Atlantic and Pacific gateways

Greater Mexico City accounts for about 17% and 22% of the country's population and GDP respectively. It possesses multiple gateways on both the Pacific and Atlantic coasts. However, since the implementation of the North American Free Trade Agreement (NAFTA) in 1994, more than 50% of Mexican trade is with the United States, on one dominant trucking corridor passing through Laredo on the border with Texas (Haralambides and Londono-Kent, 2004). This situation creates both bottlenecks and delays, as large amounts of passenger traffic also use the same motorway and there is a large number of emptytrucks on the road. In addition, large retailers and manufacturers have located their warehouses at both ends of the corridor. Intermodal transport by rail increased fourfold between 2000 and 2012 (Martner and Garcia, 2015), passing through Pantaco terminal in Mexico City, Mexico's largest in terms of traffic volume, and Nuevo Laredo, ranked fourth. Nevertheless, the location of Mexico City, about 500-600km from the coast, makes rail eligible also for ports such as Manzanillo, Lazaro Cardenas (Pacific), and Veracruz (Atlantic), which are among the country's top five intermodal terminals.

Martner (2002) well depicted Mexico's changing port geography since the 1980s. In the late 1980's, the country's ports were characterized by fairly equally distributed inter- and intra-

coastal container traffic, as well as limited inland cargo penetration, before Manzanillo and Veracruz came to dominate their respective ranges in 2000, with the Gulf Coast dominating in terms of traffic. . The author explains this dominance by the fact that Veracruz had a major import function to serve Mexico City and other centrally located states, until Pacific ports – especially Manzanillo – took the lead as a result of Asian imports[11]. As such, the East coast's share of container traffic dropped steadily from 68% to 31% between 1997 and 2013 (Wilmsmeier et al., 2015).

There is thus a geographic division of trade to serve Mexico City, as Veracruz handles 65% of its traffic with Europe and the Mediterranean, and 35% of its traffic with Latin America. The capital city accounts for about 40% of the container cargo handled by HPH, the leading terminal operator of the country, which opened an inland terminal (TILH) 50km North of Mexico City in 2012 (Wilmsmeier et al., 2015). These authors clearly underlined that "*the prominence of the Asian trade on the Pacific coast clearly favours rail activities on the Pacific coast*" (p. 39), so that the share of intermodal (rail) cargo traffic is 46% in Lazaro Cardenas compared to 10% in Veracruz. Their study also demonstrates that the low intermodal share of Veracruz is not only explained by its geographic location and foreland specialization, but also by entry barriers (absence of rights to operate rail services within the port terminal area), the lack of direct rail access to the port container terminal, the lack of equipment for intermodal rail transport, the rail industry's preference for bulk transport over containers, and longer travel times to the capital city by rail (12h) than by truck (9h).

5.4 Moscow: transit trade or self-sufficiency?

[11] Data from the World Bank for 2019 shows that Mexico's imports were mainly from the USA (45.3%) and the East Asia and Pacific regions(33.0%), with Europe in third place (12.2%).

During the Soviet period, Moscow used to trade through multiple gateways along the Baltic Sea and Black Sea. After the collapse of the USSR (1991), it had to rely on gateways situated in the new republics, which adapted more rapidly to global port standards than Russian ports. Ports in the new Baltic States and Finland thus acquired a major role for transit trade, also benefiting from shorter distances and good transport connections (pipelines and rail) with the hinterland (Thorez, 2011).

Over time however, St. Petersburg became the leading port in the Baltic. The modernization of its highway and railway connections with Moscow had been given priority, as this "intermetropolitan territory" (Pawlotsky, 2017) accounts for about 15% and 25% of the country's population and GDP, respectively. Road transport continues to dominate both inbound (95% of modal share) and outbound (79%) traffic in this north-western region, but inland port terminals with rail access are gaining modal share rapidly (Korovyakovsky and Panova, 2011). Nevertheless, ports in the Baltic States, such as Tallinn, retain large market shares thanks to better railway connections (with the same gauge), and "unbeatable cross-border processes" compared with road transport (Hilmola and Henttu, 2015). There is a fixed-schedule container train between Tallinn and Moscow, which is actively supported by the Russian shippers involved in the project. Through this cross-border gateway function, Baltic ports have become highly dependent on Russian trade, to such an extent that their extreme vulnerability has become an issue (Serry, 2017). This is compensated for by the Russian aim to achieve self-sufficiency whereby liquid bulk exports, which constitute half of all its exports, are reoriented towards the Russian Baltic Ports.

5.5 Yamoussoukro: between the sea and landlocked economies

The capital city of Côte d'Ivoire is not a major urban center, but it is strategically located between Abidjan port and the landlocked countries of Mali and Burkina Faso. This corridor is

the country's only railway line and expressway. Since independence in 1960, numerous reforms and international agreements have been instituted to facilitate freight movements, together with the reduction of bottlenecks from a hundred to about 33, but transport friction remains high (Toguei and Kablan, 018). The only railway line, which dates back to the colonial period, has hardly been modernized. Besides its collapse in 2016 having caused important cargo losses its maximum speed is a mere 10km/h, while there are not enough wagons to meet demand and many are outdated, which forces the supply chain actors to use road transport.

The only section of road that is in good condition is between Abidjan and Yamoussoukro, the rest of the network being prey to potholes, accidents, delays, unplanned repairs, and robberies. This situation is aggravated by the poor technical standard and outdated character of the vehicle fleet. The police or customs frequently stop trucks on their way to/from the hinterland and subject drivers to racketeering. These difficulties explain why hinterland transport in Côte d'Ivoire costs twice as much as in its neighbors (i.e., Senegal, Ghana and Togo) to reach the same destinations. Customs controls may take up to 80minutes at the border with Burkina Faso, compared with 15-24 from Togo.

In this transport chain, the operation of Abidjan port itself is affected by major difficulties (Ouattara et al., 2017; Patrick, 2019). Except for the container terminal, quay depth is under 11 meters, while the few tugs and the cranes are outdated. The lack of space within the port creates bottlenecks for trucks, with drivers sleeping under their vehicles to avoid robberies.

As the second largest city in the country after Abidjan and given its position as a crossroads, Yamoussoukro is somewhat protected from the aforementioned logistical issues. Although its main functions are tourism and education, the capital city is a center of wholesale trade for the agricultural hinterland, but it remains under the shadow of the nearby preexisting cities of Bouaké and Toumodi (Chaléard and Dubresson, 1993). Despite rapid urban growth resulting from the rural exodus, factors like the politico-military crisis (2002-2011), the lack of

urban space for merchant activities, a high unemployment rate (62% against 2.9% nationally), the economic crisis since 1980 due to low sales (coffee, cocoa) and imposed economic programs have all played a part in delaying its take-off, with the difficulties evidenced by the emergence of survival strategies such as the use of wheelbarrows by mobile street vendors (Babele, 2020).

5.6 Phnom Penh: domestic and cross-border gateways in the Greater Mekong area

The economy of Cambodia, which was one of the World's least advancedin the late 1990s, has grown significantly. Between 1998 and 2019 its GDP grew at an average annual rate of 7.7%, underpinned by a strong export performance in labor intensive sectors such as garments (World Bank, 2021). The capital, Phnom Penh (2.3 million inhabitants, i.e. 12% of the country's population) is also a large manufacturing centre, generating substantial maritime trade. Its situation with regard to gateways is unique in view of the variety of ports and transport modes involved. The maritime trade of Phnom Penh flows through two main corridors. The first is domestic and links the capital to the deep-sea port of Sihanoukville. The second is international, and connects it with the ports of Ho Chi Minh City and Cai Mep.

The first corridor covers a distance of 231km from Phnom Penh to Sihanoukville. The latter's throughput has grown considerably over the last decade, from less than 300,000 TEUs in 2013 to 750,000 in 2021. However, it can only play a role of regional/feeder port since it is unable to accommodate vessels of more than2,000 TEUs. About 80-90% of Sihanoukville's hinterland volumes are carried by road and the rest by train. Given the poor road conditions the ageing truck fleet, and the low levels of competition, road haulage costs in Cambodia are particularly high compared to those of neighbouring countries such as Thailand or Vietnam (OECD, 2021).

The second corridor connects Phnom Penh with the deep-sea ports of Ho Chi Minh City and Cai Mep, by waterway (300-350 km) and road (230-300 km). An individual barge operating on the Mekong River can carry up to 144 TEUs, all year round, even during the dry season and despite the border crossing and obstacles such as bridges and electric power lines (Shibasaki et al, 2021). The river port of Phnom Penh has recently been expanded to cope with rapidly growing volumes. In 2021 it reported a throughput of 348,898 TEUs. The road also presents an alternative means of connecting Phnom Penh with Vietnamese ports. A flow of about 100,000 TEU transits annually across the border (JICA, 2018). With regard to connections with Vietnam, inland waterway transport appears to be a reliable and cost-efficient alternative to the road (Shimada et al, 2017).

Sihanoukville and the Vietnamese ports are largely complementary. While the former provides direct connections to several ports in South East Asia and Asia, the latter are connected to distant markets, such as Europe and the US. This is particularly the case for Cai Mep, which can accommodate the World's largest vessels which currently operate on the North Europe-Asia routes.

Given the fierce international cost competition in the labor-intensive activities in which Cambodia is specialized, high transport costs could become a barrier to future growth. It is therefore urgent to improve transport connectivity, in particular the access to ports. To improve the connectivity in the Greater Mekong Subregion (GMS), the Asian Development Bank (ADB) has launched a program for regional economic cooperation focused on corridor development. Since 1992, £US 20.4 billion have been invested in the GMS, mostly in transport and energy infrastructure (ADB, 2017). More recently, China has invested large amounts in transport infrastructure in Cambodia in the framework of the Belt and Road Initiative. Chinese involvement may have allowed Cambodia to increase support to its infrastructure sector not

only from China but also from other countries and multilateral organizations (Calabrese and Cao, 2021).

6. Discussion and conclusion

The position of inland cities vis-à-vis maritime transport is a complex topic for study. Without information on the precise distribution of imports and exports at the city and port level, international comparisons are inevitably approximative. Based on available data however, our research was able to conduct an analysis of 64 inland capital cities, and answer several key questions posed in the transport and economic geography literature. While larger cities tend to generate more traffic, the degree to which this occurs is very much influenced by the quality of the transport infrastructure and the logistics services. The most salient result is the negative correlation between remoteness from the sea and trade openness, and between city size and transport/logistics quality, which demonstrate that spatial structures and international trade are closely interrelated. Our findings are thus in line with, and tend to reconcile various schools of thought from port, transport, urban, and economic geography to the "new" economic geography. Moreover, for the first time, our results provide an empirical validation of Fujita and Mori's model (1996), by which the size of coastal cities increases the greater the distance to their (inland) core region and the worse the transport conditions, thus avoiding the lock-in or "shadow" effect of the core on the periphery.

The empirical validation of certain "rules" proposed by economic geographers, however, must not hide the functional diversity of cases. Among inland cities, the class of *major logistics hubs* is characterized by high traffic and transport efficiency, trade openness, proximity to the coast, and a location in the most developed economies (e.g., Paris, Seoul). *Underdeveloped corridors* lag far behind in all aspects, despite their proximity to the sea and a high level of trade openness, largely due to unstable political environments (as in Central

America, the Balkans and Africa, for example). In between, *constrained metropolises* suffer from remoteness, poor transport infrastructure and low trade openness, factors for which the size of the coastal and inland cities partially compensates for.

The case studies succinctly compare these findings with the concrete organization of corridors. For Paris, Moscow and Phnom Pehn, the possibility of accessing maritime networks through foreign gateways is a clear advantage compared with Seoul and especially Yamoussoukro. Another advantage which is shared by Seoul and Mexico City is that they both benefit from two national coasts, although Seoul is unable to access Eurasia due to the separation of the two Koreas. With regard to intermodalism, the low level of congestion level to and from Paris is not due to modal substitution, given the dominance of road transport with both Le Havre and Antwerp (and the low utilization of the River Seine), but to more even distribution of cargo flows between the two corridors. Despite its low rank in terms of transport quality indicators, Mexico City, like Moscow, is well connected by rail and congestion is only reported as a major issue as a result of high ship turnaround times.

Further research will pursue several avenues. In the OECD region or in continents where city level information is available, economic indicators such as metropolitan GDP or employment could be considered to better characterize inland and port cities. The research focus may shift to a wider sample of inland cities, such as those with at least 500,000 inhabitants, without necessarily being a capital. Network analysis could be applied to estimate their road and sea-land accessibility, and make it possible to measure an index of maritime specialization or dependency in a multiple city / multiple port system. The inclusion of qualitative parameters in the form of dummies to characterize port choice, modal choice, and the existence of cross-border options may refine international comparisons.

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Table 1. Sample of selected cities.

Country	Inland city	Population (thousands)	Air cargo (tons)	Port gateway	Population (thousands)	Vessel traffic (DWT)	Distance (km)
Nigeria	Abuja	1353	6158	Lagos	9968	5,751,786	764
Jordan	Amman	1206	42,412	Aqaba	101	1,961,762	326
Turkey	Ankara	4094	834	Istanbul ports	13,346	401,796	444
Madagascar	Antananarivo	1688	0	Toamasina	225	638,659	355
Eritrea	Asmara	664	1416	Massawa	49	47,036	113
Greece	Athens	3952	45,157	Piraeus	179	3,746,211	12
Iraq	Baghdad	5402	1127	Basrah-Um Qasr	1914	1,487,500	532
Brunei	Bandar Seri Begawan	140	2322	Muara	280	255,994	31
China	Beijing	16,440	498,368	Tianjin	4862	9,068,299	114
Germany	Berlin	4033	7157	Hamburg	1899	9,879,468	284
Colombia	Bogota	8465	217,929	Buenaventura	321	2,414,134	507
Congo Republic	Brazzaville	1253	1347	Pointe Noire	690	814,398	508

Country	Inland city	Population (thousands)	Air cargo (tons)	Port gateway	Population (thousands)	Vessel traffic (DWT)	Distance (km)
Belgium	Brussels	2131	150,732	Antwerp	1137	15,272,475	55
Romania	Bucharest	2171	7046	Constanta	298	4,159,177	227
Egypt	Cairo	13,488	127,828	Alexandria	4485	4,103,667	226
Venezuela	Caracas	4558	46,290	La Guaira	31	870,028	30
Bangladesh	Dacca	13,015	0	Chittagong	3868	1,798,377	248
Syria	Damas	2274	2443	Tartous	98	1,365,531	255
Tanzania	Dodoma	180	0	Dar-es-Salaam	3212	1,502,115	445
Guatemala	Guatemala City	3541	37,773	Puerto Quetzal	8	2,342,516	106
Vietnam	Hanoi	1545	57,765	Haiphong	636	546,813	118
Pakistan	Islamabad	804	35,399	Karachi	12,418	7,394,512	1411
South Africa	Johannesburg	7262	115,795	Durban	3512	7,788,865	568
Sudan	Khartoum	5904	11,609	Port Sudan	580	1,027,970	842
Ukraine	Kiev	3184	19,181	Odessa	1106	3,109,283	475

Country	Inland city	Population (thousands)	Air cargo (tons)	Port gateway	Population (thousands)	Vessel traffic (DWT)	Distance (km)
Rep. Dem. Congo	Kinshasa	8901	1437	Matadi-Boma	459	249,540	329
Malaysia	Kuala Lumpur	7088	380,853	Port Klang	1114	14,811,945	41
Peru	Lima	8000	77,677	Callao	813	2,969,789	12
Slovenia	Ljubljana	258	2141	Koper	23	2,012,023	106
Spain	Madrid	5692	222,117	Valencia	1816	7,138,815	356
Nicaragua	Managua	1417	24,840	Corinto	16	210,552	156
Mexico	Mexico City	21,409	182,036	Veracruz	622	2,983,141	397
Russia	Moscow	14,184	89,554	St. Petersburg	4632	3,565,538	706
Kenya	Nairobi	3489	82,953	Mombasa	918	687,833	488
India	New Delhi	21,750	277,764	Mumbai	13,707	4,171,172	1404
Cyprus	Nicosia	272	0	Larnaca	51	271,155	56
Canada	Ottawa	1009	3912	Montreal	3677	2,315,965	198
France	Paris	10,390	654,221	Le Havre	254	10,785,371	196
Cambodia	Phnom Penh	1486	9031	Sihanoukville	153	313,292	228

Country	Inland city	Population (thousands)	Air cargo (tons)	Port gateway	Population (thousands)	Vessel traffic (DWT)	Distance (km)
Montenegro	Podgorica	146	0	Bar	15	248,477	52
North Korea	Pyongyang	3270	139	Nampo	471	7023	58
Ecuador	Quito	1650	73,824	Guayaquil	2286	892,346	439
Morocco	Rabat	1819	0	Kenitra	403	17,251	53
Saudi Arabia	Riyad	4878	33,793	Dammam	1564	2,621,211	409
Italy	Rome	3501	64,601	Civitavecchia	51	512,349	71
Costa Rica	San Jose	1374	45,418	Caldera	40	806,599	85
Salvador	San Salvador	1779	28,212	Acajutla	28	920,863	81
Yemen	Sanaa	2079	2263	Hodeidah	471	767,373	253
Chile	Santiago	5197	49,889	Valparaiso	840	2,448,422	121
Brazil	Sao Paulo	19,745	226,678	Santos	1824	10,202,502	82
South Korea	Seoul	19,665	1,936,304	Incheon	2554	8,228,184	34
Bulgaria	Sofia	1149	2739	Bourgas	190	1,020,241	387

Country	Inland city	Population (thousands)	Air cargo (tons)	Port gateway	Population (thousands)	Vessel traffic (DWT)	Distance (km)
Georgia	Tbilisi	1272	6511	Poti	47	779,996	323
Honduras	Tegucigalpa	1106	518	Puerto Cortes	61	1,739,579	306
Iran	Tehran	12,089	7622	Bandar Khomeini	70	1,464,084	935
Albania	Tirana	570	160	Durres	180	352,658	38
Lithuania	Vilnius	543	1268	Klaipeda	192	2,834,530	307
Poland	Warsaw	2324	64,652	Gdansk-Gdynia	831	2,861,094	340
USA	Washington DC	600	123,103	Baltimore	632	8,021,920	62
Namibia	Windhoek	316	20	Walvis Bay	67	438,600	396
Côte d'Ivoire	Yamoussoukro	242	0	Abidjan	4419	5,179,286	236
Cameroon	Yaoundé	1812	1841	Douala	2143	42,630	237
Croatia	Zagreb	706	2770	Rijeka	138	795,070	161

Table 2. Selected indicators.

Variable	Description/unit	Source
Population of the inland city Population of the port city	Thousands of inhabitants of the metropolitan area (LN)	Helders (2012)
Road distance between inland city and port city	Kilometers (LN)	Google Maps (2021)
Port tonnage	Vessel traffic in deadweight tons (LN)	Lloyd's List Intelligence (2008)
Air traffic of the inland city*	Number of tons (LN)	International Civil Aviation (2009)
Paved roads	Pavement rate (%), country level	Central Intelligence Agency (2021)
Logistics Performance Index (LPI)	Country level	World Bank (2010)
Trade openness	Share of trade in goods and services in total GDP (%), country level	World Bank (2010)
Port infrastructure quality	Country level	World Economic Forum (2010)

*

Traffic for Incheon international airport.

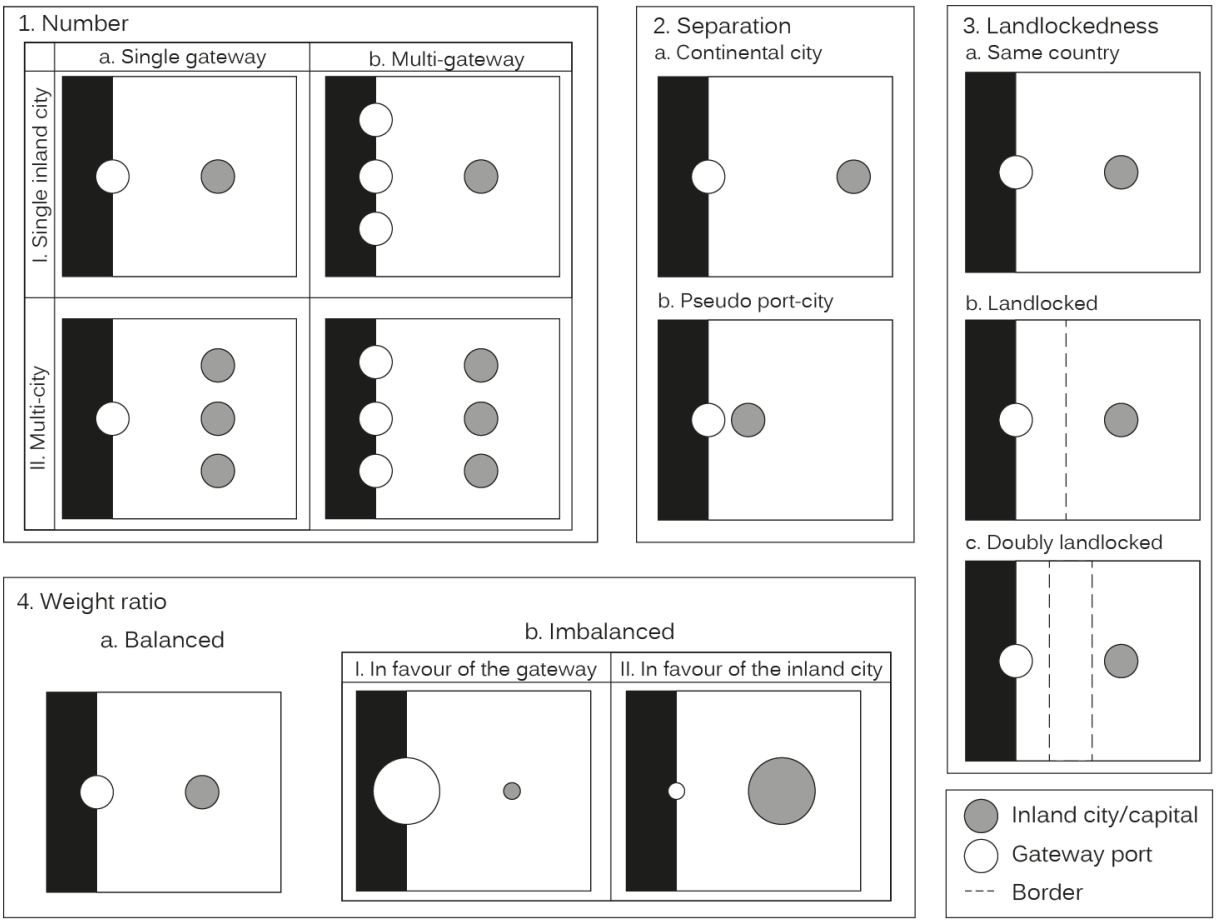

Figure 1: The different spatial configurations

Source: own realization

Figure 2: Cross-analysis of inland capital cities

Source: own realization

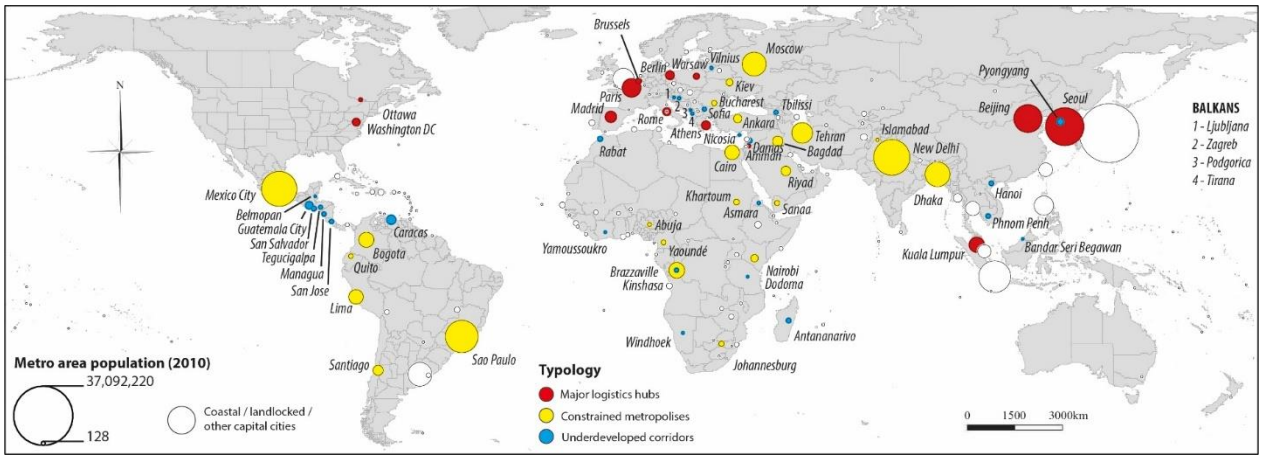

Figure 3: Typology of inland capital cities

Source: own realization

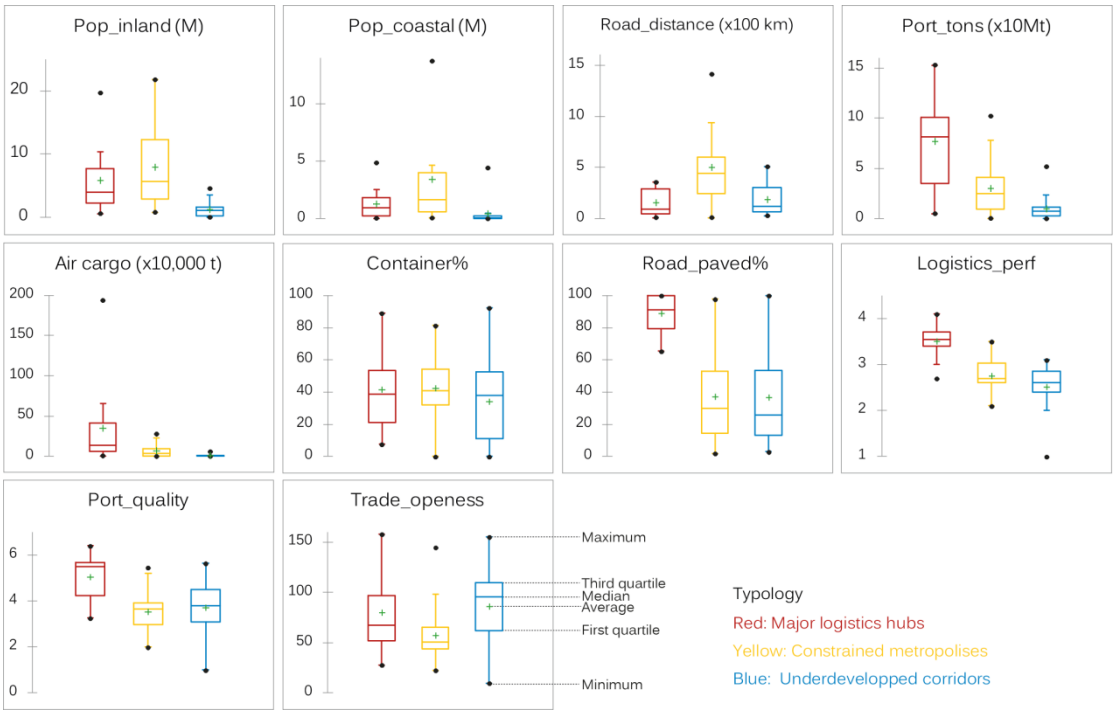

Figure 4. Box plots for the three clusters

Source: own realization

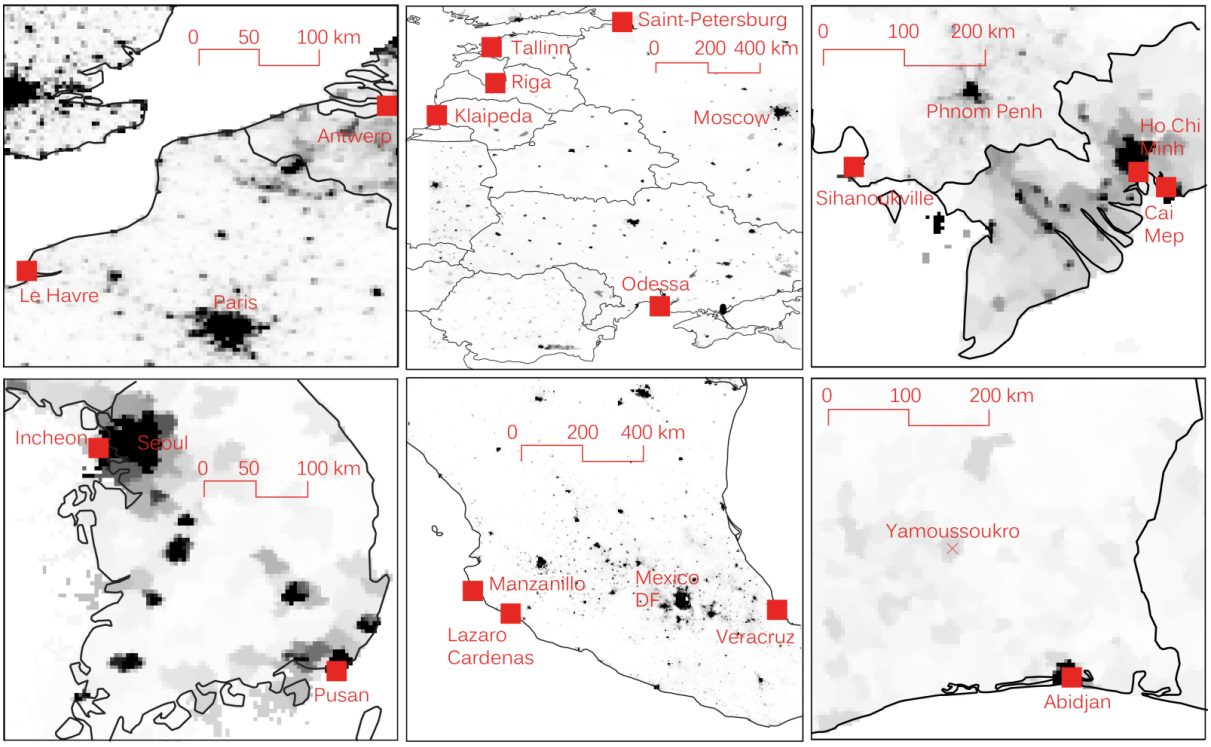

Figure 5. Geographical setting of the six case studies

Source: own realization