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ABSTRACT

This paper proposes a continental approach to the combination of transport functions within European port cities. It reviews a number of concepts and theories, regarding with transport chain integration and urban centrality in the case of ports. While many studies on intermodalism face a lack of quantifiable data, this research proposes an original methodology based on employment. The data is collected for 76 port cities, 9,000 companies and more than one million employees in all transport modes. By bringing together employment figures and basic urban and port indicators, results of the factor analysis show the different functional and spatial trends. There is a recurrent opposition between freight and passenger-oriented specializations among port cities, which are also influenced by the European core-periphery spatial pattern. In addition, a benchmarking of port cities in terms of their intermodal potentials is provided as a means for policy implications.

Keywords: Core-periphery, Europe, Freight, Intermodalism, Logistics integration, Passenger, Port city

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1. INTRODUCTION

In Europe, maybe more than in other major port regions of the world, the integration of transport functions is a crucial problem for planners and related companies. In order to support growing trade amounts efficiently, transport and logistics players have elaborated new strategies through the promotion of logistic chains, induction of high-tech systems, and door-to-door services for just-in-time freight delivery. The context of globalisation and the emergence of containerisation are important factors to motivate players to adapt themselves to the demand and supply of industries. As a consequence, transportation nodes, of which ports, are embedded in the new paradigm of value-driven transport chains (Robinson 2002). The concept of integration encompasses a number of issues like the intermodalism, inter-firm cooperation and the institutional aspects of transport planning at local, regional, national and international levels (Goetz and Rodrigue 1999; Mc Calla et al. 2001).

However, most approaches of intermodalism in the related literature either focuses on managerial, institutional aspects (Langen de and Chouly 2004), with little regard to analytical frameworks and conceptual models (Bontekoning et al. 2004). Thus, comparative studies and spatial studies are very few, notably on an international level, while there is a growing literature based on case studies. Therefore, this paper questions the existence of general factors that would explain – at least in part – the fact that in Europe, "real intermodal junctions which comply with the complex physical and functional demands (…) are still very rare" and "there is no transport company which is responsible for either building or operating intermodal junctions" (Keller 2004). Is it

possible to highlight invariant factors affecting transport nodes and their modal diversity, beyond the physical site and the individual strategies of transport firms in particular contexts? In the case of ports, some authors have argued that the development of containerization strengthens the dependence of ports on remote markets and, as a consequence, lowers the port's ability to create local externalities of which the development of a diversified intermodal network (Notteboom and Rodrigue 1999; Ducruet 2006). Then, a rise in volume and efficiency of handling techniques and distribution within and surrounding port areas do not necessarily lead to more integrated and diverse transport functions. Out of Europe, other cases show the combination of a wide set of activities, as seen in New York with the port authority (PANYNJ) also implicated in rail service between port and hinterland, the management of highways, and waterfront redevelopment (Rodrigue 2003). Asian countries offer different combinations, such as air-sea connection for freight, as seen in the global hub port cities of Hong Kong and Singapore (Lee 2005), but also in Dubai, and Incheon 'Pentaport' in South Korea. In Asia and North America, the combination of transport functions within port cities is facilitated by the coastal concentration of populations and economic activities.

In order to provide a global snapshot of the European situation, this paper proposes a continental approach to intermodalism, as argued by Hayuth (1987): "intermodal transport is highly correlated with the geographical setting and spatial organization of the region and continent". In Europe, every transport node can be thus considered as one element of a continental urban system. By shifting intermodal issues from transport to urban considerations, it is possible to interpret the different modal specializations of the transport nodes as part of a wider - and more classic - research area focused on the functions of cities. Because the literature on urban functions and urban systems in general is largely developed elsewhere, this paper can be considered as a first

attempt to relate those to intermodal issues. As for any international comparison of economic activities shaping the economy of cities, it faces a series of challenges to find the relevant data that could help verifying how different transport modes are more or less represented in an urban system.

Most frequent measures of modal shares at seaports are based on traffics by categories (sea, road, air, railway, river…). However, such dataset is not yet available throughout Europe for a number of reasons. First, European-wide datasets do not exist on modal traffics by city or even by region or province. Even case studies on intermodality rarely provide a detailed snapshot of the modal split in a single place. Port authorities that are willing to provide their statistics on modal traffics (e.g., sea, river, rail, and road) are very few, and, not only such datasets are often not comparable among different ports, but it also remain confined within the port area. Because transport and logistic activities are key elements in the port-city relationship, their measurement should be extended to the whole port city. Second, as hinted by Mc Calla et al. (2004) in the case of inland logistics, "there are no common data sources, and (…) quantifiable sets of parameters cannot be produced" [and the] "lack of comprehensiveness of indicators of logistics operations restricts any substantive evaluations". This explains why previous studies of intermodality at European ports have chosen an infrastructure-based approach (Joly and Martell 2003). Since every mode has its own measurement units, which are not directly comparable, such as different tons, containers, passengers, and so on, it is believed that such constraints can be partly relieved by an analysis based on the employee, a single unit.

This paper argues that employment is a good indicator of the weight of transport and logistic activities within port cities, while "transport workers get little attention" when dealing with intermodalism (Barzman and James 2004). New variables built from

employment figures collected from the Kompass[1] database allow using classical quantitative techniques such as factor analysis, which are used extensively in the case of ports (Tongzon 1995; Lee and Kim 2006). Furthermore, such data source seems more effective than the collection of national-based censuses already used in previous studies. For example, analysing the distribution of employment in transport activities by using local data and national census has proved very challenging while comparing Le Havre and Southampton due to the mismatch of the different classification systems (Frémont and Ducruet 2002). Recent studies of port-related employment (Gripaios and Gripaios 1995; Gripaios 1999; Musso et al. 2000) benefit from the existence of nation-wide datasets, but remain limited to a single country or place, such as Plymouth or Genoa. Although a methodology based on modal figures might not be matched with the core issue of intermodalism, or may even contradict the concept itself based on the integrated transport of unitised goods (ECMT 1993), at least it can be considered as an attempt to evaluate the different ways in which transport functions are *associated*, rather than effectively *combined*.

The first section introduces the theories of port-urban linkages with regard to the European case, and addresses the main hypothesis of the research. The second section introduces the methodology used for selecting port cities and measuring employment in all transport activities. The factor analysis in the third section allows illustrating the major trends of logistics integration and intermodalism in Europe, together with their spatial distribution. Finally, some implications of the results are given for ports, port cities, industries, and related planning and policies.

2. PORT-URBAN LINKAGES AND LOGISTICS INTEGRATION IN EUROPE

[1] http://www.kompass.com

2.1 Ports and Economic Functions

The case of ports is often peculiar, traditionally combining the advantage of maritime transport and the disadvantage of land transport, as "eccentric centres" (Bird 1973). The theory of gateway functions (Bird 1977), which has been relevant in Europe during periods of coastal urban development and industrialization, implies that port cities can overcome their peripheral situation through economies of scale brought by maritime transport (Vallega 1983; Goss 1990) and, in some cases, reach higher rank and size than those determined by the central place theory.

The gateway theory, which aimed at giving ports a more respectable position within urban studies, has been verified in some cases like Bordeaux (Gutmann 1986), Le Havre and Southampton (Brocard 1994), which have grown more than the central place theory would have predicted, thanks to their wide connections to global maritime systems. The development of global cities is based on this paradigm (Keeling 1995), as most of these places developed from maritime functions (Dogan 1988) and attracted regional air hub functions, while dominating their hinterland for rail and road transport infrastructures and services. However, such trends are more likely to be found in the developing and formerly colonial world, with the formation of primate cities (McGee 1967), rather than in Europe. Thus, there is a strong diversity of hinterland spatial organizations on a continental scale, as showed in Figure 1.

[Insert Figure 1 about here]

Another theory on the "self-agglomeration and hub effect" taking place in port cities has developed the "lock-in effect" of urban systems (Fujita and Mori 1996). Because already established urban centres retain major economic functions, those

functions cannot be developed through or attracted by modern ports and terminals, which are planned outside cities and do not have a sufficient attractivity or employment returns. This particularly applies to spatially centralized countries where core areas such as Paris, France or Seoul, Korea concentrate higher service functions while port cities such as Le Havre, Marseilles, Incheon and Busan are specialised in industrial and port functions (Frémont and Ducruet 2005). This is also hinted by Stern and Hayuth (1984) in their model of the remote gateway, in which port functions do not foster urban development, in terms of economic diversity or urban demographic growth. In the end, it is assumed that the variety of transport functions in port cities is a corollary of their urban and regional economic diversity. Furthermore, the regional environment of port cities is also dependent on the geographical, political and economical fragmentation of Europe regarding intermodal transport issues (Charlier and Ridolfi 1994).

2.2 Freight Transport vs. Passenger Transport

The implications of such theories are important for European ports in many ways. The liberalization of the European market is giving more impetus to port competition and concentration in serving a single and extending hinterland. However, the positive effects of traffic growth on local economic diversity can be questioned. While the connection between ports and the European heartland is getting more complex and more efficient, port cities remain secondary markets compared to the rest of the hinterland. The improvement of transport linkages between ports and the hinterland, in fact, do not motivate economic players to invest in port cities. Several studies indicate a lower economic weight and diversity of port cities in Europe (Lever 1994; Rozenblat 2004). Inland cities tend to retain higher functions (Brunet 1989; Rozenblat and Cicille 2003). This spatial division of functions has taken place, with heavy industry shifting towards

ports from the 1960s, accentuating their dependence on uneven global change, and leading to the combination of higher unemployment and lower services (Lawton and Lee 2002). This also explains why port cities have been often given lower ranks in urban typologies (Pumain and Saint-Julien 1976). The risk for the European transport policy is to reinforce the problems of peripheral regions (of which port regions) while seeking to improve their connection to core regions. Oppositely, the problems faced by port cities can be turned as advantages, notably in terms of waterfront redevelopment, as seen as one example of urban regeneration (Gordon 1997; Hoyle 2000; Marshall 2001). One important strategy of port cities is, therefore, to develop passenger transport (air, rail) rather than freight transport, as a means to improve their position within the European urban system and their economic attractiveness. Thus, the purpose of gateways to bypass "the threat of traffic gridlock in metropolitan areas" [and to improve their] "unique position to stimulate intermodal transport in Europe and use intermodal systems as a tool to enlarge their hinterlands" (van Klink and van den Berg 1998) can be seen as both complementing and contradicting the urban strategy. This research is thus also looking at the different associations of transport functions in relation with either port or urban attributes.

3. METHODOLOGY

3.1 Selecting the Port Cities

The sample of port cities is composed of 76 places, representing 871,059,239 tons of waterborne trade (7.2% of world total), 48,374,388 TEUs (16.4% of world total) and 86,128,000 inhabitants (22% of national-related population). Places were chosen throughout European territory for their belonging to both seaborne container and air services, each of them reflecting a specific dimension of transport networks. Some cities

being only inserted in one of the two services have been excluded, like Felixstowe, Zeebrugge, Dunkirk, Gioia Tauro, Algeciras, Messina, Salerno, Kotka, and Marsaxlokk. Moreover, inland port cities have been excluded even though they share both river trade and air traffic like Paris, Strasbourg, and Duisburg so as to keep a geographical homogeneity based on seaports. Estuarine upstream port cities, being more close to the sea, have been kept, like Nantes, Bordeaux, Rouen, Hamburg, Rotterdam, Sevilla, Antwerp, Bilbao, Bremen, Bristol, Cardiff, Southampton, Glasgow, Hull, and London although there shall be an effect of this particular location on their modal split. Due to data collection on a metropolitan rather than a local administrative level, some cities may have their population larger than generally.

3.2 Measuring Employment

Given the trend of logistic development in outer urban areas, employment figures have not been restrained to the inner city area. Many activities such as air transport and related logistics, distriparks, multimodal platforms and also container terminals tend to locate at peripheral sites that are more convenient for environmental and technical matters. We have therefore considered the various official metropolitan areas in all countries. When this was not provided, the contiguous or morphological urban area has been preferred so as to include suburban districts (Moriconi-Ebrard 1994), by selecting the companies with their postal addresses.

The Kompass database provides information for a 1.9 million companies in 70 countries worldwide. Because financial information such as annual turnover is not available for all firms, employment has been preferred although it is less efficient to weight the activities. Transport activities have been selected among others by using the different codes (Table 1). Calculating the total number of employees by port city and

transport mode has faced some difficulties. Because several companies operate in more than one transport mode (e.g., sea and air) their employees have been redistributed equally among those different modes. We are aware of the limits of such methods. Table 1 provides the detail of the activities together with aggregated figures. The aggregation of some activities has been necessary to get a clearer picture of the modal distribution, and also to avoid the lack of correlation between the different activities, that is a requisite for a standard factor analysis. In the end, seven categories are kept for analysing the distribution of activities among port cities, from a collection of 8,926 transport-related companies and resulting in a total of 1,154,866 employees. Total employment is well balanced among port and maritime transport (28.1%), air transport (19.5%), logistics and warehousing (15.7%), rail transport (15.4%), road transport (14.5%), and forwarding (6.8%). In the following sections, those employment variables are gathered with basic attributes of port cities such as demographic size (Helders 2005), port traffics (Lloyd's List 2005), and air traffics (Aéroports Magazine 2005). The complete dataset is provided in Appendix A.

[Insert Table 1 about here]

3.3 Preliminary Outcomes

The distribution of employment by main region (Table 2) shows the dominance of Northern Europe in all branches of activities, although it has a comparable number of port cities with Southern Europe. Within the north, the Scandinavia / Baltic area shows a strong specialisation in port, railways, logistics, air, and road transport. This illustrates the historical importance of Scandinavia in the European transport sector. Northwest Europe is better represented by maritime transport, port tonnage and forwarding. This clearly

indicates the strategic position of this region regarding the mass transit of freight movements to and from the European heartland. Comparatively, other areas are poorly represented, except for the British Isles with air tonnage and population (the London hub); West Mediterranean with population, land transport and port tonnage; East Mediterranean with air tonnage. Such differences in employment volumes can also be explained by the different economic structures of the countries. In Northern Europe, major groups are located such as Multinational Corporations, but in the south, transport activities are more likely to be dominated by small and medium-sized companies. Also, the areas have a different history in terms of public/private investment in transport activities.

[Insert Table 2 about here]

In terms of the distribution of passenger-related activities relative to freight-related activities, the spatial pattern is also interesting (Figure 2). Most cities having a high share of passenger-related activities compared to the share of freight-related employment locate away from the European heartland, except for some cities such as Bordeaux and Nice in France, and Amsterdam in Holland. This highlights the importance of remote metropolises that are either national capitals, such as Dublin, Lisbon, Athens-Piraeus, Stockholm, Helsinki, Riga, or regional capitals, such as Gothenburg and Leixoes-Porto. Those major urban settlements combine a lack of inland connectedness with the core regions and the problems related to lack of space for extensive port activities in large urban areas.

[Insert Figure 2 about here]

The distribution of the share of transport employment by mode and by port city offers a better perspective (Figure 3). Although such analyzing tool is not perfect due to the variety of situations, there is a noticeable opposition between different groups of variables and, therefore, of port cities. Port and sea transport employment are opposed to logistics and road transport employment, while air, railway, and forwarding stand in between those two groups. Unsurprisingly, the first group is represented by major seaports such as Hamburg, Le Havre, Genoa, Liverpool, Rotterdam, and Marseilles. The second group by coastal cities where port functions are not very important compared to their role as distribution centres, such as Rouen, Nantes, Bordeaux, Nice, and Brest in France. Finally, the third group, though it is smaller in size, comprises major air transport hubs and large urban areas such as London, Amsterdam, Athens, and Lisbon.

[Insert Figure 2 about here]

However, this snapshot of the situation does not provide sufficient evidence on the interplay of the different transport functions, which can be estimated better through a factor analysis.

4. FACTOR ANALYSIS

4.1 General Trends

Before running the factor analysis, the variables have been changed to logarithms in order to reduce peak values. The factor analysis is based on a Spearman correlation matrix. This latter correlation is calculated by applying the Pearson correlation formula to the ranks of the data rather than to the actual data values themselves. In so doing, “many

of the distortions that plague the Pearson correlation are reduced considerably" (Nagpaul 2005). The graph of most significant correlations (Figure 4) shows both the importance of forwarding activities in the integration of transport modes, and the division between on one side freight-oriented activities (forwarding, road, port, sea, logistics), and passenger-oriented activities, on the other side (railway, air).

[Insert Figure 4 about here]

Results provide four main factors accounting for more than 85% of the total variance (Table 3). The following sections describe the meaning of the observed trends and provide an interpretation of their geographical distribution.

The first logic (F1) gives the most important direction of transport functions' concentration, with forwarding, warehousing, sea and road employment at the top of the hierarchy. This order can be interpreted as a hierarchy of transport nodes across the European continent.

The second logic (F2) clearly opposes maritime transport to air transport. Port traffic, port and sea employment are opposed to air traffic, air and railway employment, and population. It is clear that ports' efficiency attracting freight traffics is not well matched with passenger-oriented activities and the size of cities. Then, places of transit or 'port gateways' are opposed to 'central places' for which the attractivity is more based on passengers (i.e., tourists or high-skilled workers).

The third logic (F3) is also an opposition. Port and air traffics show the importance of freight generation, while road, forwarding and warehousing employment show the importance of distribution and logistics. We propose thus to interpret such trend as an opposition between freight centres and logistics centres.

Finally, the fourth logic (F4) offers a very interesting opposition. Employment in several transport modes (air, port, sea, and railway) is opposed to demographic size and road employment. Although it is a very secondary trend, it can be interpreted as a meaningful distinction between the banal characteristics of cities and their transport specialization. Thus, transport activities will not have a predominant role for 'anycities', while other places with a less developed economy will be more specialized as 'transport nodes'.

[Insert Table 3 about here]

4.2 Concentration of Transport Activities (F1)

The first factor is dominated by forwarding, logistics, and sea transport. It means that those activities are the most commonly represented in the port cities, and are likely to be combined in a hierarchical way. The two most important variables have in common to reflect in the freight sector, but they operate for various industries and act as integrators of different modes, among which sea and road transport are better represented.

As noticed above, northern port cities are more concentrated (Figure 5), notably in the Scandinavia/Baltic area and the northern range (here from Antwerp to Hamburg). Elsewhere, we see the importance of major cities, either national capitals (London, Dublin, Lisbon, and Piraeus-Athens) or regional capitals (e.g., Marseilles, Barcelona, and Naples). The poor representation of the Atlantic Arc and the Mediterranean, for a majority of port cities, comes from their relative peripheral situation from the European heartland, but also reflect different histories. The privatisation of several transport sectors in UK since the 1980s has probably affected employment volumes in the port cities. Another explanation is the different configurations of the national urban systems.

Spatially-centralised countries (e.g., France, Spain) show a lower concentration level in their port cities than more balanced countries (i.e., the 'Rhine' model), due to the primacy of national capitals. The largest and dominant city tends to combine all transport modes while port cities remain specialised in port and distribution. The highest score for Hamburg is easily explained by its central situation within the heartland compared to other port cities, which has undoubtedly fostered its multifunctional character. For instance, several global carriers have elected Hamburg as their European head office, such as COSCO, CSCL, China Shipping, and even Yang Ming moved its head office from London to Hamburg in 1992, illustrating the new phase of the European market and integration.

[Insert Figure 5 about here]

4.3 Port Gateways vs. Central Places (F2)

The radical opposition between passenger-oriented activities (air, rail, population) and freight-oriented activities (port, sea, forwarding), and more precisely of air and port traffics, is emblematic of the distinction in Europe between gateways and central places (Ducruet et al. 2007). The development of airports has followed the already existing urban hierarchy, and thus the pattern of railway nodes, while port activities and maritime transport have developed separately, for the purpose of serving continental markets from eccentric locations. As in the French case, waterway barging and rail transport have been fiercely competing for decades, which had serious consequences on the contemporary 'divorce' between ports and railways (Merger 2004). In terms of statistical relevancy, the combination of port traffic with port employment and air traffic with air transport

employment, although it may appear obvious, is proving the quality of the original dataset from Kompass.

[Insert Figure 6 about here]

The related map (Figure 6) shows clearly the port and maritime specialisation of port cities located along the 'heartland'. Apart few exceptions such as Nice and Amsterdam, most of all other cities are in a peripheral situation. Such spatial and functional opposition clearly reflects the influence of the core-periphery pattern of European activities and settlements on the nature of transport activities within port cities. The specialization of Le Havre and Rouen is accentuated by their proximity to the Paris urban region, their main hinterland. Other similar profiles in northern Italy and along the North and Baltic seas have lower scores probably due to better connections to the heartland. It is interesting to remark that for Barcelona, the air and landside activity is more important than the port and maritime activity, but other port cities located around Madrid are also specialized in port activities. The cases of Bergen, Bari and Constantza are well explained by the absence of an important airport and by their important seaborne bulk cargoes.

4.4 Logistics Centres vs. Freight Centres (F3)

Some cities are more likely to have developed trucking (road, logistics, and forwarding) while other are specialized in the handling of cargo volumes in general (air-sea freight). Although in reality, road transport and sea-air freights cannot be separated, such opposition may be interpreted as a distinction between value-added centres, with

additional activities such as distribution, packaging, and storage, and load centres, which are better defined by the level of cargo volumes passing through.

[Insert Figure 7 about here]

In the map (Figure 7), load centres are concentrated around the heartland (northern range Antwerp-Hamburg and southern range Barcelona-Trieste) and value-added centres are more likely to locate in the western fringe (Edinburgh-Malaga) and in the Scandinavia-Baltic (Aarhus-Helsinki) area, but the pattern is not perfect and has several exceptions. Some are obvious, such as the case of island port cities (Palma, Valletta, St. Helier, and Belfast), where road transport is limited, or the case of remotely located port cities where the airport plays a crucial role for freight (e.g., Bergen, Edinburgh, and Thessaloniki). Value-added centres usually have lower port activities and are more likely to be regional economic centres for their regional or national economy (e.g., Rouen, Nantes, and Bordeaux).

4.5 Anycities vs. Transport Nodes (F4)

Although this factor is less weighty (only 6% of the variance) as shown in Table 3, if offers a possibility to distinguish cities according to their overall level of specialisation in the transport sector. For some cities, their size as market centres is more important than the employment generated in transport activities. Inversely, some cities are developed in the transport sector but they are not well represented as market centres. Again, such distinction between central place and gateway is usual in Europe and is depicted in a vast literature such as typologies of cities (Ducruet and Lee 2006).

When transferred to a map (Figure 8), this trend takes a remarkable signification. Market centres locate mostly in the western part (from southern Iberian Peninsula to British Isles) and in the southeast (southern Italy and Greece). Transport nodes concentrate in the Scandinavia-Baltic area, northern Italy, and some more in Ireland and along the English Channel. For the southern cities, perhaps it is reasonable to explain their profile by the importance of tourism in their development. The rapid urbanisation of coastal zones, notably along the Spanish gold coast since the 1960s, has increased the size of cities while their traditional industries and ports have stagnated. For the British cities, the aforementioned argument on the probable effects of privatisation on the transport sector is again well illustrated. Large urban areas exist in UK, but it is not accompanied by equivalent employment either in industrial or transport activities.

[Insert Figure 8 about here]

4.6 Balanced vs. Unbalanced Modal Splits: A Synthesis

A possible method to go beyond the different oppositions is to evaluate the degree to which some port cities show a balanced profile rather than a specialization. For each factor, port cities for which the contribution is less than 0.1% to at least one factor, have been considered equilibrate between the opposing trends (Table 4).

One striking result is that among those 34 port cities, 28 are remotely located from the 'heartland' of the continent. The other cities can be said to have successfully "resisted" to specialization, such as Le Havre, Trieste (road-logistics & air-sea), Hamburg, Bremen, Nice (city size & transport), and Valencia (air-railway and port-sea). Among the 42 "specialized" port cities which were excluded from the table, 19 are located around the heartland, of which the main European ports (Rotterdam, Antwerp,

Genoa, Barcelona…). It means that the core-periphery pattern has a strong effect on the European gateways, in terms of intermodal potentials. Although this spatial 'rule' is not perfect, it confirms that the distance between a port city and a core region is a major component of its economic diversity and self-development (Fujita and Mori, op. Cit.). Another explanation is that remote port cities have been forced to develop a wider and more balanced variety of transport functions, due to the physical constraints and the spatial discontinuities.

[Insert Table 4 about here]

5. CONCLUSION

This paper has proposed an alternative approach to intermodalism, through the measurement of transport employment among 76 European port cities. It raises several issues such as the different contexts and evolutions of the port cities. On one side, the research is successful because the results provided by the new data are not contradicting our empirical knowledge of ports and port cities in Europe. Thus, the measurement of employment using a European-wide database on companies, though it is not perfect due to the arbitrary methodology, notably for companies operating in more than one activity, is fruitful in many ways, and allows getting a new geographical perspective of European port-city relationships.

On the other side, this research brings new evidence to the wider study field of intermodalism. Although the methodology cannot fully demonstrate the technical integration among different transport modes, it shows an estimation of intermodal potentials within European port cities. Among the observed trends, there is no strong interaction between different modes, such as between air and maritime transport.

Transport modes of the same 'family' (e.g., freight transport and passenger transport) are better combined through the principal components. Only less significant factors show some interaction, such as between road and logistics, or between air and sea traffics. Thus, we have in Europe a modal specialization of transportation nodes rather than an effective combination, as hinted by Hayuth (1987) in his pioneer works on intermodalism.

In the end, results all point at the separation between gateways and central places. On one hand, the hierarchy of logistics, the trends of air-rail transport, road-logistics, and city size could apply to "anycity" (Lee and Ducruet 2006). On the other hand, trends of port-sea specialisation, air-sea freight, and transport employment specialisation reveal the specific dimension of the port cities. Not only this distinction is verified for the first time through quantitative measurements on a continental scale, but also it is matched with a classical understanding of the European territory. From a very deterministic point of view, it could be argued that the degree and variety of intermodalism at port cities are diminished by the European core-periphery pattern and its lock-in effects. It would mean that apart few exceptions, European port cities are condemned to specialise in a narrow set of functions based on freight transport while inland cities keep on widening their economic diversity and attractiveness, based on passengers. It may explain why some port cities face difficulties while they strive to develop their attractiveness for high-skilled workers and more sophisticated economic functions.

From a more optimistic perspective, it can be argued that the different specialisations of cities are a means to avoid concentrating all activities in a small set of multifunctional hubs, like in Asia. In order to give more reality to this theory, more voluntarism is needed from the European policies, by giving extra incentives for investing in peripheral areas, while valuing the diversity of sub-regional systems and avoiding excessive concentration at transport nodes. Further research can be conducted from the

same data by, for example, redistributing employment according to intermodal – rather than modal – categories, since many companies operate in more than one transport mode simultaneously. This would probably help understanding better the factors underlying the distinction between modal cities and intermodal cities.

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Table 1: Distribution of transport employment by activities in the port cities

Detailed activities	Aggregated activities	Total employees	% total
Air charter services	AIR TRANSPORT	225,177	19.5
Air transport services, passengers and freight			
Air services, specialised			
Aircraft hire and rental services, air taxis			
Airport administration			
Airport equipment			
Airport services			
Cargo confirming and inspection services	LOGISTICS & WAREHOUSING	181,400	15.7
Packaging and crating services for transportation			
Pallets and freight containers			
Storage services for liquids			
Warehouse services, specialised			
Warehouses, cold storage			
Warehouses, storage sites			
Warehousing and distribution logistical services, international			
Haulage and storage of hazardous materials	ROAD TRANSPORT	167,599	14.5
Road haulage, bulk			
Road haulage, tanker			
Road haulage, part loads			
Road transport services classified by type of freight			
Port and harbour administration	PORT SERVICES	139,651	12.1
Stevedoring, harbour and dock services, ship attendance			
Tug, salvage and offshore shipping services			
Shipping services, tanker			
Furniture, ship			
Rail transport services	RAIL TRANSPORT	178,270	15.4
Railway administration			
Shipping and forwarding agents	FORWARDING	78,805	6.8
Shipping services, passenger and freight	SEA & RIVER TRANSPORT	183,964	16.0
Ship classification			
Ship registration			
Inland waterway transport services			
Ferry services			
Ships, boats and yachts			
TOTAL		1,154,866	100.0

Source: calculated from Kompass

Table 2: Regional distribution of variables (Unit: %)

REGION	Scandinavia / Baltic	British Isles	Northwest Europe	West Med. / Iberian Peninsula	East Med. / Black Sea	TOTAL
Number of port cities	15	16	11	26	8	76
Railway	**52.0**	8.7	7.1	21.8	10.4	100.0
Road	**43.2**	8.5	22.0	22.5	3.9	100.0
Port	**54.6**	6.6	17.7	10.6	10.4	100.0
Air	**43.6**	9.5	30.4	13.1	3.3	100.0
Sea & river	36.3	7.7	**46.4**	7.9	1.7	100.0
Forwarding	28.2	13.9	**36.9**	15.9	5.1	100.0
Logistics & warehousing	**48.3**	12.9	20.7	12.9	5.3	100.0
Population	18.5	28.1	14.0	**33.0**	6.5	100.0
Air tonnage	13.3	**33.1**	24.7	7.0	21.9	100.0
Port tonnage	16.4	12.8	**39.3**	21.9	9.6	100.0

Source: calculated from Kompass

Table 3: Major trends

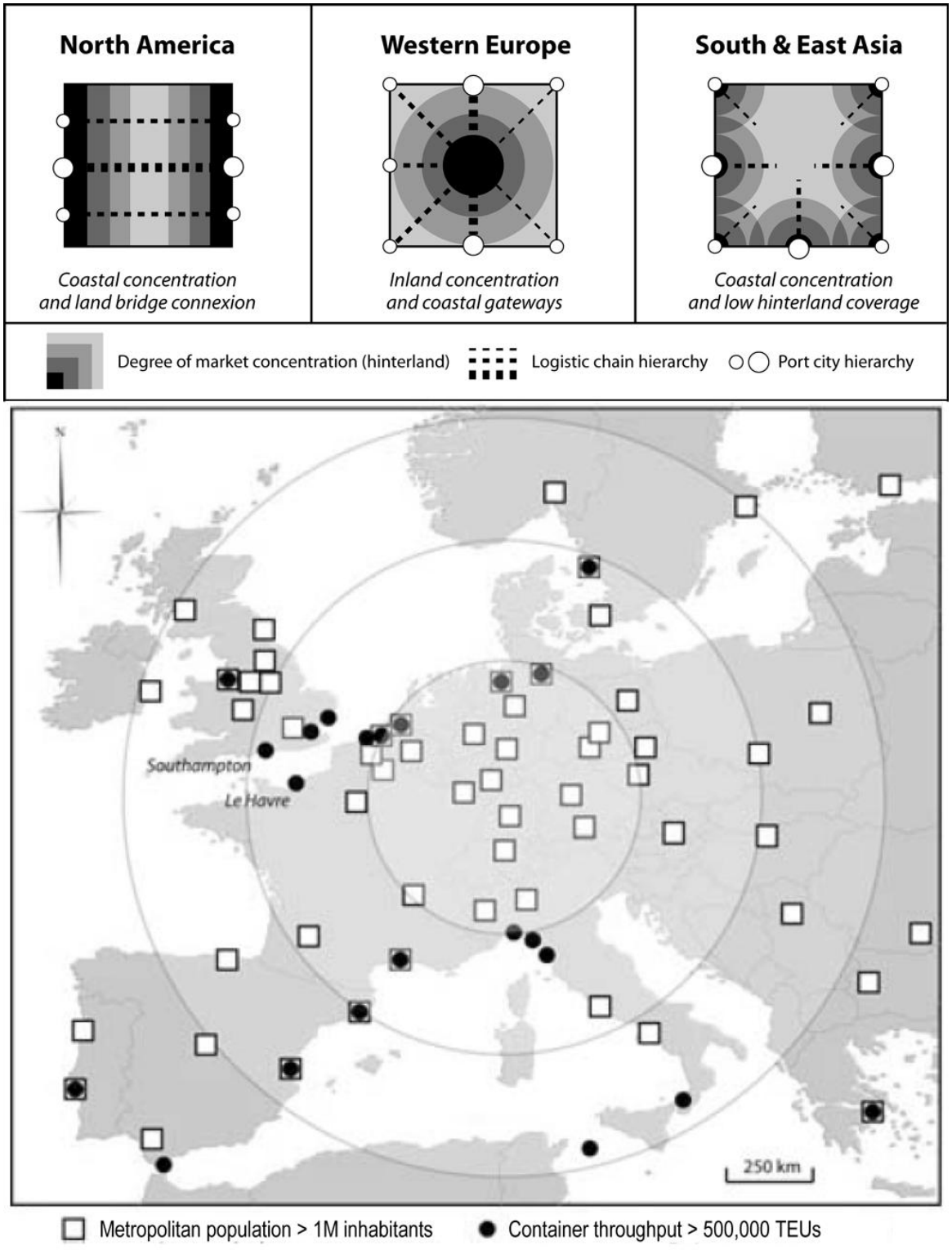
	F1	F2	F3	F4
Eigenvalues	5.88	1.44	0.62	0.57
Cumulated variance (%)	58.83	73.20	79.41	85.15
Contribution (%)				
RAILWAY	11.22	- 3.87	0.58	- 2.43
ROAD	12.23	0.28	- 22.58	5.40
PORT	10.23	13.54	0.28	- 10.00
AIR	11.03	- 8.37	- 0.59	- 12.23
SEA & RIVER	12.65	1.74	0.09	- 8.77
FORWARDING	13.13	1.09	- 1.79	0.59
LOGISTICS & WAREHOUSING	12.87	0.53	- 6.23	1.79
POPULATION	8.54	- 6.61	2.96	53.59
AIR TONNAGE	4.47	- 31.42	25.90	- 2.03
PORT TONNAGE	3.62	32.56	38.99	3.17

N.B. Negative signs refer to the negative coordinates of the variables on each factor

Table 4: Types of intermodalism at selected European port cities

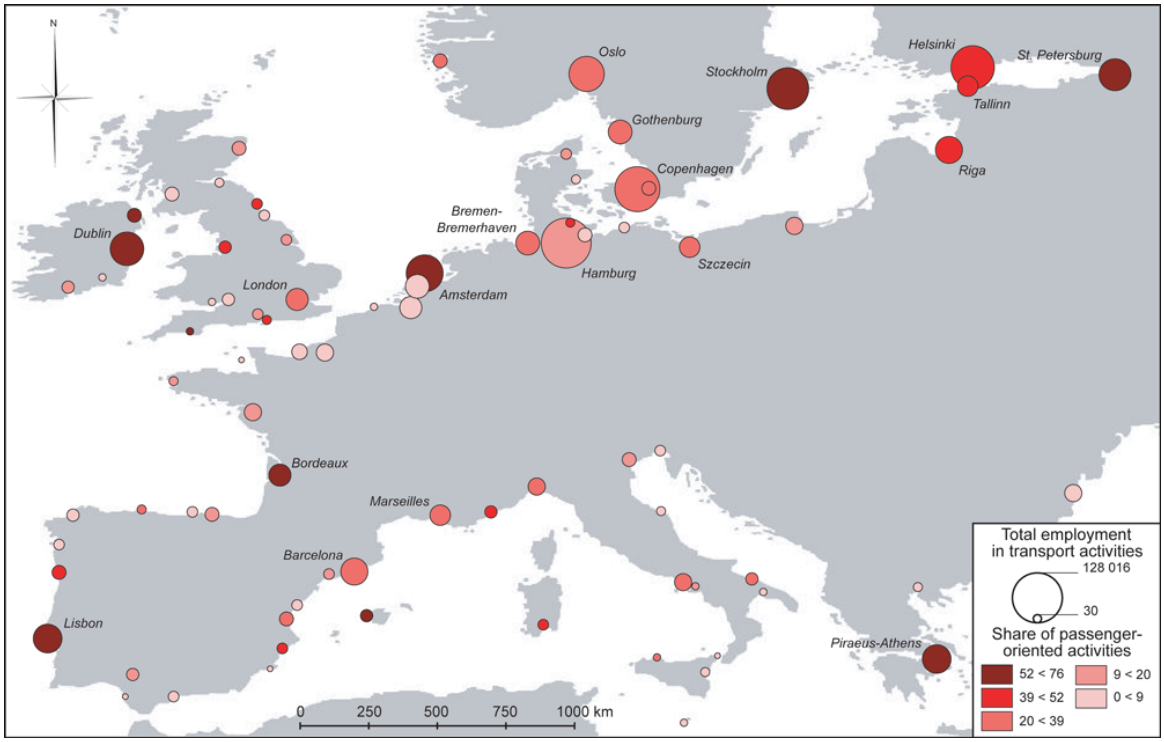
Port city	Rank on F1	Air-railway & Port-sea (F2)	Road-logistics & Air-sea (F3)	City size & Transport (F4)
BRISTOL	42	1	1	0
ANCONA	59	1	1	0
CADIZ	74	1	1	0
ST PETERSBURG	5	1	0	0
NAPLES	21	1	0	0
VALENCIA	24	1	0	0
GLASGOW	32	1	0	0
CORK	38	1	0	0
EDINBURGH	62	1	0	0
BREST	63	1	0	0
LE HAVRE	35	0	1	1
COPENHAGEN	2	0	1	0
DUBLIN	4	0	1	0
TALLINN	19	0	1	0
TRIESTE	44	0	1	0
AARHUS	52	0	1	0
PLYMOUTH	69	0	1	0
TARANTO	73	0	1	0
HAMBURG	1	0	0	1
STOCKHOLM	7	0	0	1
PIRAEUS	11	0	0	1
LISBON	13	0	0	1
BREMEN	14	0	0	1
RIGA	18	0	0	1
GDANSK	25	0	0	1
CONSTANTZA	28	0	0	1
NANTES	30	0	0	1
LA CORUNA	41	0	0	1
NICE	46	0	0	1
VIGO	47	0	0	1
TARRAGONA	54	0	0	1
KINGSTON UPON HULL	57	0	0	1
ALICANTE	64	0	0	1
GIJON	65	0	0	1

Figure 1: Comparison of three main continental hinterlands of seaports



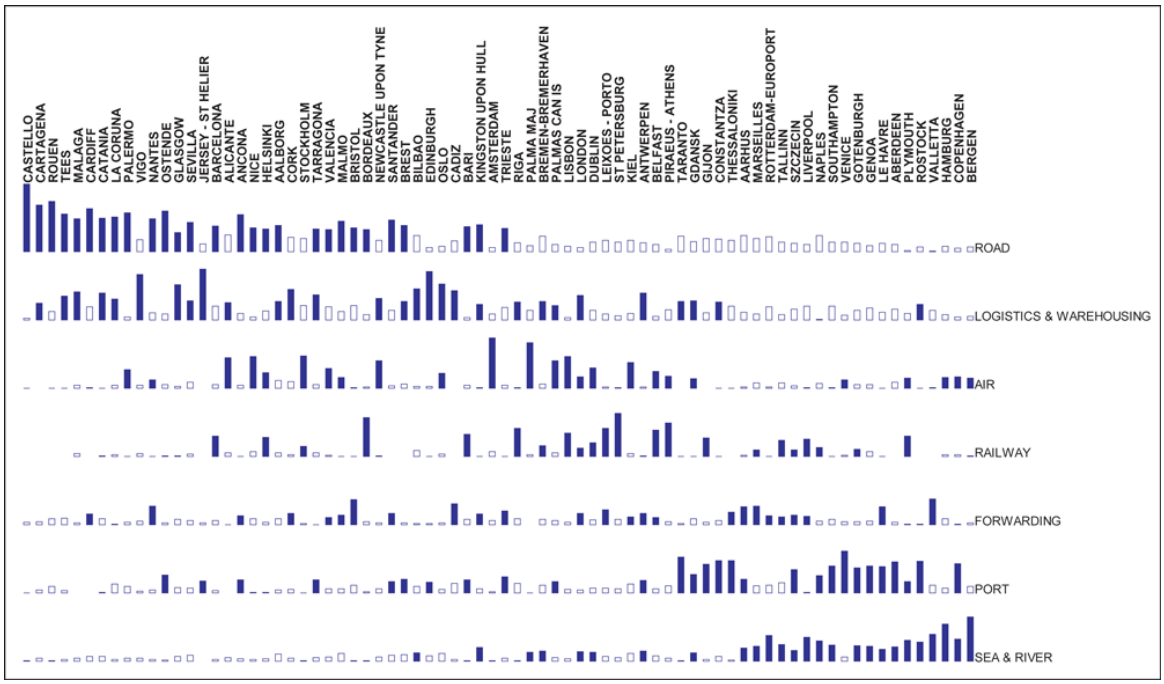
Sources: Lee, Song and Ducruet (2007); Lee and Ducruet (2006)

Figure 2: The distribution of transport and passenger-related employment



Source: adapted from Kompass

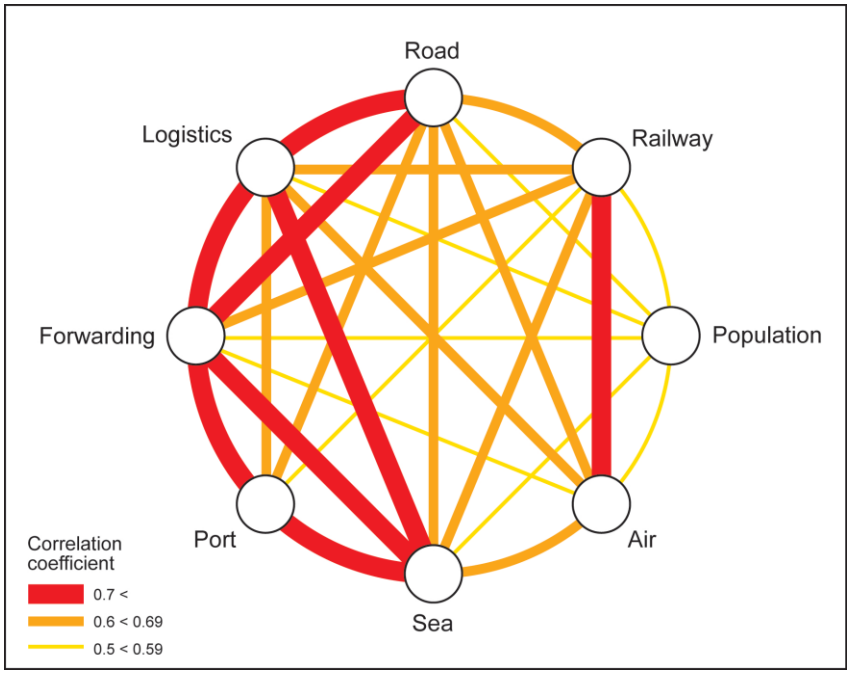
Figure 3: Matrix of transport employment distribution in the port cities (%)



Source: calculated from Kompass

N.B. dark colours indicate values higher than the average of each row

Figure 4: Graph of major correlations among variables*



N.B. Air and port tonnages are excluded due to average correlations lower than 0.5

Figure 5: Concentration of transport activities

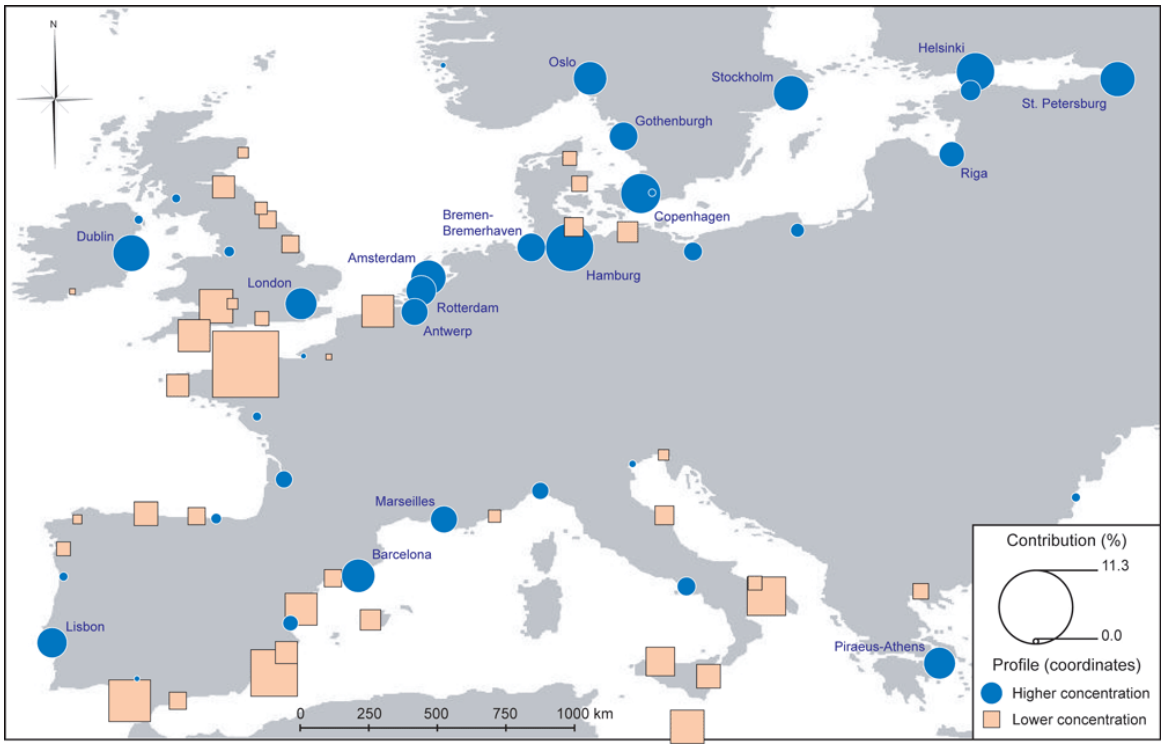


Figure 6: Port gateways vs. central places

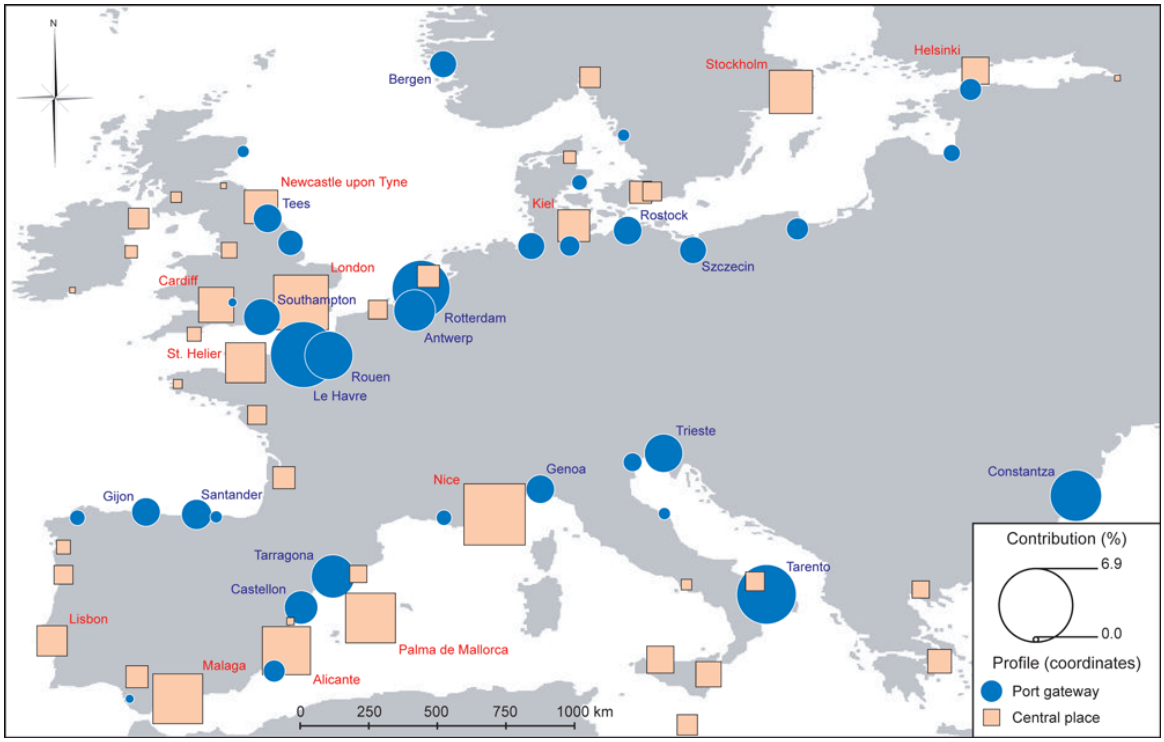


Figure 7: Logistics centre vs. freight centre

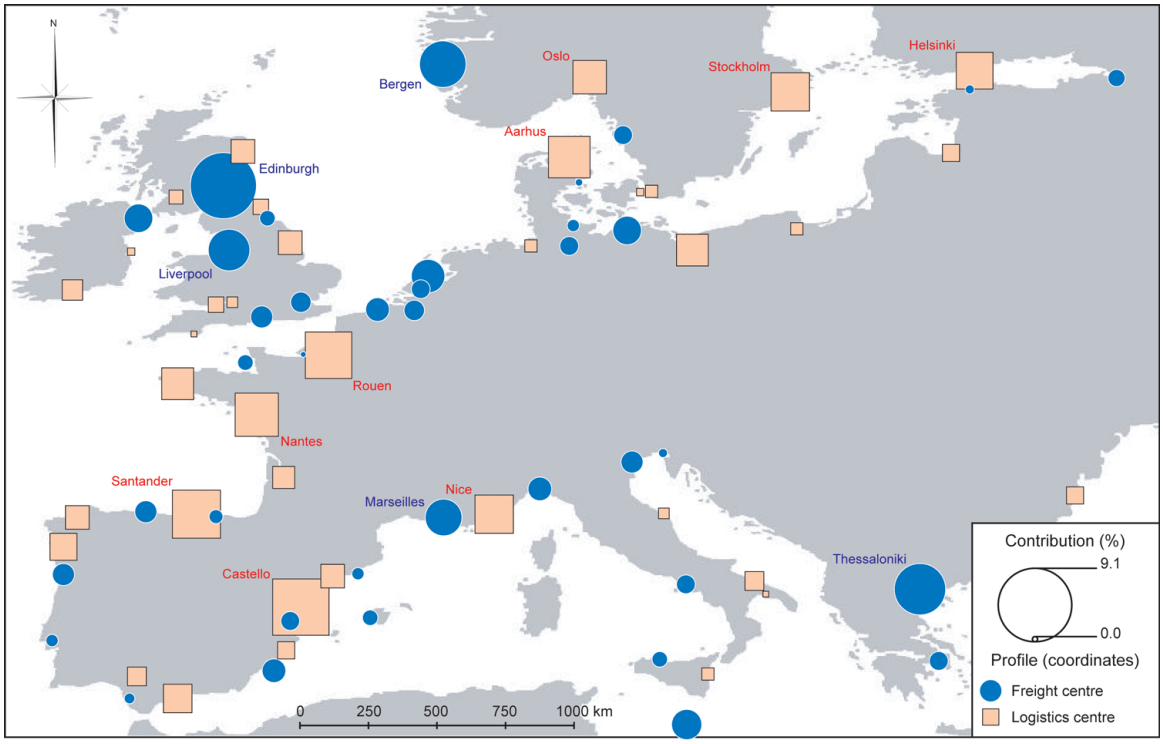
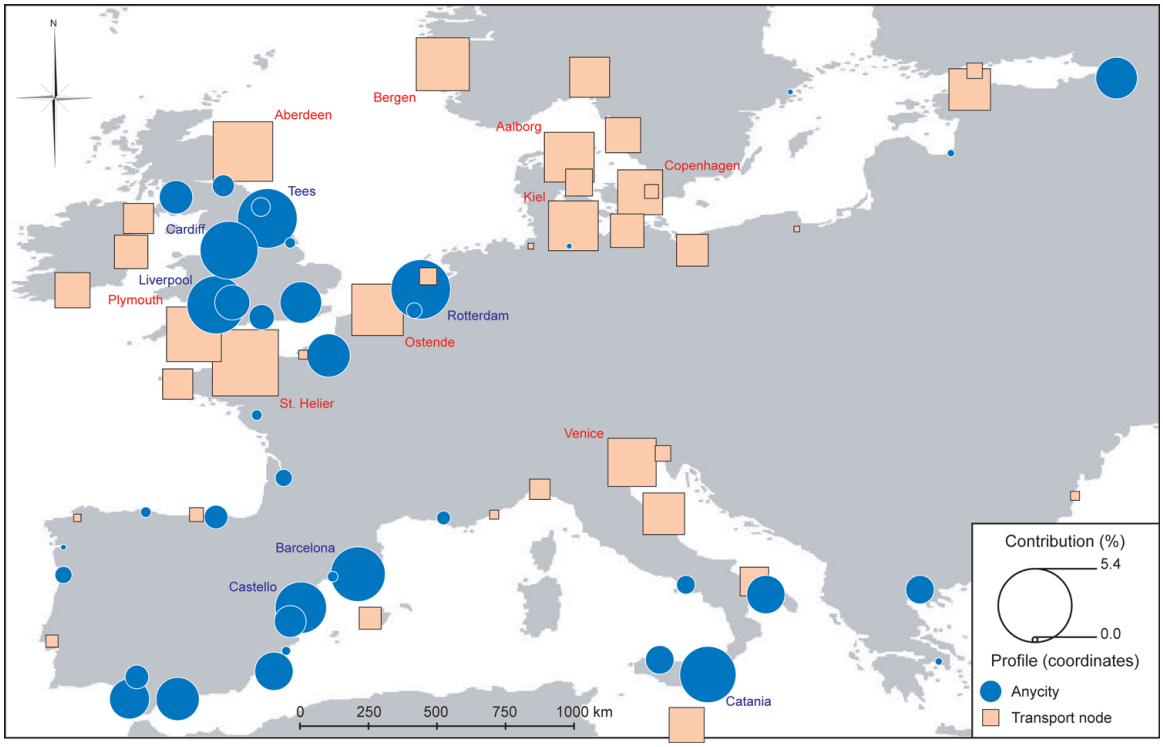


Figure 8: Anycities vs. transport nodes



Appendix: Database on employment, population and traffics

Port city	RAILWAY	ROAD	PORT	AIR	SEA & RIVER	FORWARDING	LOGISTICS & WAREHOUSING	POPULATION (000s) 2005	AIR TONNAGE 2003	PORT TONNAGE 2003
AALBORG	123	852	99	257	249	192	597	122	1229	2651894
AARHUS	33	325	287	29	273	371	165	226	1961	10141000
ABERDEEN	0	489	2055	416	961	180	724	183	3997	4150435
ALICANTE	111	478	0	861	111	8	483	428	5849	3367046
AMSTERDAM	4758	4218	1349	44865	674	4185	5554	1188	1353760	65461000
ANCONA	7	795	278	71	60	198	149	100	5469	9574807
ANTWERPEN	232	2530	3556	375	2948	3150	7513	933	4903	142874512
BARCELONA	8382	10447	1046	1534	773	1838	5677	4973	76173	35512073
BARI	882	983	522	131	34	217	110	303	3740	3608480
BELFAST	1762	503	310	1126	391	496	255	585	42116	17057000
BERGEN	59	373	487	745	3146	145	260	213	9958	97662524
BILBAO	474	1210	524	144	648	130	2345	1120	3826	29010145
BORDEAUX	10746	6079	337	405	232	885	1491	971	15592	8394219
BREMEN-BREMERHAVEN	3670	5259	2744	1419	3521	1813	6399	1001	2237	48973000
BREST	0	541	292	96	144	44	389	213	1917	2368397
BRISTOL	12	1069	342	28	30	1109	654	616	5279	11439000
CADIZ	0	28	25	0	5	54	75	407	146	4758407
CARDIFF	0	287	0	5	35	72	87	720	3292	2287000
CARTAGENA	0	82	6	0	6	6	30	201	74	21300792
CASTELLO	0	2392	6	21	39	87	68	290	0	9984994
CATANIA	11	495	16	1	71	91	405	852	12354	2636778
CONSTANTZA	61	1872	4786	22	727	680	2685	303	281	40524000
COPENHAGEN	3040	5361	43662	17249	33396	1255	5109	2366	379037	7197000
CORK	111	882	249	413	191	711	1838	188	7114	9500000
DUBLIN	10101	7372	3772	14981	6588	3759	7319	1024	133871	23500000
EDINBURGH	4	46	116	19	58	17	500	696	53281	41607000
GDANSK	12	1262	2306	1168	1072	774	2378	867	1954	21293000
GENOA	600	798	3320	495	1858	454	1502	692	2813	54680994
GIJON	330	242	510	0	38	47	137	285	484	19165080
GLASGOW	41	1209	344	148	307	353	2209	1379	5791	9214000
GOTENBURGH	2435	2879	8433	1382	5345	1006	3211	786	58976	33300000
HAMBURG	3838	10029	9276	19583	64561	11045	9666	3278	35968	106300000
HELSINKI	26137	31159	1005	21034	3459	3746	12177	1215	88140	9304898
JERSEY - ST HELIER	0	3	5	0	0	1	21	28	5680	552539
KIEL	49	157	131	362	111	111	95	235	27200	3049000
KINGSTON UPON HULL	9	593	98	19	307	238	353	302	130	10298000
LA CORUNA	111	1959	537	184	114	50	1203	387	703	12659350
LE HAVRE	11	940	2963	9	1403	2049	886	254	133	71933680
LEIXOES - PORTO	1801	740	310	105	312	976	398	1218	28140	12647541
LISBON	12732	3059	2041	17085	1598	1552	1351	2613	95767	12154815
LIVERPOOL	1005	411	59	37	1383	495	810	3562	24253	31753000
LONDON	2278	1143	859	3125	2688	3082	6725	11327	1736563	5100000

MALAGA	111	1141	0	111	111	65	979	843	11318	2292703
MALMO	36	1925	270	687	505	627	530	598	28504	7619000
MARSEILLES	1300	2656	1442	1047	3000	3702	1162	1573	53547	95600000
NANTES	3	4170	455	1106	253	2404	963	765	10589	3104071
NAPLES	1368	2490	2621	794	3146	573	102	3770	6200	15023374
NEWCASTLE UPON TYNE	20	335	123	799	132	64	630	1428	4089	2763000
NICE	190	971	30	1276	84	238	137	908	15315	611092
OSLO	2291	4773	3161	12982	6566	1922	30104	808	72688	5960000
OSTENDE	5	271	118	24	10	14	43	69	78066	6238731
PALERMO	0	314	58	150	25	21	27	987	5372	4906177
PALMA MAJ	111	308	3	2293	466	0	499	475	22358	5774675
PALMAS CAN IS	111	235	360	860	111	136	459	621	43307	14274491
PIRAEUS - ATHENS	17428	1506	3887	6383	1697	1840	5286	3231	109741	16318000
PLYMOUTH	175	15	100	88	183	8	60	247	68	2053000
RIGA	11658	3724	4180	285	488	2664	7478	843	5209	21721700
ROSTOCK	0	146	923	15	560	18	448	205	3424	21600000
ROTTERDAM-EUROPORT	101	5166	2603	457	8710	3163	4466	3328	230	327796000
ROUEN	0	7124	946	49	153	877	1231	535	38	22000000
SANTANDER	0	1022	381	89	203	374	308	229	40	5374037
SEVILLA	111	1281	227	275	267	191	825	1312	5287	4834657
SOUTHAMPTON	3	252	675	16	406	147	352	764	322	34774000
ST PETERSBURG	29469	6797	3159	683	2625	3898	3187	4784	26045	41309200
STOCKHOLM	12656	15967	397	39762	1295	1770	17713	1692	131355	5420000
SZCZECIN	1490	1849	4896	547	2317	2083	2286	505	340	12253000
TALLINN	3196	1946	2083	1164	3274	1583	1161	394	4541	37632800
TARANTO	4	108	244	0	8	10	129	255	0	36833652
TARRAGONA	111	675	403	111	111	13	758	357	4	29023633
TEES	0	933	67	14	46	163	601	675	943	53800000
THESSALONIKI	0	247	681	6	30	269	296	829	1211639	14329553
TRIESTE	4	891	617	135	130	522	482	201	901	47173863
VALENCIA	126	1777	351	1554	349	600	1041	1740	11776	35332817
VALLETTA	0	8	59	6	195	186	69	258	12925	2352614
VENICE	112	776	3376	684	343	254	396	259	11222	28176203
VIGO	111	429	68	111	115	125	1582	419	1137	4438633

Sources: Kompass, Aéroports Magazine, Lloyd's Ports of the World, Helders