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Inland cities, maritime gateways, and international trade

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Abstract

This research focuses on the relationships between inland city and port gateway. A quantitative analysis of 64 inland capital cities situated in coastal countries is proposed based on port, transport, trade, and urban indicators. The obtained trends suggest that there is a trade-off between remoteness from the sea and trade openness, which differentiates three clusters of inland cities: major logistics hubs, constrained metropolises, and underdeveloped corridors. We review more qualitatively intermodalism and port choice issues along six selected case studies.

Keywords: corridor; maritime transport; port hinterland; spatial frictions; urban system

1. Introduction

“Paris, Rouen and Le Havre are one same 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). As such, maritime transport historically played an essential role in the emergence and development of cities (Bretagnolle, 2015). The quality of maritime connections fostered the growth of certain cities at the expense of 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 at the eve of the Revolutionary War (1775-1790), it grew after the war and maintained its primacy within the US urban hierarchy until today, through strong national and international trade networks, gateway functions concentrating as much as 50% of US overseas trade during the 1812-1860 period, and the development of canals and railways allowing the rapid expansion of its hinterland (Haig, 1926).

But the uneven access to maritime transport only provides a partial explanation of the success of certain cities at the expense of others. Some important cities have emerged at distant locations from the sea, such as for example Chicago, where the primary factor of success was not its proximity vis-à-vis the Lake Michigan but the productivity of the Middle West (Ullman, 1941, p.855) and *“the railroads’ need to employ capital as fully as possible to meet fixed costs and remain profitable”* (Cronon, 1991, p. 182). Therefore the growth of Chicago as a market for grain, stock and lumber was enhanced by the subsequent development of rail transport. Some of the most populated cities in the world such as Delhi, Mexico or Johannesburg are more than 400 km far 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 into infrastructures like ports, canals or railways is most likely to be strongest among

economically successful places (Ahlfeldt and Feddersen, 2018, Cronon, 1991). Good initial freight transport conditions may lead, on the long run, to urban growth differentials even after the initial advantage had become irrelevant (Fujita and Mori, 1996). 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 tight 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 move part of freight-generating activities, such as manufacturing or wholesaling, away from large urban centers. As emphasized by the OECD (2014), port cities increasingly bear the costs of international trade, while benefits are polarized by inland regions. Therefore, the remoteness from the sea does not necessarily have a negative impact on city growth. Some scholars even claimed that the inland situation may be advantageous for a region if it is centrally located with regard to the trade of truly landlocked regions (Debie and Steck, 2001). For U.S. cities, it was demonstrated 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) confirmed that advanced services involved in trade and maritime transport preferentially locate in large cities (e.g., Paris, Madrid) but not necessarily in large ports.

By focusing on inland cities and their maritime gateways, this research raises a number of unsolved questions in port and economic geography. How do inland cities offset the 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? Answering these questions necessitates to review a wide spectrum of earlier works on ports, cities, and

hinterlands. The maritime accessibility of inland cities is also tightly related with 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 complement earlier works on the foreign trade accessibility of cities (Guo and Yang, 2018), or 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, forwarders) have no option but to maintain and improve their crucial sea access to remain competitive. Cost, time-effective transport solutions are also necessary for the port community, including 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 range, thereby fostering port competition. Transport congestion and environmental impacts are more or less acute from one corridor to the other.

To shed light on these issues, a quantitative analysis of 64 inland capital cities situated in coastal countries is proposed based on port, transport, trade, and urban indicators. Quantitative results are supplemented by six case studies revealing how non-measurable dimensions, such as intermodalism and port choice, influence relationships between inland cities and gateways.

The remainders of this article are organized as follows. Section 2 reviews three strands of literature on ports, cities, and international trade. The third section defines the research framework destined to run an international comparison of inland cities in relation to their coastal gateway(s). Based on the previous, section 4 proposes a quantitative analysis and typology of inland capital cities. Section 5 presents in more detail the logistical challenges of six selected

examples. Lastly, section 6 discusses the novelty of this research and concludes about its contribution to transport and economic geography.

2. Literature review

This research is much influenced by a trend towards a 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 contributed to 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 through a colonial logic by expanding linear transport connections towards the hinterland, while the latter reinforced its landward centrality and developed a maritime outpost. The earlier “Anyport” model of Bird (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, Nantes). The spatial model of Stern and Hayuth (1984) on extended gateways considered the presence of an inland, non-port core region, which limits the developmental effects of ports on their local economy despite the emergence of a dense corridor in between. Nonetheless and 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). The main objective of Bird (1970) had been to give seaports a decent status in the analysis of cities, as location theory long left such eccentric gateways in a dark corner.

This inland/coastal dichotomy is a key concern in the New Economic Geography research framework. Since the seminal work of Krugman (1991), numerous scholars investigated how international trade fosters spatial inequalities. For instance, Venables (2005) discussed the conditions of the emergence of industrial clusters in developing economies depending on the degree of the openness of the economy and the number of ports. A useful review of the numerous existing spatial models was provided by Brühlhart (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” (of which the coast). However, the author observed that 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 of Coşar and Fagelbaum (2016), the dual-economy structure is made of a commercially integrated coastal region and an autarkic interior region, where the first gains industrial employment at the expense of the second in the advent of international integration and good domestic infrastructure (see also Mansori, 2003). Conversely, it was 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) having in common to 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 observed that inland ports

increasingly take initiatives 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 a port-related perspective, although some research has investigated the inland port-city relationship (Witte et al., 2014). Other works looked at port competition for contestable hinterlands, namely in the case where a given inland region can be served by multiple gateways, such as the Rhône-Alpes region in France including 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, reliability) for different cargoes and different ports, so that port issues dominate the analysis, leaving the urban issues aside.

Third, systematic quantitative analyses of the relationship between inland cities and maritime networks have been proposed in recent years, reinvigorating in some way the “tritych” 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 of which maritime routes. In Europe, Guerrero et al. (2015) found that 43% of general cargo and 36% of container transport supply were explained by the variation in inland population accessibility, while such results could differ according to the targeted overseas market. Australian inland and coastal cities were compared by Berli et al. (2018) according to their centrality in single and combined maritime and road networks. Like for Europe (Berli et al., 2020), they concluded that urban population was more significantly correlated with intermodal centrality than with single-mode centrality. Yet, such studies did not zoom on particular places nor did they propose an index of “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 USA (Shen et al., 2020). Other studies analyzed global or continental multimodal transport networks (Tavasszy et al., 2011;

Shibasaki et al., 2020), but without discussing the specific situation of inland cities in such systems. The link between inland cities and maritime networks was also approached by Ducruet et al. (2018) in their global study covering the 1890-2010 period. They particularly showed that while the correlation between urban population and vessel traffic declined over time for port cities, it increased at the contrary for major cities directly connected to ports via land transport¹. The authors explained such a 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 remains rather dispersed across the academic spectrum. 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 generalize research outcomes. This calls for the elaboration of a unified research framework resting on two main pillars. First, a synthesis of existing spatial models is necessary to better encapsulate the geographic diversity of the nexus between inland city and port gateway. Second, the elaboration of a global urban and port database allows, for the first time, international comparisons and the confrontation of models with empirics.

3. Research framework

3.1 The diversity of spatial configurations

Before discussing the relationship between inland city and maritime gateway, it is important to note that the limit between coastal and inland areas remains ill-defined, so that estimates of coastal population vary greatly across sources². This problem is approached in Figure 1, with a distinction between continental city (2a) and “pseudo port city” (2b). While the two locations

¹ In this study, not all major cities are considered, but for each port, the largest (port or non-port) city of the outlying region.

² The United Nations retain the threshold of 100km inland to define coastal areas, which hosted about 40% of world population in recent years.

are non-port cities, 2b is roughly adjacent to a port city, to such an extent that it may be in some cases – such as depending on urban morphology – considered as one and only city hosting a port. Examples abound, like in Latin America (e.g. Lima and Callao) and in 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). The configuration 2a may, depending on the scale of analysis, correspond to an estuary or delta if the continental city is in fact upstream (Paris, London, Constanta), more or less accessible to modern ships. River navigability is an additional option for the inland city to reach maritime trade, as seen with the considerable efforts put (and costs spent) on dredging the port entrances of Antwerp and Hamburg to maintain their port function and competitiveness (Notteboom, 2016).

The relationship between inland city and maritime gateway also depends on the weight ratio between the two (demographic, economic), which is more or less balanced. This recalls the aforementioned spatial models, with a coastal urban primacy in former colonies and/or developing economies (4bi), or an inland centrality recalling the central place theory (4bii). Based on our own count, among the 203 reported coastal countries in the world, 138 have their capital and most populated city on the coast, 8 have their capital city but not the most populated city inland, and 57 have their capital and most populated city inland. The latter countries represent only 28% of the total in number, but more than 50% of world GDP in 2019. In such countries, the access to maritime trade for the core city is thus vital. It is highly influenced, however, by the level of urban and port concentration.

For a single gateway and inland city (1ai), the latter fully depends on the first, due to geographic and/or political reasons, as seen with Amman and Aqaba, Nairobi and Mombasa, Vilnius and Klaipeda, Walvis Bay and Windhoek, etc. A wider port choice is available for certain dominant cities (1bi), with the presence of multiple gateways on the same port range (e.g. Brussels, Santiago, Cairo) or on different port ranges (e.g. Mexico City, Riyadh, Bogota,

Madrid). Port choice may also occur through 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 in Vietnam), but also the Ruhr area with German ports nationally and the Benelux ports. 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 farther inland (2a), the wider the port choice (1bi) in theory, but the higher the impedance accessing maritime trade. The narrower the port choice (1ai), the more likely is to encounter transport congestion and high costs in a monopoly situation. In the advent of a shock or crisis (e.g., natural disaster, war, blockade, congestion, labor unrest), the inland city finds itself much more vulnerable when having only a single gateway.

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). From this sample were excluded capital cities being non-port but coastal (Accra, Tel-Aviv), upstream seaports (i.e., London), as well as capital cities created out of decentralization policies (Brasilia, 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. One and only gateway was attributed to each capital under the same criteria: within national borders and the nearest by road distance. We thus hypothesize that such a gateway is the capital city's principal access

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

to the sea, although many cases fall into the multiple gateway category. For instance, Busan and Virginia Ports supersede 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 capital cities in our sample are larger than port cities (cf. Figure 1, 4bi). Opposite cases (4bii) were kept in the sample although such cities may not be prime locations in port hinterlands⁴. As emphasized by Gottmann (1977, 1983), capital functions secure “strong and lasting centrality”, foster the development of ancillary activities and accessibility, especially in autocratic political regimes, but less in federal ones and where a division of power has been made to promote regional balance or other reason. As such, capital cities may not always be economically relevant to study ports. Yet this selection has the advantage to restrain the study to one single corridor per country, as very large economies such as China, India, Russia, Brazil, and the United States (Figure 1, 1bii) contain many more, but also Europe or other transnational markets (Africa, Eurasia). Another advantage is to avoid selecting ports and cities based on arbitrary values of population, traffic, and distance to define corridors, and to avoid the complexity of assigning multiple ports to multiple cities without concrete evidence about the precise distribution of hinterland flows.

[Table 1 about here]

In the absence of economic indicators for cities such as GDP, demographic size is chosen as a surrogate for the urban economic weight at both ends of each corridor (gateway and inland city). The road distance between inland city and gateway is a simple but crucial variable that expresses the level of 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

⁴ Yamoussoukro, Dodoma, Abuja, Yaoundé, Islamabad, Ankara, Belmopan, Quito, Bandar Seri Begawan, Ottawa, and Washington DC. Urban geographers much debated about the right definition of capital cities, given their diversity and the distinction between “natural” and “artificial” cities (see Spate, 1942).

and Wilson, 2006), “significant improvements in domestic transportation system 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 thinner level, we complement road distance by the share of paved roads in the national total. As the quality of transport infrastructures is of key concern for inland cities and trade participation in general (Clark et al., 2004), indices of port infrastructure quality and logistics performance are added to the database. In order to verify the assumptions made by new economic geographers on the relationship between spatial structures and international trade, we include the level of trade openness, which corresponds to the share of the imports and exports of goods and services in total GDP. These national-level indicators allow the analysis to consider the context in which inland cities and gateways develop and operate. Inland cities are characterized by total air cargo traffic. Although this traffic cannot replace seaborne traffic in the case of remoteness from the coast, it is a good 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 total vessel traffic).

[Table 2 about here]

These indicators serve a multivariate statistical analysis, including a principal components analysis (or factor analysis) and a hierarchical clustering. The main objective of these approaches is to unravel the main trends at stake, by observing the relationships among variables, and the groupings of cities along these relationships, resulting in a typology. Based on the results of next section, two case studies for each type of inland city are examined more thoroughly and qualitatively. The six cities were chosen as a means to cover various continents and logistical situations. This part of the analysis makes it possible to discuss several non-

measurable aspects of which cross-border trade, port choice, intermodalism, and actors' strategies in the current period, and verify whether the selected cities deviate from their belonged cluster's trends.

4. Towards a typology of inland capital cities

The main trends characterizing inland capital cities can be observed through applying a Principal Components Analysis (PCA) to our data, as illustrated by Figure 2. The first four components concentrate no less than 75.4% of total variance with respective eigenvalue > 1. The first component (F1) corresponds to a size effect, whereby all variables are positive on component 1 (horizontal axis). The most representative variables (highest scores) of this trend 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 activity of the nearest port gateway is in accordance with the size of the inland city, although the correlation coefficient (Pearson) is moderately significant ($R^2=0.35$)⁵. In comparison, air traffic is much more correlated with inland city size ($R^2=0.54$).

The trend that best answers our research questions is the one observed along the component 2 (vertical axis). The strong opposition between road distance and trade openness (20.2% variance) confirms that remoteness from maritime transport is detrimental to international trade⁶. The spatial friction of distance is also opposed to the quality of transport infrastructures (port, paved roads), suggesting that remoteness is aggravated by low transport quality. Another interesting aspect is the proximity between distance and population, especially gateway population. This is in accordance with the model of Fujita and Mori (1996), where the

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) ($R^2=0.38$).

⁶ Appendix 1 includes the elevation level of inland cities, which also acts as spatial friction.

growth of port cities is constrained by the “shadow effect” exerted by the core (here, inland city) on the periphery (the port city). Our results show that the farther are gateway and inland city from each other, the larger is the gateway, as a “self-agglomeration and hub effect” (Fujita and Mori, 1996). While the opposition between trade openness and gateway population seems to contradict the literature in economic geography, it can be explained by the fact that large gateways enjoy both market size and direct sea access, thus lowering the need to serve hinterlands. Thus, there is a trade-off among inland cities between trade openness and land transport costs, whereas certain gateways have developed as economic capitals. The relative opposition 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 remoteness. In a more recent work, Behrens et al. (2017) showed that spatial frictions between cities (called *trade* frictions) motivate 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 such works only focus on landward relationships, we innovate by adding the port dimension, or the fact that poorly developed port infrastructures are spatial frictions reinforcing urban concentration in the interior. The crossing of components 3 and 4, not showed in Figure 2, confirms these trends, with the very close proximity between gateway population and road distance on the one hand, inland city population and air cargo on the other.

[Figure 2 here]

A hierarchical clustering is applied to the results of the PCA (four components) so as to classify inland capital cities and verify the geographic distribution of the obtained types (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 are the averages and the horizontal bars are the medians. The upper and lower dots designate respectively the maximum and the minimum. Points above or below the whiskers' upper and lower bounds can be considered as outliers.

Three clusters are obtained. *Major logistics hubs* stand out by their proximity to the coast (150km on average), their prominent sea and air traffics, and best transport infrastructure quality. They also rank high in terms of average inland city population (over 5 million inhabitants)⁷, average containerization rate (41.8%), and average degree of trade openness (80.4%). Such a profile confirms the main trend of the PCA previously coined as the “size effect”. The geographic distribution of these cities is far from being random, as their majority locates in the northern hemisphere or “Triade” (USA, Western Europe, and Northeast Asia), with the only exception of Kuala Lumpur.

The second cluster, *constrained metropolises* is, conversely, defined by remoteness from the coast (500km on average), the largest inland city (over 8 million inhabitants) and gateway city (over 3 million inhabitants) population on average, the highest containerization rate (42.7%), but the most limited degree of trade openness (57.7%) of the three clusters. This group is typical of the second trend observed in the PCA, namely the opposition between road distance and trade openness, and the proximity between distance and city size. In addition, the cluster enjoys the worst port infrastructure quality index (3.6 on average), and although it stands second among the three clusters for road pavement rate (37.5%) and logistics performance (2.8), it lags far behind the *major logistics hubs*. The geographic distribution of this cluster is also not random, as such cities concentrate in West Asia mostly, followed by Latin America (with

⁷ For a comparison, the 173 coastal capitals of the world are just below 1.4 million inhabitants on average.

Mexico), and Africa. A common feature is to situate in very large countries, often with important natural barriers such as elevation.

Lastly, the third cluster is named *underdeveloped corridors* as it cumulates the lowest scores in nearly all aspects, except from the degree of trade openness, which is the highest among the clusters (86.5%). It ranks second for port infrastructure quality (3.7) and distance to the coast (188km), although the two values remain rather low. This cluster therefore participates in the first trend observed 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 other clusters, these capitals are 35 times larger than their maritime gateway on average, against 14 for constrained metropolises and 13 for major logistics hubs. The geographic distribution of the cluster covers Central America / Caribbean, Eastern Europe, Southeast Asia, and Africa, notwithstanding the special case of Pyongyang in North Korea. Many of these economies have faced political instability and crisis in the past decades or so, contributing to the poor state of 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 belonged countries⁸.

[Figure 3 here]

[Figure 4 here]

⁸ For Latin American cases in this cluster, a strong spatial (trade) friction is elevation, as the search for gold and the presence of an indigenous people (agriculture, buildings, wood, water) were prime location factors to settle most capitals in the colonial period (Hardoy, 1993). For former (or current) socialist states as well as autocratic regimes, the prevalence of political over economic imperatives often resulted in the (re)location of the capital city in the interior as a mean to better control the territory, with a reluctance against maritime trade compared with land transport (Vigarié, 1995). By contrast, “most traditional Asian cities were located inland and performed primarily administrative and cultural functions” until the European colonial rule (Murphey, 1969). In the greater part of Africa, the capital (like the nation state) is a relatively recent concept (European), except for historic and native cases (Arab area, ancient empires) (Hamdan, 1964).

5. The role of port choice and intermodalism for selected cities

5.1 Paris: between the Seine axis and the Benelux

In France, the Greater Paris Region⁹ (GPR) concentrates 18.5% of the population and 31% of the GDP. It also generates 21% of the exports and 26% of the imports (in value). Most of the maritime trade is containerized, and the retail sector, automotive industry, aeronautics, and luxury sector play important roles.

The port of Le Havre is, by far, the GPR gateway with about 50-55% of the regional tonnage, followed by the ports of Benelux with about 20% (Guerrero, 2019). However, the dominance of Le Havre is less clear when it comes to Asian trade. In such a case, the Benelux ports dominate at the East and the North, where most of the groupage transport terminals are located (Heitz et al., 2019). The sharp reorientation of French international trade towards China during the past two decades has played in favor of Benelux ports (Guerrero and Pais-Montes, 2021).

Most of the maritime trade of the GPR is carried by road (85%). During the past two decades, the modal report policies implemented by successive governments have failed to curb this trend. 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 called Haropa. The other one is the Seine-Nord-Europe canal project, heavily funded by the French State, the European Commission and the Northern region¹⁰. These two corridors are not only competing to attract public investments, but also compete to attract the GPR maritime trade. From the perspective of the GPR this could be positive, since it enhances competition between Le Havre and Benelux ports. However, there

⁹ Région Ile-de-France

¹⁰ Région Hauts-de-France.

is also a real risk of overcapacity, given the limited demand of the GPR as compared to core European regions such as the Randstad or the Ruhr.

5.2 Seoul: trade reorientation through West coast ports

In South Korea, the capital region includes Incheon, Seoul, and the Gyeonggi province, which altogether concentrate about half of the nation's population and GDP. Seoul is the manufacturing hub of this export-oriented economy. Two major changes occurred in the past three decades: the fast growth of high-valued exports (semi-conductors, mobile phones, automobiles, vessels), and the reorientation of trade towards China, both resulting in the increased importance of West Coast ports of which Incheon, Pyeongtaek, and Gunsan. Cargo flows between Incheon and Seoul occur dominantly by road, suffering from high congestion due to their volume and the mix with passenger cars. While this corridor is too short to bet on railway (30km), the canal's limited capacity did not allow cargo transfers from road to river. Despite its initial ambition to allow direct sea-river container shipping between China and Seoul, the canal is in fact too narrow to allow 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, of which the proximity to global shipping lines and Japan for transshipment. Busan New Port is directly connected to Seoul Uiwang Inland Container Depot (25km south) by railway; 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 hinterland¹¹. As underlined by Lee

¹¹ More than 60% of Busan's container throughput comes from transshipment. The Seoul-Busan Grand Korean Waterway project imagined in 2008 was abandoned for environmental and economic reasons.

and Rodrigue (2006), “*Using Busan instead of Incheon [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 airport (including air-sea cargo), R&D facilities, universities, and top-level residential amenities, through central and municipal government efforts 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 devoted to Incheon city itself, followed by Seoul (17%) and the Gyeonggi province (37%), namely about 90%. In comparison, Seoul and the Gyeonggi province only occupy about 9% and 0.5% of Busan and Gwangyang ports’ container traffic, respectively (Li et al., 2018).

5.3 Mexico City: complementarity between Atlantic and Pacific gateways

Greater Mexico City concentrates about 17% and 22% of the country’s population and GDP, respectively. It possesses multiple gateways on both Pacific and Atlantic coasts. However, since the implementation of the North American Free Trade Agreement (NAFTA) in 1994, more than 50% of Mexican trade occurs with the United States, materialized by one dominant trucking corridor passing through Laredo at the border with Texas (Haralambides and Londono-Kent, 2004). This situation is not without creating bottlenecks and delays, with the concentration of passenger traffic on the same motorway and the increase of empty truck movements. In addition, large retailers and manufacturers located their warehouses at both ends of the corridor. Intermodal transport by rail increased fourfold between 2000 and 2012 (Martner and Garcia, 2015), involving Pantaco terminal in Mexico City, the largest by 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, as Manzanillo, Lazaro Cardenas (Pacific), and Veracruz (Atlantic) are among the top five intermodal terminals in the country.

Martner (2002) well depicted the changing port geography of Mexico since the 1980s. A relatively balanced inter- and intra-coastal container traffic distribution characterized Mexican ports in the late 1980s, as well as a limited inland cargo penetration, before Manzanillo and Veracruz came to dominate their respective range in 2000, with a traffic dominance of the Gulf Coast. 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 through Asian imports¹². As such, the container traffic share of the East coast dropped regularly from 68% to 31% between 1997 and 2013 (Wilmsmeier et al., 2015).

A geographic division of trade is thus in place to serve Mexico City, as Veracruz handles 65% of its traffic with Europe and the Mediterranean, and 35% with Latin America. The capital city represents about 40% of 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). The latter authors well 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 against 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 within the terminal area of the port), the lack of direct rail access to the port container terminal, the lack of equipment for intermodal rail transport, the rail industry’s

¹² Data from the World Bank for the year 2019 shows that Mexico’s imports were dominantly from USA (45.3%) and East Asia and Pacific (33.0%), followed by Europe (12.2%).

preference for bulk transport over containers, and a longer travel time by rail (12h) than by truck (9h) with the capital city.

5.4 Moscow: transit trade or self-sufficiency?

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 benefitting from shorter distance and good transport connections with the hinterland (pipelines, rail) (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) concentrates about 15% and 25% of the country’s population and GDP, respectively. Road transport keeps dominating inbound (95% modal share) and outbound (79%) traffic in this north-western region, but inland port terminals with rail access are developing fast (Korovyakovsky and Panova, 2011). Nevertheless, ports in the Baltic States, such as Tallinn, maintain important market shares thanks to better railway connections (with same gauge), and “unbeatable cross-border processes” compared with road (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 it raises the issue of their extreme vulnerability (Serry, 2017). This is compensated by a Russian strategy of self-sufficiency whereby liquid bulk exports, which constitute half of Russian exports, are reoriented towards 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 is strategically located between Abidjan port and the landlocked countries of Mali and Burkina Faso. This corridor is the only railway line and expressway of the country. Since its independence in 1960, numerous reforms and international agreements have been achieved to improve freight circulation, together with the reduction of roadblocks from a hundred to about 33, but transport frictions remain high (Toguet and Kablan, 2018). The unique railway, which dates back to the colonial period, has barely been modernized. Besides its collapse in 2016 having caused important cargo losses, it reaches a maximum speed of 10km/h, while wagons are insufficient to meet the demand and many are outdated, thereby forcing supply chain actors using road transport.

The only road segment technically safe lies between Abidjan and Yamoussoukro, the rest of the network being subject to potholes, accidents, delays, unplanned repairs, and robberies. This situation is aggravated by the poor technical standard and outdated character of the vehicle fleet. Police or customs frequently stop trucks on their way to/from the hinterland and practice racketeering on drivers. These fallacies explain the higher cost (double) of hinterland transport in this country compared with its neighbors (i.e., Senegal, Ghana, Togo) to reach the same destinations. Customs controls may take up to 80mn at the border with Burkina Faso, compared with 15-24mn from Togo.

In this transport chain, the port of Abidjan itself is subject to important 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 vehicle to avoid robberies.

As the second largest city in the country after Abidjan and given its position as a crossroad, Yamoussoukro is somewhat preserved from a number of 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 nearby and preexisting cities Bouaké and Toumodi (Chaléard and Dubresson, 1993). Despite rapid urban growth from 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 all contributed to delaying its take-off, as seen with the emergence of survival strategies such as mobile street vendors using wheelbarrows (Babele, 2020).

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

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

The first corridor runs over 231 km from Phnom Penh to Sihanoukville. The throughput of the latter has grown considerably over the last decade, from less than 300,000 in 2013 to 750,000 TEUs in 2021. However, it can only play a role of regional/feeder port since it can accommodate vessels of a maximum of 2,000 TEUs. About 80-90% of the hinterland volumes of Sihanoukville 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 as 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 and Cai Mep, through waterway (300-350 km) and road (230-300 km). Along the Mekong River a barge can carry up to 144 TEUs, and can operate all year long, even during the dry season and despite border crossing and obstacles such bridges and electric lines (Shibasaki et al, 2021). The river port of Phnom Penh has been recently expanded to face rapidly growing volumes. In 2021 it reported a throughput of 348,898 TEUs. Alternatively, the road is also used to connect Phnom Penh with Vietnamese ports. A flow of about 100,000 TEU transits annually through the border (JICA, 2018). In the connections with Vietnam, inland waterway transport appears as 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 true 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 the Asian Development Bank (ADB) launched a program for regional economic cooperation focused on corridor development. Since 1992, 20.4 billion USD were invested in the GMS, mostly in transport and energy infrastructure (ADB, 2017). More recently, China, has strongly invested in transport infrastructure in Cambodia through the Belt and Road Initiative. The involvement of China may have allowed

Cambodia to increase the support to its infrastructure sector not only by 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 study object. Without information on the precise distribution of imports and exports at the city and port level, international comparisons are necessarily approximative. Based on available data however, our research could propose an analysis of 64 inland capital cities, and answer several key questions of the transport and economic geography literature. While larger cities tend to generate more traffic, this relationship is very much influenced by transport infrastructure quality and logistics performance. 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 various schools of thought in international trade studies, but the innovation is to provide a city-level and comparative approach. Moreover, our results provide for the first time an empirical validation of Fujita and Mori (1996)'s model, whereby coastal cities are larger as distance to the (inland) core region is longer and transport conditions are poorer, 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 are located 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 trade openness, largely due to unstable political environments (e.g., Central America, Balkans, Africa). In between, *constrained metropolises* suffer from remoteness, bad transport

infrastructure, and low trade openness, which are somewhat compensated by coastal and inland city size.

The case studies succinctly confront such findings with the concrete organization of corridors. For Paris, Moscow, and Phnom Pehn, the possibility to access maritime networks through foreign gateways is a clear advantage compared with Seoul and especially Yamoussoukro. A commonality between Seoul and Mexico City is to benefit from two national coasts respectively, which is another advantage, although for Seoul, accessing Eurasia is not possible due to the separation between the two Koreas. In terms of intermodalism, the low congestion level to/from Paris does not come from modal substitution, given the dominant high share of road with both Le Havre and Antwerp (and the low utilization of the Seine River), but from a more even distribution of cargo flows among these two corridors. Despite its low rank in transport quality indicators, Mexico City is well connected by rail, like Moscow, and congestion is not reported as a major issue except from high ship turnaround times.

Further research shall lean towards several pathways. In the OECD region or within continents where information is accessible at the city level, economic indicators such as metropolitan GDP or employment could be envisaged 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, or a more bottom-up selection of corridors. Network analysis could help to estimate their road and sea-land accessibility, and allow measuring an index of maritime specialization or dependency in a multiple city / multiple port system. The inclusion of qualitative parameters to characterize port choice, modal choice, and the existence of cross-border options may refine international comparisons, together with several other spatial frictions (e.g., elevation).

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Country	Inland city	Population (thousands)	Air cargo (tons)	Port gateway	Population (thousands)	Vessel traffic (DWT)	Distance (km)
Nigeria	Abuja	1353	6158	Lagos	9968	5751786	764
Jordan	Amman	1206	42412	Aqaba	101	1961762	326
Turkey	Ankara	4094	834	Istanbul ports	13346	401796	444
Madagascar	Antananarivo	1688	0	Toamasina	225	638659	355
Eritrea	Asmara	664	1416	Massawa	49	47036	113
Greece	Athens	3952	45157	Piraeus	179	3746211	12
Iraq	Baghdad	5402	1127	Basrah-Um Qasr	1914	1487500	532
Brunei	Bandar Seri Begawan	140	2322	Muara	280	255994	31
China	Beijing	16440	498368	Tianjin	4862	9068299	114
Germany	Berlin	4033	7157	Hamburg	1899	9879468	284
Colombia	Bogota	8465	217929	Buenaventura	321	2414134	507
Congo Republic	Brazzaville	1253	1347	Pointe Noire	690	814398	508
Belgium	Brussels	2131	150732	Antwerp	1137	15272475	55
Romania	Bucharest	2171	7046	Constanta	298	4159177	227
Egypt	Cairo	13488	127828	Alexandria	4485	4103667	226
Venezuela	Caracas	4558	46290	La Guaira	31	870028	30
Bangladesh	Dacca	13015	0	Chittagong	3868	1798377	248
Syria	Damas	2274	2443	Tartous	98	1365531	255
Tanzania	Dodoma	180	0	Dar-es-Salaam	3212	1502115	445
Guatemala	Guatemala City	3541	37773	Puerto Quetzal	8	2342516	106
Vietnam	Hanoi	1545	57765	Haiphong	636	546813	118
Pakistan	Islamabad	804	35399	Karachi	12418	7394512	1411
South Africa	Johannesburg	7262	115795	Durban	3512	7788865	568
Sudan	Khartoum	5904	11609	Port Sudan	580	1027970	842
Ukraine	Kiev	3184	19181	Odessa	1106	3109283	475
Rep. Dem. Congo	Kinshasa	8901	1437	Matadi-Boma	459	249540	329
Malaysia	Kuala Lumpur	7088	380853	Port Klang	1114	14811945	41
Peru	Lima	8000	77677	Callao	813	2969789	12
Slovenia	Ljubljana	258	2141	Koper	23	2012023	106
Spain	Madrid	5692	222117	Valencia	1816	7138815	356
Nicaragua	Managua	1417	24840	Corinto	16	210552	156
Mexico	Mexico City	21409	182036	Veracruz	622	2983141	397
Russia	Moscow	14184	89554	St. Petersburg	4632	3565538	706
Kenya	Nairobi	3489	82953	Mombasa	918	687833	488
India	New Delhi	21750	277764	Mumbai	13707	4171172	1404
Cyprus	Nicosia	272	0	Larnaca	51	271155	56
Canada	Ottawa	1009	3912	Montreal	3677	2315965	198
France	Paris	10390	654221	Le Havre	254	10785371	196
Cambodia	Phnom Penh	1486	9031	Sihanoukville	153	313292	228
Montenegro	Podgorica	146	0	Bar	15	248477	52
North Korea	Pyongyang	3270	139	Nampo	471	7023	58
Ecuador	Quito	1650	73824	Guayaquil	2286	892346	439
Morocco	Rabat	1819	0	Kenitra	403	17251	53
Saudi Arabia	Riyad	4878	33793	Dammam	1564	2621211	409
Italy	Rome	3501	64601	Civitavecchia	51	512349	71
Costa Rica	San Jose	1374	45418	Caldera	40	806599	85
Salvador	San Salvador	1779	28212	Acajutla	28	920863	81
Yemen	Sanaa	2079	2263	Hodeidah	471	767373	253
Chile	Santiago	5197	49889	Valparaiso	840	2448422	121
Brazil	Sao Paulo	19745	226678	Santos	1824	10202502	82
South Korea	Seoul	19665	1936304	Incheon	2554	8228184	34
Bulgaria	Sofia	1149	2739	Bourgas	190	1020241	387
Georgia	Tbilisi	1272	6511	Poti	47	779996	323
Honduras	Tegucigalpa	1106	518	Puerto Cortes	61	1739579	306
Iran	Tehran	12089	7622	Bandar Khomeini	70	1464084	935
Albania	Tirana	570	160	Durres	180	352658	38
Lithuania	Vilnius	543	1268	Klaipeda	192	2834530	307
Poland	Warsaw	2324	64652	Gdansk-Gdynia	831	2861094	340
USA	Washington DC	600	123103	Baltimore	632	8021920	62

Namibia	Windhoek	316	20	Walvis Bay	67	438600	396
Côte d'Ivoire	Yamoussoukro	242	0	Abidjan	4419	5179286	236
Cameroon	Yaoundé	1812	1841	Douala	2143	42630	237
Croatia	Zagreb	706	2770	Rijeka	138	795070	161

Table 1: Sample of selected cities

Variable	Description/unit	Source
Population of the inland city	Thousands of inhabitants of the metropolitan area (LN)	World gazetteer (2010)
Population of the port city		
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)
Port container throughput	Twenty-Foot Equivalent units (LN)	Containerisation International (2008)
Air traffic of the inland city*	Number of tons (LN)	OACI (2009)
Elevation of the inland city	Meters	City Elevations Worldwide (2021)
Paved roads	Pavement rate (%), country level	CIA World Factbook (2010)
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)

Table 2: Selected indicators

* Traffic for Incheon international airport

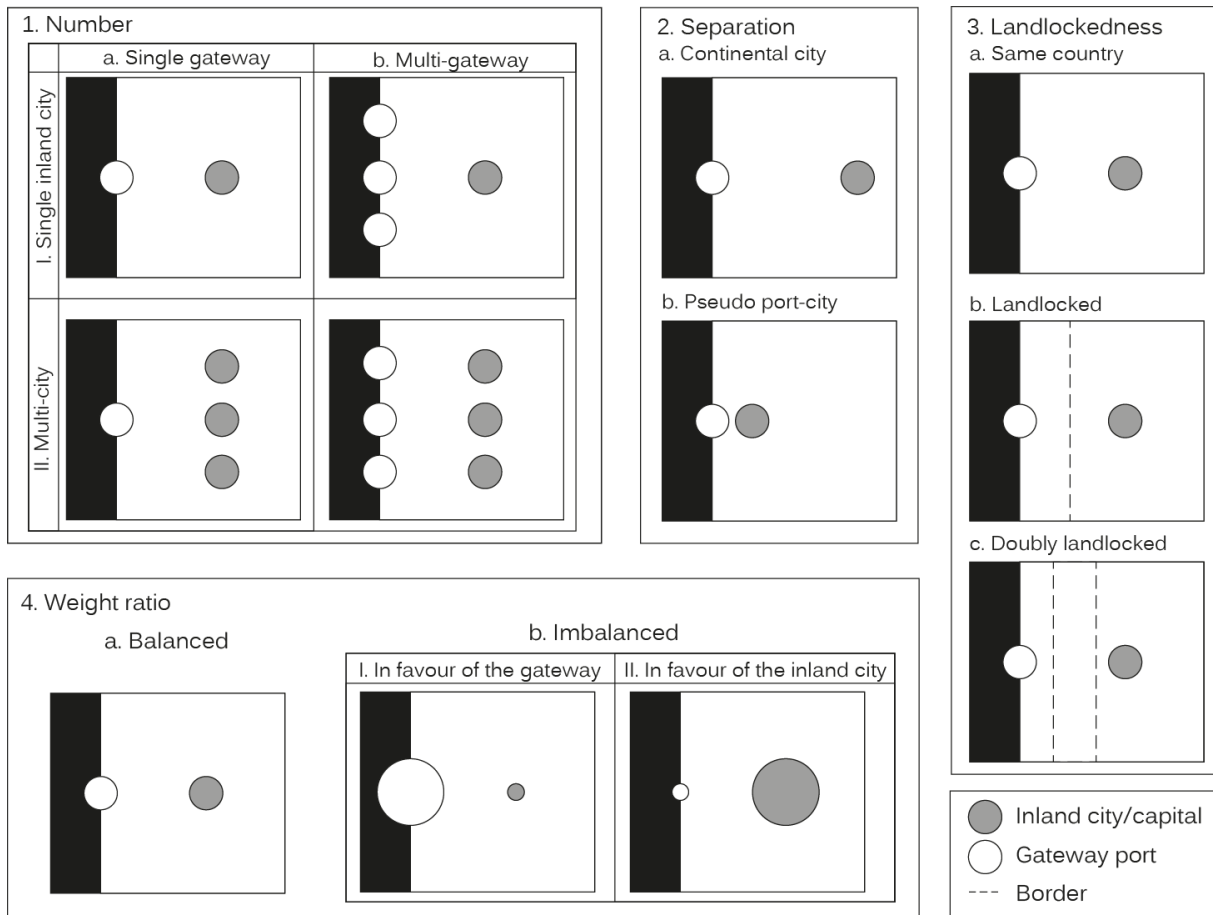


Figure 1: The different spatial configurations

Source: own realization

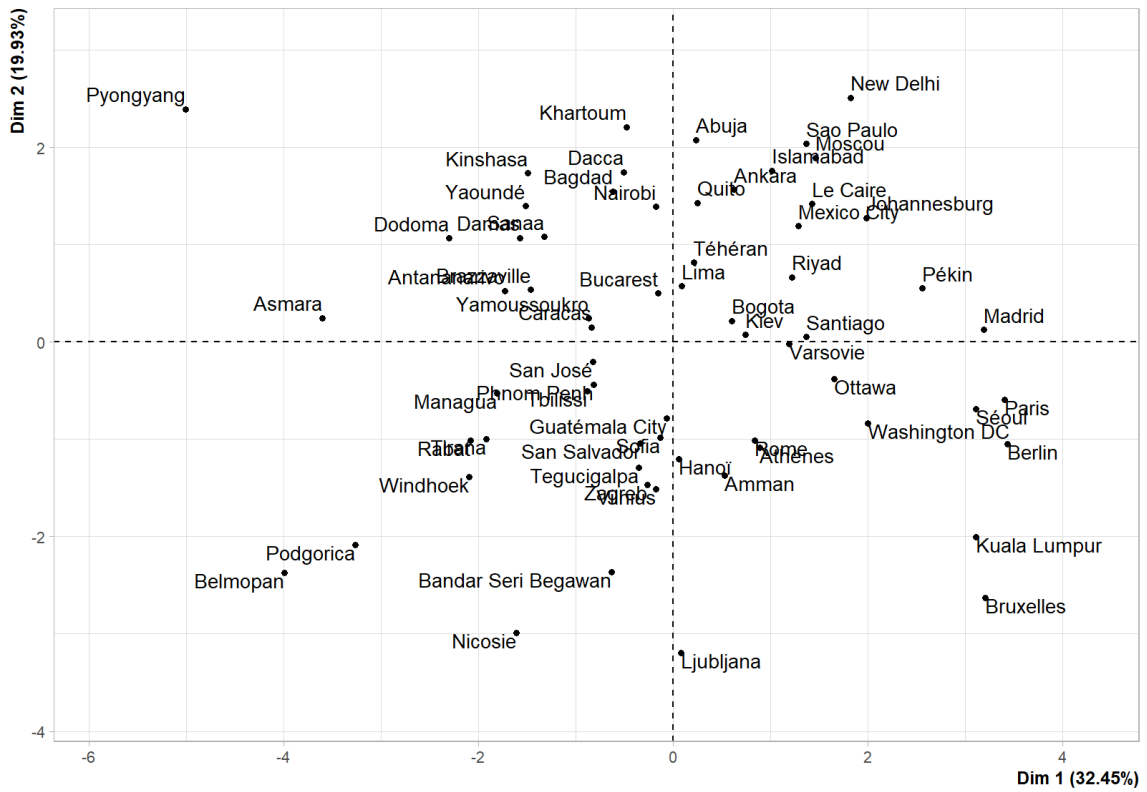
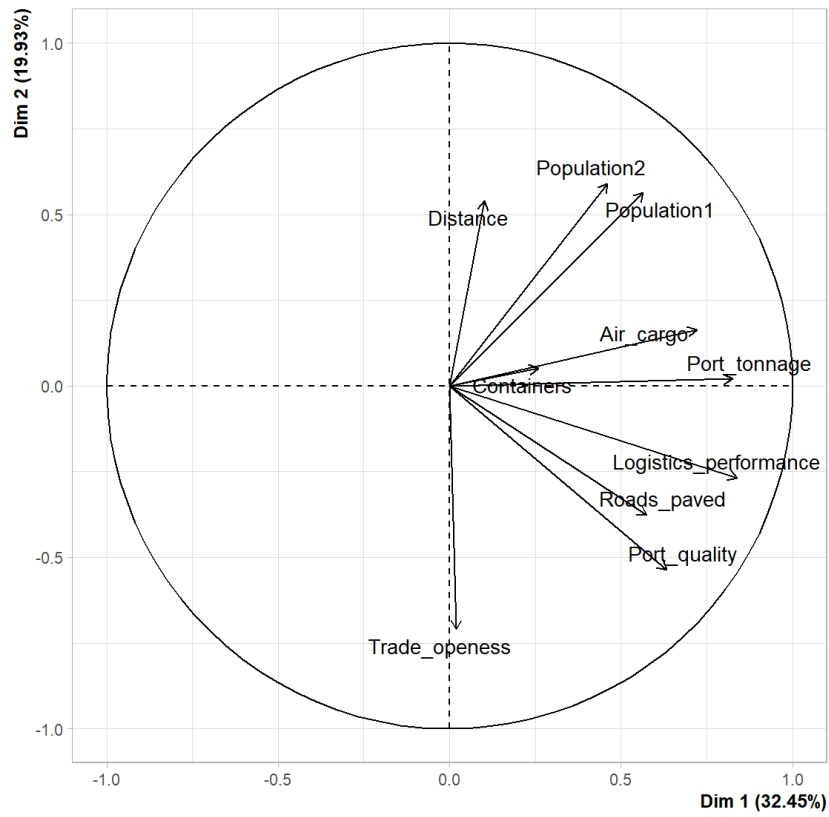


Figure 2: Cross-analysis of inland capital cities

Source: own realization

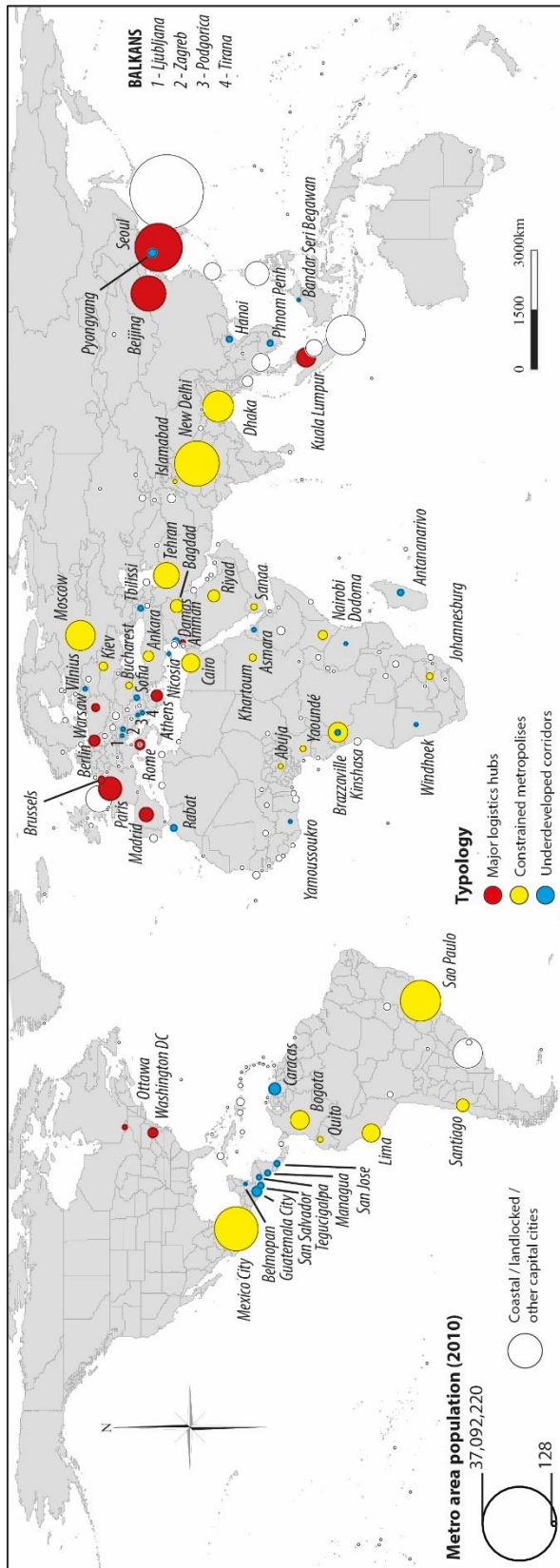


Figure 3: Typology of inland capital cities

Source: own realization

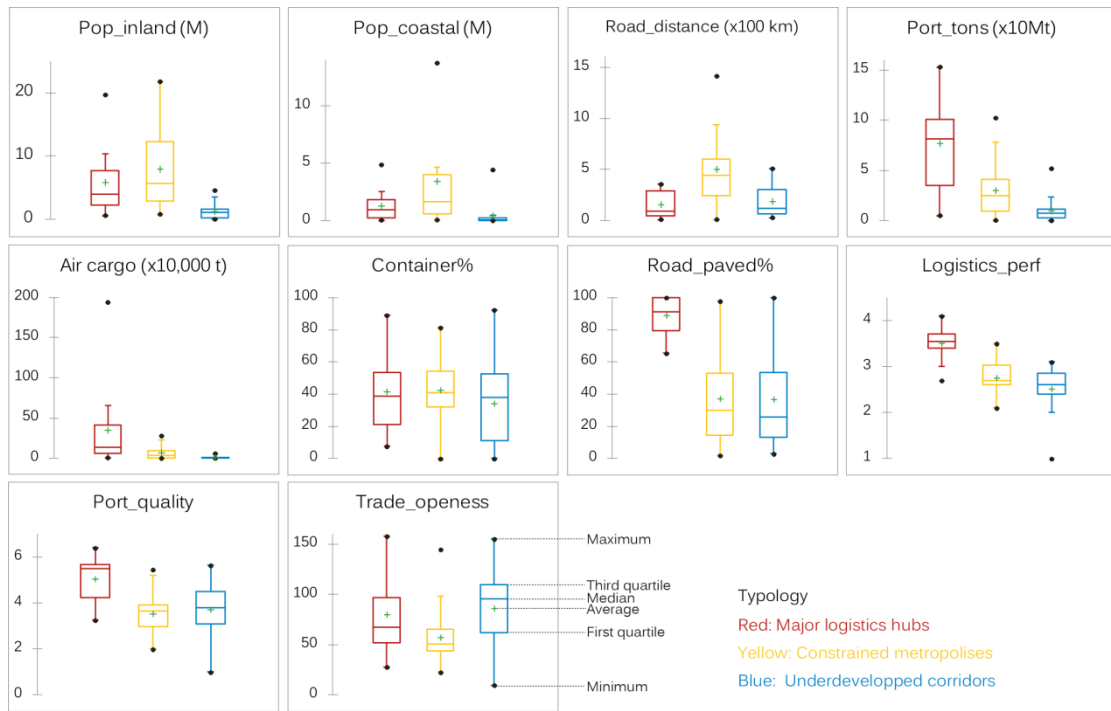
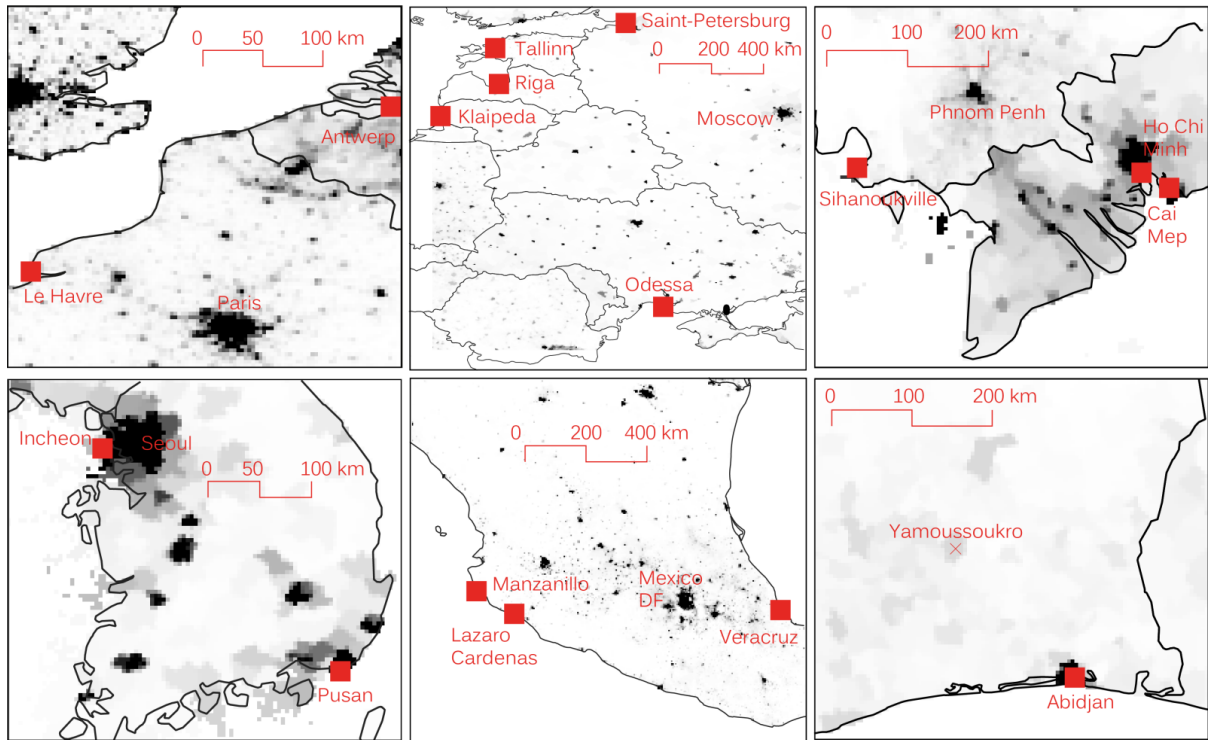


Figure 4. Box plots for the three clusters

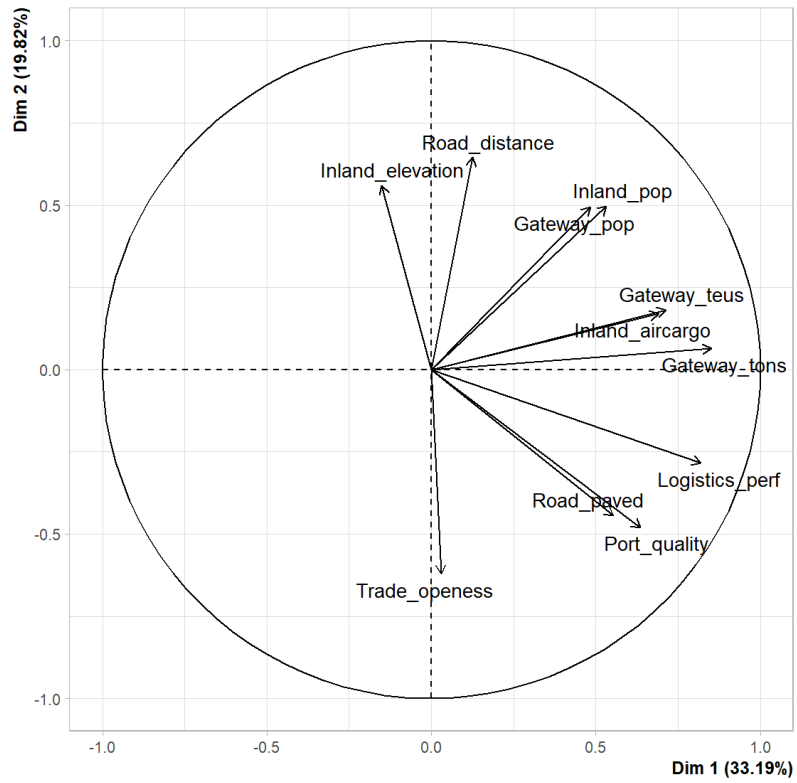
Source: own realization



Grided population of the world. 2.5 min/arc resolution. Source: SEDAC (2020)

Figure 5. Geographical setting of the six case studies

Source: own realization



Appendix 1: Principal Component Analysis including inland city's elevation and gateway's container port throughput

Source: own realization