MEASURING INTERMODALISM AT EUROPEAN PORT CITIES: AN EMPLOYMENT-BASED STUDY

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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, Intermodalism, Logistics integration, 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 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 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). Despite the growing discourses on transport integration, "omni-modal" nodes are still few, and some authors have argued that the development of containerization strengthens the dependence of ports on remote markets (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.

Since most authors emphasized intermodality as either a technical or an institutional process, this paper proposes a complementary approach based on employment figures collected from the Kompass[1] database. It 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 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 helps bypassing several methodological constraints.

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 between 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, every mode has its own measurement units, which are not directly comparable, such as different tons, containers, passengers, and so on, while the employee is a same unit for any activity. This explains why previous studies of intermodality at European ports have

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

chosen an infrastructure-based approach (Joly and Martell 2003). Also, analysing the distribution of employment in transport activities by using local data and national census with different classification systems has proved very challenging while comparing Le Havre and Southampton (Frémont and Ducruet 2002), and seems rather impossible on a European scale. 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. Third, a traffic-based approach would be distorted by the various dimensions of urban areas, while a company-based approach can be adjusted to a same definition based on morphological urban areas (Moriconi-Ebrard 1994), by selecting the companies with their postal addresses. 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". It is believed that such constraints can be partly relieved by an analysis based on employment. 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 measure 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

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 according to 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.

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. At 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; IRSIT 2004). Inland

cities tend to retain higher functions (Brunet 1989; Rozenblat and Cicille 2004). 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, 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.

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 considered the various official metropolitan areas in all countries. When this was not provided, the contiguous urban area has been preferred so as to include suburban districts.

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. At 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).

[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]

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). Results provide four main factors accounting for more than 85% of the total variance (Table 3).

The first logic (F1) gives the most important direction of transport functions’ concentration, with sea employment, storage and warehousing employment, international

freight forwarders and logistics agents, railway employment and container-related companies at the top of the hierarchy. This order can be interpreted as a level of integration of sea transport within the transport chain.

The second logic (F2) clearly opposes maritime transport to air transport. Direct calls, container-related companies and international freight forwarders are opposed to employment in air transport, ancillary services, storage, warehousing, and railway transport. It is clear that port efficiency to attract shipping lines, container businesses and freight forwarders is radically in opposition to the capacity of port cities to create added value, coming from the additional services to transport and from passenger flows. Then, places of transit or 'port gateways' are opposed to places based on logistics and passengers (i.e., tourists or high-skilled workers).

The third logic (F3) is also an opposition. Urban demographic and spatial size, ancillary services, international freight forwarders, and railway transport employment are grouped and reveal a trend with the importance of the local economy. Employment in port, short-sea and sea transport is grouped with container-related activities, indicating a profile of maritime city. Then this logic can be interpreted as an opposition between important cities, where port and marine-related employment is low compared to the classic functions of central places like additional services and railways; and important ports, where the influence of sea transport is strong on the local economy but, in turns, which is less diversified.

Finally, the fourth logic (F4) offers a very interesting opposition between two kinds of activities. Employment in short-sea, air, and railway transport is grouped with metropolitan population, showing the importance of passenger transport and city size. Oppositely, employment in ancillary services, storage and warehousing, road transport, and port employment implies the dominance of freight transport.

The following sections describe the meaning of the observed trends and provide an interpretation of their geographical distribution.

[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 (Fig.1), 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 in their port cities than more balanced countries (i.e., the 'Rhine' model). The largest and dominant city tends to combine all transport modes while port cities remain specialised in port and distribution. The highest contribution of Hamburg as shown in Figure 1 is easily explained by its central situation close to the heartland, 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 1 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 2 about here]

The related map (Fig.2) 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 Inland Logistics vs. Sea-air Freight (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 3 about here]

In the map, 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 Market Centres 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, 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 4 about here]

4.6 Intermodal vs. Modal Port Cities: 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.

At the end, results all point at the separation between gateways and central places. On the 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 while inland cities keep on widening their economic diversity, supported by the respective integration of transport systems for freight *and* passengers. 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.

REFERENCES

Banister, D. (1995): "Transport and Urban Development," Alexandrine Press, Oxford.

Barzman, J. and James, E. (2004): "'Speed Freaks' and 'Sloths': Debates on New Transportation Connections in Le Havre (1840s to Today)," in Dienel, H.-L. (ed) Unconnected Transport Networks: European Intermodal Traffic Junctions 1800-2000, Campus Verlag, Frankfurt/New York, 101-137.

Benacchio, M., Ferrari, C., Haralambides, H.E. and Musso, E. (2001): "On the Economic Impact of Ports: Local vs. National Costs and Benefits," World Conference on Transport Research, Seoul Conference, July 22-27.

Bird, J. (1973): "Of Central Places, Cities and Seaports," Geography, 58: 105-118.

Bird, J. (1977): "Centrality and Cities," Routledge Direct Editions, London.

Brocard, M. (1994): "Deux Villes Frontières Portuaires: Le Havre et Southampton," La Revue d'Ici, 11: 8-12.

Brunet, R. (1989): "Les Villes 'Européennes'," La Documentation Française, Paris.

Charlier, J.J. and Ridolfi, G. (1994): "Intermodal Transportation in Europe: of Modes, Corridors and Nodes," Maritime Policy and Management, 21(3): 237-250.

Dogan, M. (1988): “Giant Cities as Maritime Gateways,” in Dogan, M. and Kasarda, J.D. (eds) The Metropolis Era (1) A World of Giant Cities, S.A.G.E. Publications, London, 30-55.

Ducruet, C. (2004): “Port Cities, Laboratories of Globalization,” Unpublished PhD in Geography, Le Havre University, France.

Ducruet, C. (2005): “Approche Comparée du Développement des Villes-ports à l’Échelle Mondiale: Problèmes Théoriques et Méthodologiques,” Cahiers Scientifiques du Transport, 48: 59-79.

Ducruet, C. (2006): “Port-city Relationships in Europe and Asia,” Journal of International Logistics and Trade, 4: 13-35.

Ducruet, C. and Jeong, O. (2005): “European Port-city Interface and its Asian Application,” Korea Research Institute for Human Settlements, Anyang.

Ducruet, C., Joly, O. and Martell, H. (2007): “Air-sea Linkages in European Port Cities,” in Fredouet, C.H. and Rimmer, P.J. (eds) International Transport and Logistics: East Asian and European Experiences, Routledge (forthcoming).

Ducruet, C. and Lee, S.W. (2006): “Frontline Soldiers of Globalization: Port-city Evolution and Regional Competition,” Geojournal, 67(2): 107-122.

ECMT (2003): “Terminology on Combined Transport,” OECD, Paris.

Frémont, A. and Ducruet, C. (2002): “Activités et métiers du transport: Le Havre et Southampton,” Etudes Normandes, 1: 25-36.

Frémont, A. and Ducruet, C. (2005): “The Emergence of a Mega Port, from the Local to the Global, the Case of Busan,” Tijdschrift voor Econ. En Soc. Geografie, 96(4): 421-432.

Fujita, M. and Mori, T. (1996): “The Role of Ports in the Making of Major Cities: Self-Agglomeration and Hub-effect,” Journal of Development Economics, 49(1): 93-120.

Goetz, A.R. and Rodrigue, J.P. (1999): “Transportation Terminals: New Perspectives,” Journal of Transport Geography, 7(4): 237-240.

Gordon, D.L.A. (1997): “Managing the Changing Political Environment in Urban Waterfront Redevelopment,” Urban Studies, 34(1): 61-83.

Goss, R.O. (1990): “Economic Policies and Seaports (1) The Economic Functions of Seaports,” Maritime Policy and Management, 17(3): 207-219.

Gripaios, R. (1999): “Ports and Their Influence on Local Economies: A UK Perspective,” The Dock and Harbour Authority, 79: 235-241.

Gripaios, P. and Gripaios, R. (1995): “The Impact of a Port on Its Local Economy: the Case of Plymouth,” Maritime Policy and Management, 22(1): 13-23.

Gutmann, M.P. (1986): “The Dynamics of Urban Decline in the Late Middle Ages and Early Modern Times: Economic Response and Social Effects,” 9th International Economic History Congress, Bern, International Economic History Association, p. 36.

Helders, S. (2005): “The World Gazetteer,” http://www.world-gazetteer.com/home.htm

Hoyle, B.S. (2000): “Global and Local Change on the Port-city Waterfront,” The Geographical Review, 90(3): 395-417.

I.R.S.I.T. (2004): “Les Villes Portuaires en Europe, Analyse Comparative,” CNRS, Le Havre.

Joly, O. and Martell, H. (2003): "Infrastructure Benchmarks for European Container Ports," in: *Regional Cooperation and Economic Integration*, 4th Inha & Le Havre International Conference, October 8-9, Inha University, Incheon, Republic of Korea. pp. 147-154.

Keeling, D.J. (1995): "Transport and the World City Paradigm," in Knox, P.L. and Taylor, P.J. (eds) World Cities in a World System, Cambridge University Press, Cambridge, 115-129.

Keller, P. (2004): "Intermodality of Network Points: the Planner's View," in Dienel, H.-L. (ed) Unconnected Transport Networks: European Intermodal Traffic Junctions 1800-2000, Campus Verlag, Frankfurt/New York, 37-48.

Lawton, R. and Lee, R. (2002): "Port Development and the Demographic Dynamics of European Urbanization," in Lawton, R. and Lee, R. (eds) Population and Society in Western European Port Cities, c. 1650-1939, Liverpool University Press, Liverpool, 1-36.

Lee, S.W. (2005): "Interaction Between City and Port in Asian Hub Port Cities," Unpublished PhD in Urban Planning, University of Seoul.

Lee, S.W. and Ducruet, C. (2006): "Waterfront Redevelopment and Territorial Integration in Le Havre (France) and Southampton (UK): Implications for Busan, Korea," Ocean Policy Research, 21: 127-156.

Lee, S.W. and Kim, C.H. (2006): "Performance Evaluation of Asian Port Distriparks Using Factor Analysis," Ocean Policy Research, 21(1), 52-82.

Lever, W.F. (1995): "Regional Economic Growth and Port Activities in European Cities," in Portes Océanes et Développement des Territoires Intérieurs, 5th International Conference Cities and Ports, International Association Cities and Ports, Dakar, 309-316.

Lloyd's List (2005): "Lloyd's Ports of the World 2004," Informa, London.

Marshall, R. (2001): "Waterfronts in Post-industrial Cities," Spon Press, New York.

Mc Calla, R.J., Slack, B. and Comtois, C. (2001): "Intermodal Freight Terminals: Locality and Industrial Linkages," The Canadian Geographer, 45(3): 404-413.

Mc Calla, R., Slack, B. and Comtois, C. (2004): "Dealing with Globalisation at the Regional and Local Levels: the Case of Contemporary Containerisation," The Canadian Geographer, 48(4): 473-487.

Mc Gee, T. (1967): "The Southeast Asian City: a Social Geography of the Primate Cities," G. Bell & Sons Ltd., London.

Merger, M. (2004): "Inner Ports and Railway Networks in France or the 'History of a Divorce' (1830-1914)," in Dienel, H.-L. (ed) Unconnected Transport Networks: European Intermodal Traffic Junctions 1800-2000, Campus Verlag, Frankfurt/New York, 87-99.

Moriconi-Ebrard, F. (1994): "Geopolis: Pour Comparer les Villes du Monde," Anthropos, Paris.

Musso, E., Benacchio, M. and Ferrari, C. (2000): "Ports and Employment in Port Cities," International Journal of Maritime Economics, 2(4): 283-312.

Nagpaul, P.S. (2005): "Guide to Advanced Data Analysis Using IDAMS Software," UNESCO: http://www.unesco.org/webworld/idams/advguide/TOC.htm

O' Connor, K. (1989): "Australian Ports, Metropolitan Areas and Trade-related Services," Australian Geographer, 20(2): 167-172.

Pumain, D. and Saint-Julien, T. (1976): “Fonctions et Hiérarchies des Villes Françaises,” Annales de Géographie, 470: 385-440.

Robinson, R. (2002): “Ports as Elements in Value-driven Chain Systems: The New Paradigm,” Maritime Policy and Management, 29(3): 241-255.

Rodrigue, J.-P. (2003): “Maritime Transportation and the Port Authority of New York and New Jersey: Global Changes, Regional Gains and Local Pains,” in *Maritime Transport, Globalisation, Regional Integration and Territorial Development*, June 5th, Le Havre.

Rozenblat, C. and Cicille, P. (2003): “Les Villes Européennes: Analyse Comparative,” Maison de la Géographie, Montpellier.

Slack, B. (1989): “Port Services, Ports and the Urban Hierarchy,” Tijdschrift voor Econ. En Soc.Geografie, 80(4): 236-243.

Stern, E. and Hayuth, Y. (1984): “Developmental Effects of Geopolitically Located Ports,” in Hoyle, B.S. and Hilling, D. (eds) Seaport Systems and Spatial Change, John Wiley and Sons, Chichester, 239-249.

Tongzon, J. (1995): “Determinants of Port Performance and Efficiency,” Transportation Research Part A, 29(3): 245-252.

“Trafic Aéroportuaire 2004: Le Palmarès Mondial,” Aéroports Magazine, December.

Vallega, A. (1983): “Nodalité et Centralité Face à la Multimodalité: Éléments pour un Relais entre Théorie Régionale et Théorie des Transports,” in Muscara, C. and Poli, C. (eds) Transport Geography Facing Geography, Dipartimento di Pianificazione Territoriale e Urbanistica, Roma, 69-88.

van Klink, H.A. and van den Berg, G.C. (1998): “Gateways and Intermodalism,” Journal of Transport Geography, 6(1): 1-9.

Table 1: Distribution of transport-related employment

Detailed activities	Aggregated activities	Total employees	Share (%)
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: 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: Kompass

Table 3: The four main principal components

	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. sign refers to the negative coordinates of 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: Concentration of transport activities

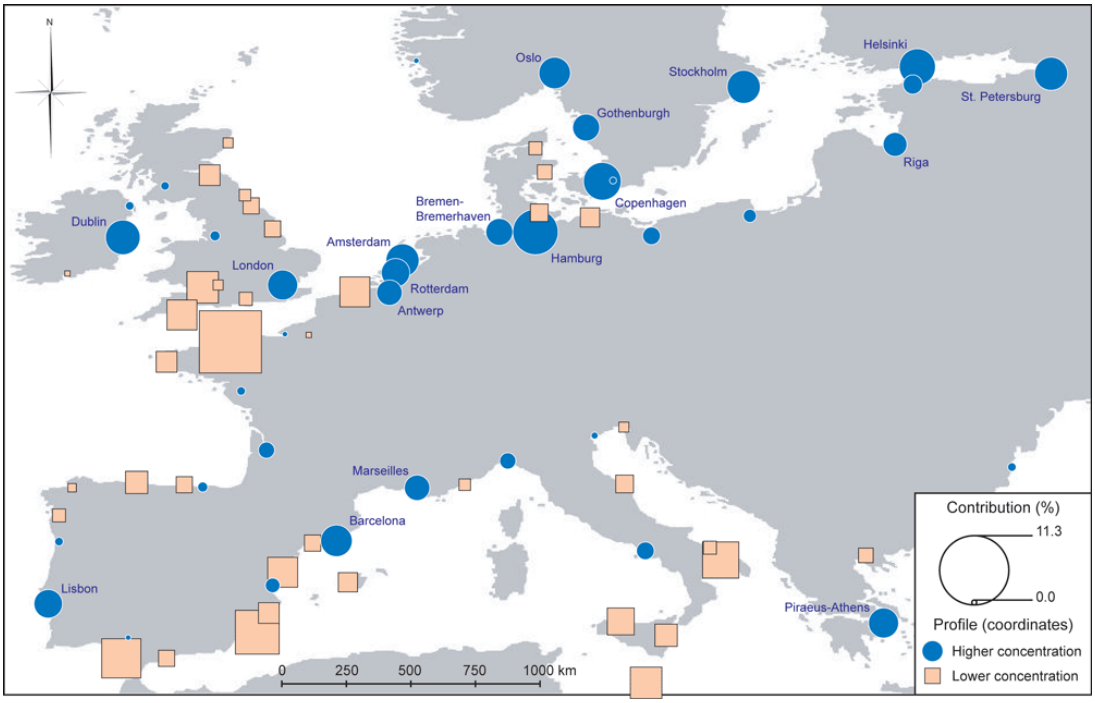

Figure 2: Port gateways vs. central places

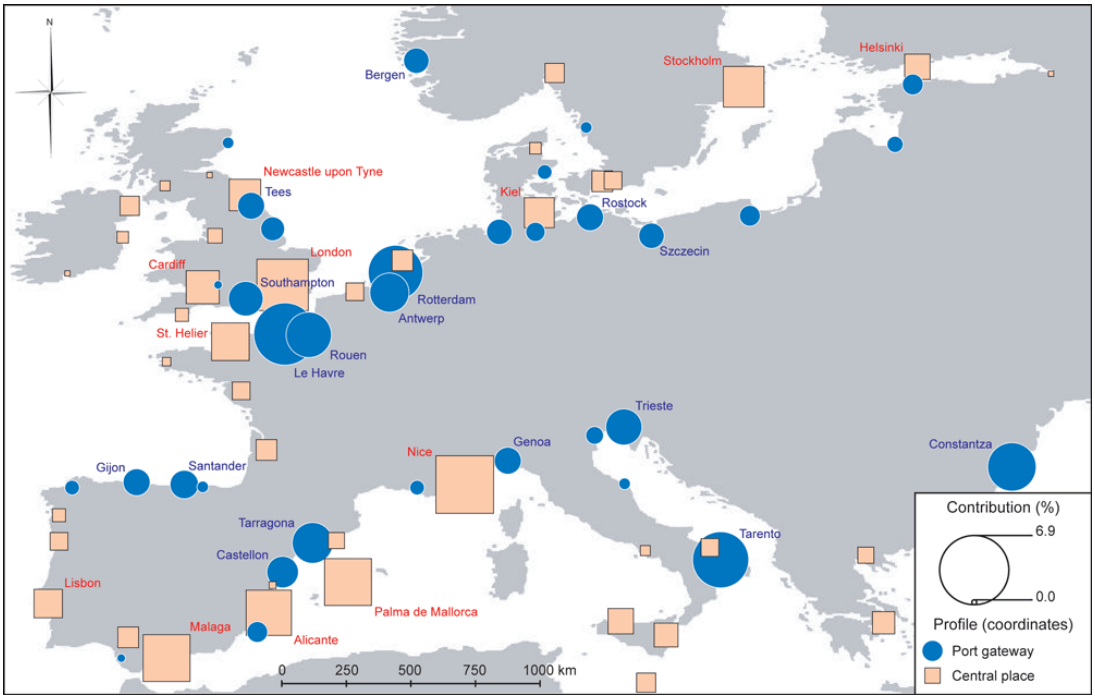

Figure 3: Inland logistics vs. sea-air freight

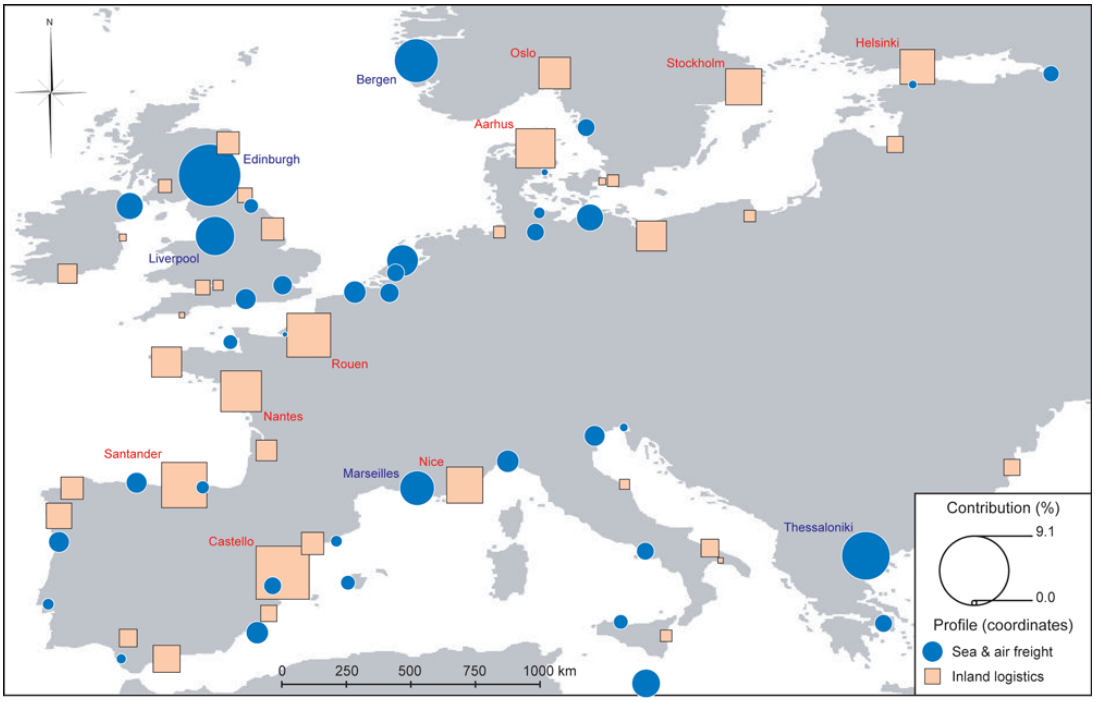

Figure 4: Market centres vs. transport nodes