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EJTIR

Issue **9**(2)
June 2009
pp. 121-142
ISSN: 1567-7141
www.ejtir.tbm.tudelft.nl

Transport Integration at European Ports: Measuring the Role and Position of Intermediaries

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Received June 2008; accepted January 2009

The integration of ports within logistics and supply chains has become a major issue for both public and private players worldwide. Notably, the role of intermediaries in establishing efficient integration within transport chains in which ports are embedded is not well-known. International comparison is limited by the drastic lack of quantifiable information about inter-firm linkages and intermodal operations. Based on a European business database, this paper analyses the modal portfolio and employment distribution of about 8,000 transport firms, intermodal operators, and freight forwarders among 80 European ports. It allows measuring the degree to which different industries such as port activities, logistics, warehousing, road, sea, river, rail, and air transport, integrate within firms and within ports. Main results of the quantitative analysis show that transport integration and port performance have significant interdependence, but this is influenced by hinterland size, accessibility, and regional legacies differentiating Northern from Southern ports.

Keywords: Europe; forwarder; integration; intermodal transport; ports; transport chain

1. Introduction

An increasing volume of research focuses on how ports and port cities are inserted in transport and logistics chains (Wang et al., 2007). However, little empirical evidence exists assessing the relation between transport integration and port performance. Notably, the role of intermediaries in establishing efficient connectivity within transport chains in which ports are embedded is not well-known, despite the strong concern of the European Commission about such issues (Schmidt, 2004). Indeed, intermediaries are often placed within the broad category of distribution, logistics,

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and supply, while their motives and roles differ substantially in nature and scope. For example, traditional freight forwarders dominantly concentrate their networks within national boundaries, what can be seen as a weakness in a context of just-in-time manufacturing and customized delivery across the continent, notably regarding the provision of more integrated services (Bird, 1988). Other players involved in logistics, such as transport firms, and intermodal operators, participate to the trends of alliance, horizontal and vertical integration of third-party logistics providers internationally (Carbone and Stone, 2005). Still, land-based freight forwarders move up to 80% of goods within the European Union, generating about US$ 150 billion revenue annually although their role is threatened by the impact of deregulation, which fosters fragmentation and competition in the industry (Burckhardt et al., 1998).

The purpose of this paper is to provide an empirical verification of the role of intermediaries in the transport integration and overall performance of European ports. Although there is a lack of definition about the notion of transport integration, it may be understood in this paper as the "linking of disjointed (and often incompatible) [transport] systems" (Potter and Skinner, 2000). It encompasses the physical (or technical) integration and the organizational (knowledge) integration, together with societal issues of sustainability (environmental impact) and efficiency (economic impact). For instance, the physical integration may be envisaged by planners in order to limit congestion (Stubs and Jegede, 1998), while the organizational integration is the result of horizontal and/or vertical strategies of carriers such as shipping lines involved in terminal operations within ports (Slack and Frémont, 2005). Indeed, most research about the integration of ports in transport chains focus on the role of ocean carriers (Franc and Van der Horst, 2008), but this papers opts for a broader and complementary approach focusing on intermediaries.

In such context, ports can be considered as important clusters of economic activities which include value added logistics activities (De Langen, 2004), but there are regional variations of the locational pattern of logistics and port activities worldwide (Ducruet, 2006). For instance, "most logistics facilities are not located in ports" in the case of import regions such as Europe, but they tend to agglomerate around Asian ports for freight consolidation (Van Der Lugt and De Langen, 2005). This association is also subject to functional complexity: "improving the hinterland access of seaports is, at least partially, an inter-organizational challenge, because the quality of the hinterland access depends on the behavior of a large variety of actors, such as terminal operators, freight forwarders, transport operators, and port authorities" (De Langen and Chouly, 2004). In order to assess the impact of intermediaries, a series of issues need to be overcome, such as:

- The lack of information about intermodal traffic and inter-firm cooperation;
- The necessary distinction amongst intermediaries within the transport industry;
- The difficulty measuring interaction between port activities and other transport activities internationally; and
- The absence of proper spatial delimitation of transport nodes in which transport integration takes place.

One possible solution proposed in this paper is to analyze the portfolio of different types of firms located in port cities. It allows a series of measures based on how firms integrate different transport modes and services within port cities. The presence of various transport modes and services within a firm's portfolio allows differentiating among transport firms, intermodal operators, and freight forwarders. In the quantitative analysis, data is aggregated from transport industries in metropolitan areas. The metropolitan urban area, rather than the port itself or city centre, better reflects the contemporary territories in which transport integration takes place. Many activities have shifted away from city centers and port areas to suburban locations such as highway junctions, logistics parks, dry ports, and multimodal platforms due to lack of space and rising land prices in the urban core (Slack, 1999; Hesse, 2004; Notteboom and Rodrigue, 2005).

The paper is organized as follows. The first section introduces recent research about ports and transport integration, with a special focus on the place of logistics among port performance indicators. The second section presents the methodological issues of a European-wide measurement of transport integration in port cities. Also, it presents some preliminary results by transport industry and type of firm. The core of the research lies in the third section, with the cartography of the results. Concluding remarks are provided as a means for policy and research implications in the field of intermodalism, transport chain integration, and port studies.

2. The integration of ports in transport chains

2.1 A lack of empirical evidence

The reality of transport chain management reaches such complexity that its research has been constrained to one single port area, such as inter-firm arrangements within the hinterland transport chain in Rotterdam (Van Der Horst and De Langen, 2008), and port insertion in automotive chains in Le Havre (Carbone and Martino, 2003) and Durban (Hall and Robbins, 2007). A synthesis of relevant indicators is proposed in Table 1 based on Panayides (2007) and Carbone and Gouvernal (2007), together with examples of comparative studies in the fields of port performance, transport integration, and port insertion in logistics and supply chains. Although a specific body of research covers supply chain management issues as a whole (Fabbe-Costes, 2007), our review is intentionally restricted to the relations between ports and supply chains from a port perspective.

First of all, there is a striking mismatch between theoretical and applied research. On the one hand, we find a number of qualitative aspects such as urban area fluidity, port service reliability, and partnership building. On the other hand, most scholars have concentrated their efforts based on available datasets on physical infrastructures, traffic, and socio-economic characteristics. In fact, relevant indicators for understanding modern port activities and stakes are difficult to quantify by nature, and there is great difficulty measuring them with usual data sources. Therefore, the application of field observation and theoretical research in comparative studies is often realized through surveys and questionnaires among transport players.

Such dichotomy in port integration studies is accentuated by the fact that most quantitative research on port (or terminal) performance is restricted to the port (or terminal) itself.[3] Although the measurement of port-city relationships allowed a better understanding of the different spatial and economic local factors which constrain or foster port activities[4], there is no study showing the different roles of various transport players, except through in-depth case studies such as in Antwerp (Coppens et al., 2007), but such methodology is hardly applicable on a European level due to lack of data. In addition, recent efforts clarifying, for instance, the role of shipping lines in terminal operation (Slack and Frémont, 2005), port selection and concentration (Frémont and Soppé, 2007) were much focused on a specific segment of the transport chain. In the end, understanding the insertion of ports within transport and supply chains is facing a dramatic lack of empirical validation of the conceptual findings. Research remains limited to hypothetical assumptions about the role of the different variables influencing the relation between ports and supply chains.[5]

[3] For a review of port performance indicators, see De Langen et al. (2007)
[4] For a review of quantitative measures of port-city relationships, see Ducruet (2007)
[5] For a review of the literature on ports and supply chains, see Panayides (2007)

Table 1. Theory and practice among port integration studies

Main themes	Relevant issues	Applied and comparative studies
Port competitiveness & key performance	Efficient infrastructure Market proximity Good labor climate Service quality, reliability, frequency, leanness, agility Competitive prices Customization Responsiveness Urban area fluidity	Port throughputs analysis and port performance indicators (PPIs), weighting rules Relative market and population accessibility Traffic concentration among port ranges and regions
Transport integration	Road and rail network efficiency Inland waterways efficiency Direct overseas connections Feeder services extension Intermodal services Hinterland chain efficiency Vertical & horizontal integration	Infrastructure benchmark Modal split of traffic Intermediacy levels Location of transport companies Distribution of modal employment Network analysis
Port relation with other players & value-added services	SC relations stability Information availability Communication through EDI Partnership building Ancillary services availability Cargo, route and market segments diversity	Port clusters Average wage level of port counties Environmental measures Local and regional economic impact studies (e.g. multiplier effects, direct and indirect impact, value added…)

Source: compiled from Panayides (2007), Carbone and Gouvernal (2007)

On the one hand, this paper cries out for an engagement in current research on firms' behavior regarding port locations, of which shippers and transport operators. On the other hand, one should not forget the role of political and spatial factors in shaping port development, such as market size, urban attractiveness and constraint, hinterland chain connectivity, and the structure of provision based on physical attributes and governance (Jacobs and Hall, 2007). Those factors, although they may appear outdated in a footloose environment, still explain to a large extent the way firms locate in a port or shift to another port.

Among recent studies, much has been said about the strong involvement of ocean carriers in container and intermodal transport, while ports themselves "rarely control logistics channels although they are key institutions in international shipping and logistics" (Bichou and Gray, 2004). This is because ports, which are not global, but territorial players, embed in local, regional and national politics, except from special cases as seen in the Dubai or Singapore cases (Jacobs and Hall, 2007). In order to understand port performance and transport integration, a look at the particular role of intermediaries among other transport players is necessary.

2.2 The role of intermediaries to coordinate hinterland chains

It has long been recognized that since ports have become links in a global logistics chain (Robinson, 2002), port competition has moved from competition between ports to competition between transport chains. As a result, ports are eager to enhance the quality of their hinterland transport services (Notteboom and Winkelmans, 2004), because efficient organized hinterland chains are a key factor in port competition (Bundesamt für Güterverkehr, 2005; De Langen, 2004). However, as demonstrated by Van der Horst and De Langen (2008), many coordination problems occur in hinterland chains. Coordination problems arise when coordination beyond price is

required on the one hand, to ensure an efficient transport chain, but is problematic on the other hand, due to opportunism and bounded rationality.

As empirically tested by De Langen (2004), intermediaries help to overcome coordination problems in hinterland chains. From a shipper or *cargo* perspective, forwarders help reducing related coordination costs such as costs of finding the right transport company, negotiating tariffs, preparing and concluding transport contracts, and monitoring the execution of agreements. This is important because, first, these costs can be substantial, especially for complex transport contracts, such as intermodal transport, in which more than two transport modes are involved. Secondly, reducing these costs is important because hinterland transport costs account for a much larger component than maritime transport costs. In container shipping, the portion of hinterland transport costs in the total cost ranges from 40% to 80% (Notteboom and Winkelmans, 2004).

In this paper we distinguish three actors who can act as an intermediary in transport integration: the forwarder, the intermodal operator, and the transport firm. In terms of practice, there is much difficulty drawing a clear limit between those three types, since transport firms, for instance, advertise themselves as forwarders although in reality they only perform in trucking. Although a precise definition of - and requirements for - forwarding may vary across countries and have changed over time, our starting point is the forwarder as it is regarded by the port industry as an important intermediary. Based on his expertise and experience, the forwarder is an independent agent in the transport chain (Figure 1). The literature shows different definitions of forwarders. For example, a forwarder can be seen as a *consolidator* (Coyle et al, 1996). In this role the forwarder collects small shipments from shippers, consolidates these shipments into large loads, and presents the consolidated shipment to transport carriers.

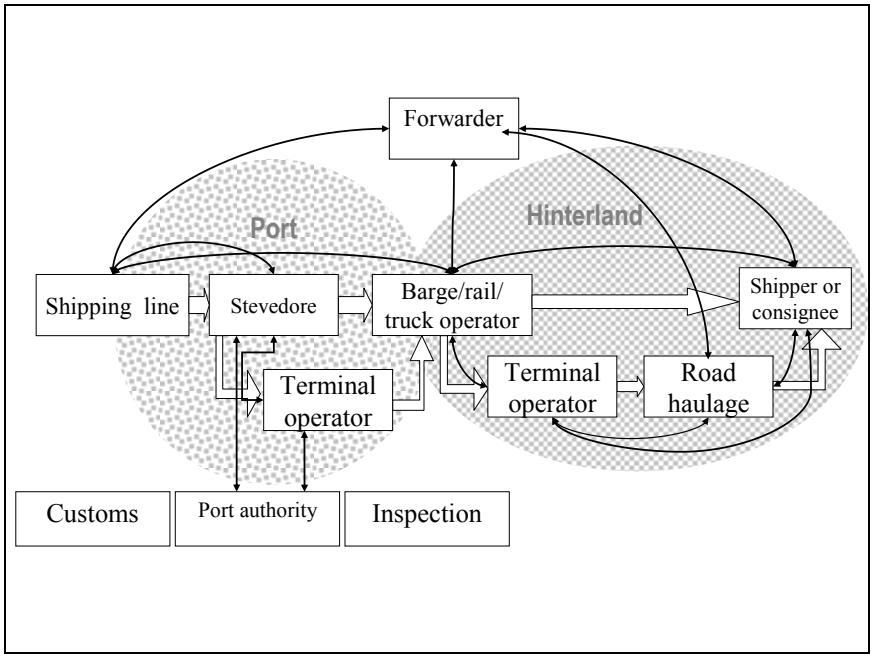

Figure 1. Organizational structure of port-hinterland transport chains

Source: Van Der Horst and De Langen (2008)

In his role as a *document service provider* the forwarder takes care of transport documents, including the notification of required customs documents. Thirdly, the forwarder can also be seen as an *architect* (De Wit and Van Gent, 1996). Because of market knowledge he has an overview on

transport possibilities and tariffs. The forwarder's role is to provide a door-to-door transport solution for a shipper (e.g. manufacturer).[6] The different definitions of the forwarder confirm that he is mainly involved in organizational issues. In order to make a clear distinction with other intermediaries, we distinguish organizational from physical operations (Figure 2).

Transport firms are firms owning (physical) assets and which economic rationale is to carry goods by means of various vehicles. Thus, transport firms are dominantly represented by physical operations, such as trucking, barging and rail transport. In between those two situations, intermodal operators have a more complex economic rationale because they are involved in both physical and organizational operations. We could define intermodal operators as transport companies who vertically integrate in the transport chain. In fact, intermodal operators exist in order to overcome different types of separations between transport modalities (Keller, 2004), such as separation in time, space, and ownership.

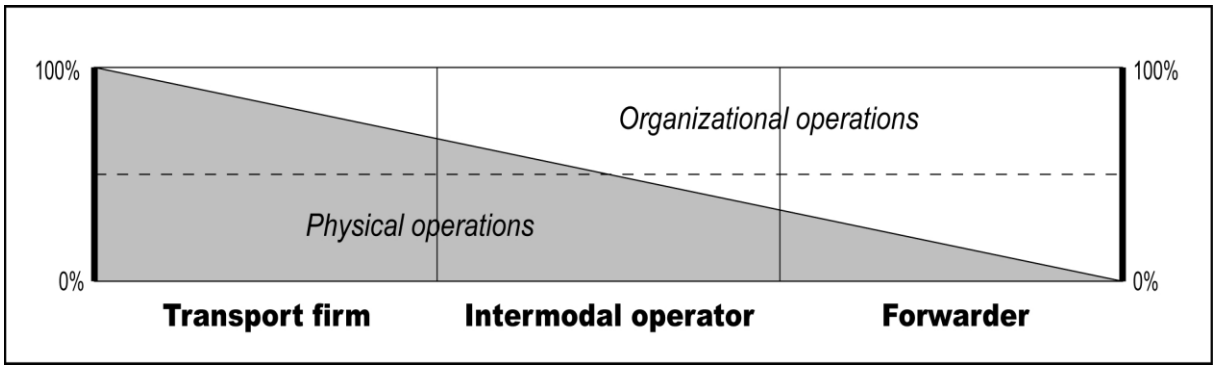

Figure 2. Main economic rationale of the three types of firms
Source: drawn by authors

In our analysis we emphasize the role of forwarders as an intermediary, but we also recognize that forwarders are relatively footloose. It is not necessary for forwarders to settle in port cities. However, the presence of intermediaries in port clusters is advantageous because the costs are lower and they are better situated to act as bridging tie (De Langen, 2004). For instance, non-asset owning forwarders are especially important in Rotterdam because of the strong position of this port (and of the Netherlands as a whole) in the logistics sector, where there is a dramatic need for intermediary services. Other factors that may influence the importance of forwarders within port cities may be synthesized as follows:

- Thickness and variety of commodity flows: ports with large cargo volumes are likely to attract more forwarders than smaller ports;
- Position in the maritime routes: first ports of call for import and last ports of call for export may be advantageous for forwarders that are willing to consolidate cargoes;

[6] These three traditional core activities of the forwarder have changed and enlarged in the last decades. First, forwarders became more involved in warehousing functions. For example, about 70% of Dutch forwarding companies generate turnovers with warehousing activities. The greater part has a warehousing capacity of more than 10,000 square meters (ING, 2004). Next, forwarders became more involved in organizational innovations, as they moved towards new positions in supply chains. As described by Visser et al. (2004), in the 1980s, the trend of logistic outsourcing led to the rise of forwarders who operate as a 3rd party Logistics Service Provider (3PL). The task of 3PLs is to optimize supply chain performance by managing and executing particular logistics functions, using its own assets and resources, on behalf of another company.

- Tax climate and customs procedures: more forwarders will settle in a given port city if the tax climate is more positive, moreover if the customs physical control procedures are organized more efficiently;
- ICT applications: this factor may reduce the need for forwarders, notably if ICT applications with custom authorities are efficient;
- Labor climate and knowledge of transport chains: for historical reasons and according to the level of education facilities in the field of logistics, forwarders will be more or less needed in the port city; and
- Liberalization level of the country in terms of freight transport: the degree to which a given country is opened to vertical and horizontal integration, stemming from the impact of legal and institutional entry barriers in seaports and in the transport chain (De Langen and Pallis, 2007).

3. Measuring transport integration

3.1 Data collection

Data on transport and logistics activities relates to the 32 industry codes of the Kompass database. This database provides information for a 2.2 million firms in 70 countries worldwide. A sample of 80 port cities was selected in accordance with three main criteria, i.e. demographic size of over 200,000 inhabitants, commercial port functions (e.g. container and Ro-Ro traffics), and air transport facilities and traffics.[7] Although there has not been threshold limits for port or air traffics, such criteria avoid including too specific categories such as hub ports (e.g. Gioia Tauro, Marsaxlokk) and outports (e.g. Felixstowe, Zeebrugge) whose economy remains limited in size and variety. In the end, our database represents 7,837 transport firms for a total of 1,040,892 employees.

Another dimension of data collection is geographical. Since many transport activities locate in suburban areas, such as airports, logistic parks, and intermodal junctions, collecting data only within the local administrative area would be misleading. For some cities, the local administrative area covers the urban area. In other cases, data was collected at the metropolitan area level. Table 2 compares the relative concentration of firms, employment, and turnover in the suburban areas of selected port cities. It shows the substantial weight of such areas. In some cases, suburban areas are more concentrated for number of firms than for employment, because of the smaller size of firms, as in Bordeaux, Nantes, Bari, Thessaloniki, Barcelona, Naples, Palermo, Glasgow, Helsinki, Lisbon, and Marseilles. In other cases, outer areas concentrate large firms, as in Piraeus-Athens, Valencia, Bilbao, Amsterdam, Catania, and Le Havre. The figure is more contrasted for turnover concentration, either in outer areas (e.g. Nice and Glasgow) or in central areas (e.g. Bordeaux, Nantes, Bari, Santander, Venice, Naples, Glasgow, Lisbon, and Marseilles). This implies that the comparative study of transport integration should not ignore the spatial layout of transport nodes themselves.

[7] Air transport is retained in this study because an increasing number of firms advertise themselves as air-sea logistics providers, such as Dachser (USA), Bondex (USA), Air Sea Logistics (UK), and DHL Danzas Air & Ocean (UK).

Table 2. Suburban concentration in selected port cities

Port city	Firms (%)	Employment (%)	Turnover (%)	Port city	Firms (%)	Employment (%)	Turnover (%)
Bordeaux	77.8	28.1	76.6	Barcelona	50.5	39.6	22.7
Leixoes-Porto	75.9	87.0	86.7	Vigo	45.2	55.3	37.7
Stockholm	75.4	76.5	83.4	Naples	43.5	16.1	19.3
Nantes	73.1	42.6	81.4	Palermo	43.1	28.1	29.9
Piraeus-Athens	66.8	85.6	74.5	Glasgow	36.8	20.8	78.0
Bari	63.6	32.0	44.0	Catania	35.6	41.9	56.2
Santander	60.0	36.6	89.0	Helsinki	35.5	12.2	21.7
Venice	59.7	31.6	55.5	Lisbon	24.0	11.7	9.8
Valencia	58.5	74.7	72.0	Marseilles	21.8	11.7	2.4
Bilbao	58.0	66.2	58.9	Le Havre	20.7	32.3	11.2
Amsterdam	57.8	78.8	N/A	Nice	16.9	19.9	50.5
Ancona	52.6	51.1	47.7	Bremen-Bremerhaven	12.6	5.8	3.6
Thessaloniki	51.1	39.2	44.5	Gothenburg	11.1	2.0	3.3

Source: realized by authors based on data from Kompass (2005)

3.2 Methodology

The methodology used in this paper relates to three important aspects: distinguishing forwarders from other types of firms, clarifying the different economic activities in which they operate, and measuring integration levels among those activities. First, distinguishing forwarders from transport firms and intermodal operators raised important issues since the relation between data and practice was not direct. Companies tend to broaden their portfolio of products and services in their communication strategies. While the authors are well aware of the limits of this data source, the systematic verification of firms' portfolios would have necessitated surveying each of the 8,000 firms, all of which not possessing updated or accessible online information.

In section 2.2 we propose a possible clarification. Based on the Kompass database, the portfolio of each firm is classified among the three main types accordingly. While classifying firms based on their advertised portfolio may not perfectly account for the reality of their daily operations, we have distinguished the firms based on the following[8]:

- Transport firm: a firm which portfolio includes only one transport activity, with no reference to forwarding;
- Intermodal operator: a firm which portfolio includes at least two transport activities, with no reference to forwarding;
- Forwarder: a firm which portfolio includes forwarding, either exclusively or besides other transport activities

Second, data was aggregated from 30 to 9 main transport industries, based on the recent study of Ducruet and Lee (2007) that uses the same database. In order to simplify the diversity of activities, port services, cargo handling activities, and stevedoring were grouped in one category "port". The same applies to sea, road, rail, air, logistics, river, warehousing, and forwarding. For instance, road transport corresponds to the haulage of bulk, part loads, hazardous materials, tanker, and other types of freight; the port service industry comprises port authorities themselves, together with port services (mooring, pilotage, towage, cargo handling); air transport

[8] See three examples of firms in Appendix 1

sums airport activities (administration, equipment, services) and air transport itself (charter, passenger, freight); warehousing is a group composed of storage sites, storage of liquid, cold, and specialized products.

Third, the degree of intra-firm transport integration corresponds to the sum of inter-industry links, i.e. how many times two or more industries are represented in the portfolio of a given establishment. The total by port can be considered as an overall indicator of transport integration. A new database of 36 possible inter-industry links (e.g. air-sea, sea-port, road-logistics, rail-forwarding, etc.) allows for analyzing intermodal specializations, notably about port-related integration.

3.3 Preliminary outcomes

From the total sample of port cities selected, approximately 45% of the firms, and 35% of their employment are either intermodal operators or forwarders (Table 3). The rest is concentrated by transport firms that operate in one activity only at a time. Although forwarders represent one-third of all firms studied, their employment share is relatively low due to the smaller size of those firms on average (51 employees). Transport firms are typically family-owned businesses (e.g. trucking) or large public-owned companies (e.g. port, airport, and railway companies). Intermodal operators are the largest companies because they necessitate larger amounts of labor for different physical operations. The dominance of transport firms shows the segmentation of the transport chain since the majority of companies operates in only one activity.

Table 3. Employment distribution by types of firms

Types of firms	Number of firms		Total employees		Average firm size
	No.	%	No.	%	
Transport firm	4,328	55.9	681,524	65.5	157.5
Intermodal operator	635	8.2	181,751	17.5	286.2
Forwarder	2,874	37.1	146,514	14.1	51.0
Total	7,738	100.0	1,040,893	100.0	134.5

Source: realized by authors based on data from Kompass (2005)

Table 4 shows in which industry every type of firm is most represented. While transport firms concentrate in road transport, their employment share is larger for rail and air transport. In fact, road transport firms are mostly small and medium-sized firms owning a few trucks, while airlines and railway companies are fewer but giant firms. Other core businesses are in sea transport and logistics. In comparison, intermodal operators are more involved in warehousing, river transport, and port activities, while the share of road and sea transport is also high. Finally, forwarders are of course, concentrated in their core activity (forwarding) but they are also active in road and sea transport, which are in all cases the most labor-intensive activities.

Table 4. Distribution of firms by main industries

Industries	Transport firm		Intermodal operator		Forwarder	
	Firms (%)	Employees (%)	Firms (%)	Employees (%)	Firms (%)	Employees (%)
Rail	2.3	21.4	4.5	12.3	3.7	6.3
Road	41.3	15.6	27.4	20.7	15.4	15.7
Port	8.5	6.6	9.8	11.4	3.3	3.6
Air	10.4	28.2	6.2	5.8	4.8	6.3
Sea	13.8	14.5	15.6	15.8	10.9	14.0
River	0.6	0.1	4.0	3.3	0.7	1.8
Forwarding	0.0	0.0	0.0	0.0	45.9	33.6
Logistics	10.9	9.2	12.3	8.3	5.2	7.4
Warehousing	12.2	4.4	20.2	22.3	10.2	11.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: realized by authors based on data from Kompass (2005)

Another preliminary result is the share of industries by types of firms (Table 5). In terms of employment distribution, it confirms the dominance of transport firms in air (76%) and rail (61%) transport, and to a lesser extent in logistics (44%), sea (39%), and road (37%) transport. This implies that such activities are mostly operated independently from each other. Nevertheless, there may be from case to case different coordination arrangements such as contracting, but the data does not provide information on inter-firm relations. For intermodal operators, key businesses are river transport (62%), warehousing (55%), and port activities (47%). Except from forwarding itself, the highest shares of forwarders are found in river (35%), warehousing (30%), sea (30%), road (29%), and logistics (27%).

Table 5. Distribution of transport industries by types of firms

Transport industries	Firms (%)				Employees (%)			
	Transport firm	Intermodal operator	Forwarder	Total	Transport firm	Intermodal operator	Forwarder	Total
Forwarding	0.0	0.0	100.0	100.0	0.0	0.0	100.0	100.0
River	21.2	44.7	34.1	100.0	2.9	61.7	35.5	100.0
Rail	24.6	16.5	58.9	100.0	61.1	25.1	13.8	100.0
Warehousing	36.2	20.1	43.7	100.0	14.9	54.8	30.3	100.0
Sea	39.6	15.1	45.3	100.0	39.4	31.0	29.7	100.0
Logistics	48.4	18.3	33.3	100.0	44.0	28.6	27.4	100.0
Port	51.3	20.0	28.7	100.0	37.6	46.6	15.8	100.0
Air	53.6	10.9	35.6	100.0	75.8	11.2	13.0	100.0
Road	56.7	12.7	30.6	100.0	36.6	34.8	28.6	100.0

Source: realized by authors based on data from Kompass (2005)

Finally, the analysis of transport integration is synthesized in Figure 3. An integration degree was calculated for every industry based on the counting of its links with other industries. In order to

avoid the size effect, a transformation from absolute to relative values was operated. We accentuated the preferential relations by calculating a quotient that is the share of the different shares of relations between a given industry and other industries. For instance, the share of port-river relations in total port relations is only 3%, but the share of these 3% in all river-related shares is 18%. It emphasizes the very specific relation between port and river activities as seen in the figure.

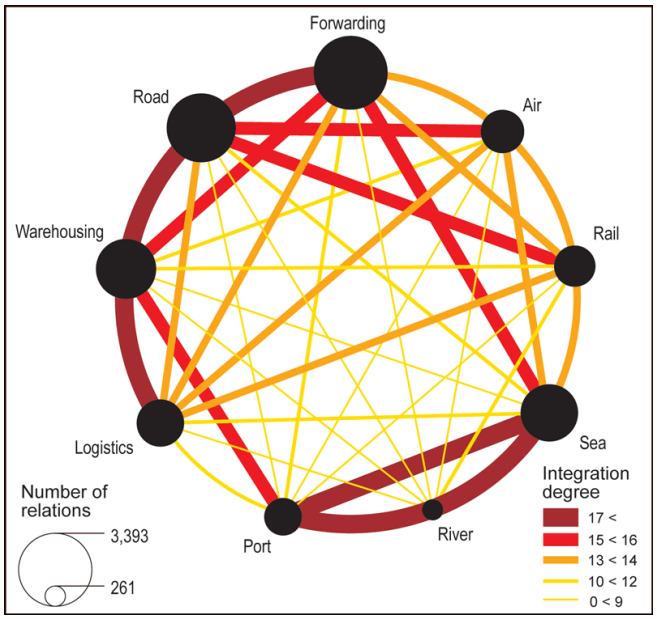

Figure 3. Integration levels among main transport industries
Source: drawn by authors based on data from Kompass (2005)

This figure offers a good overview of the general issues regarding transport integration within main European port cities. Two main sub groups exist: sea, port, and river highly integrated; forwarding, road, warehousing, and logistics as another distinct group. Thus, we see clearly a specialization in water transport as opposed to a specialization in continental transport. While logistics and road transport have many relations with air and rail transport, they have few relations with water transport in general. Warehousing has good relations with water transport, notably with port activities, but it has few relations with air and rail transport. In fact, forwarding occupies a central role in relating water transport with continental transport, notably through sea transport. Also, among all water transport activities, sea transport has the most relations with other activities (except port with warehousing). From this figure, we can hypothesize that the relation between forwarding and port performance is not direct. Port business is much more depending on sea and river transport, and warehousing is a major component of its relations within the transport chain. Still, forwarders, because they control a wide array of activities, are susceptible of influencing to a large extent port activity, through the organization of sea transport, road transport, and warehousing within port cities. A closer look at the distribution of those trends among main European ports in next section is necessary in order to understand the influence of location on such issues.

4. Main results

4.1 Distribution of firms

The first map (Figure 4) represents the total number employees by port city together with the share of employment by types of firms. It confirms the importance of city size in the distribution of employment, because bigger cities generate higher demand for transport activities. However, Hamburg - not London - lies at the top of the hierarchy, followed by port cities such as Stockholm, Helsinki, Amsterdam, Oslo, St. Petersburg, Dublin, Lisbon, and Piraeus-Athens for the largest concentrations. The lower weight of British cities in general may reflect the transformations of UK's transport sector in the past decades, with rapid liberalization resulting in drastic workforce reduction and lower port performance in traditional port areas such as Liverpool (Damesick, 1986).

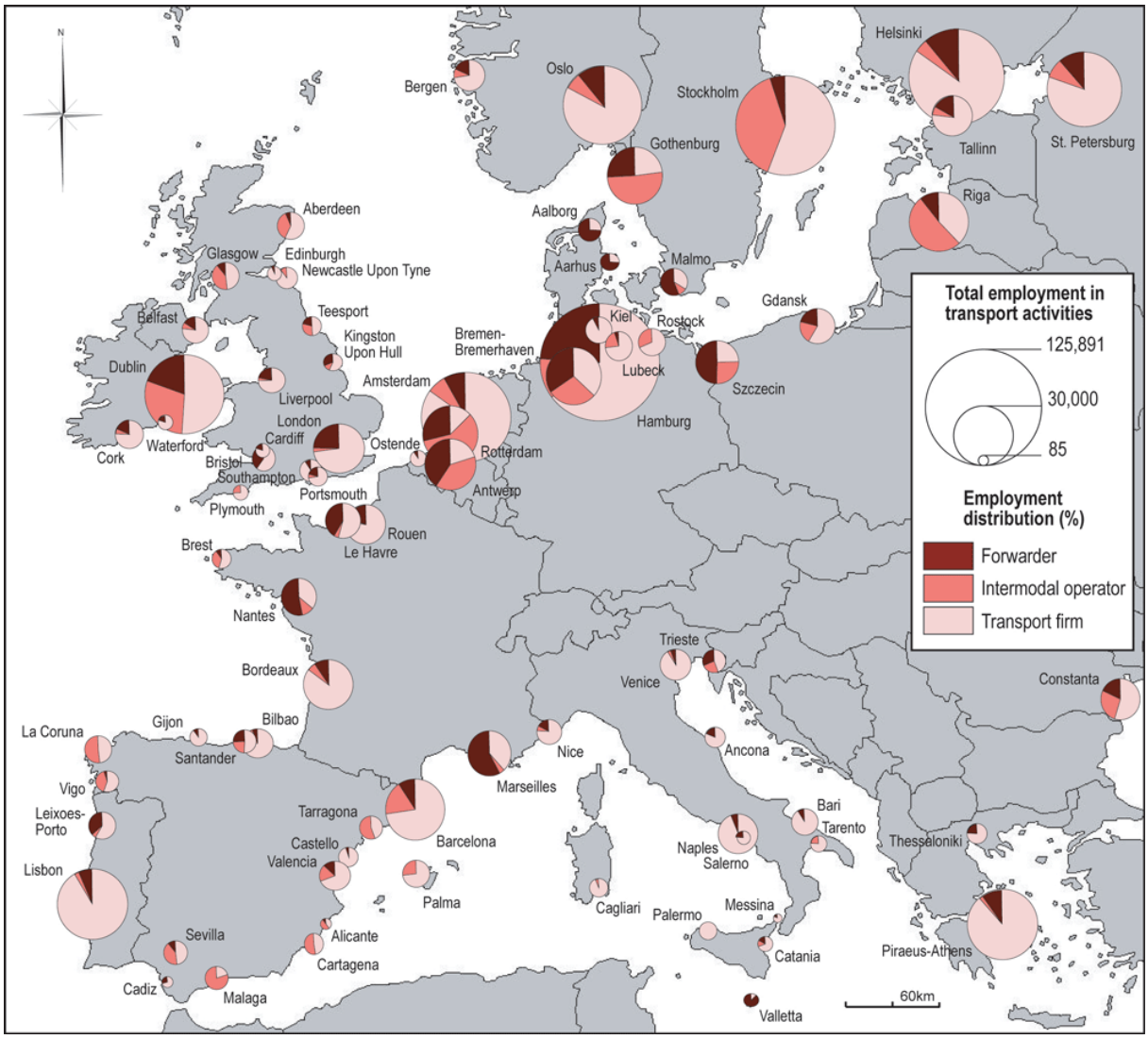

Figure 4. Distribution of employment by types of firms at European ports
Source: realized by authors based on data from Kompass (2005)

One other striking result is the higher importance of transport firms in southern European ports and in main remotely located northern cities. This may stem from the importance of air transport - that is dominated by transport firms - in those cities as a remedy to their remoteness, but it can

also illustrate the greater segmentation of the transport chain within southern port cities. This means that although it is not true in all cases, there is a higher proportion of transport integration in northern Europe than in southern Europe. Such result is also influenced by the historical and geographical setting in which northern European ports developed over time. Among others, there is a clear influence of the importance of hinterlands in the distribution of intermodal operators and forwarders. A majority of firms offering transport integration tend to locate closer to the core economic regions of Europe. Only Marseilles, Trieste, and Leixoes-Porto in the South have a substantial proportion of forwarders, while intermodal operators are concentrated across Spanish ports and in Constanta (Romania). Among northern ports, the main gateways such as Antwerp, Rotterdam, Bremen-Bremerhaven, and Hamburg have in common a higher share of intermodal operators, but this is also the case of less-developed ports such as Dublin, Stockholm, Riga, Glasgow, and Aberdeen. Forwarders concentrate along a Nantes-Szczecin axis where most powerful ports are located.

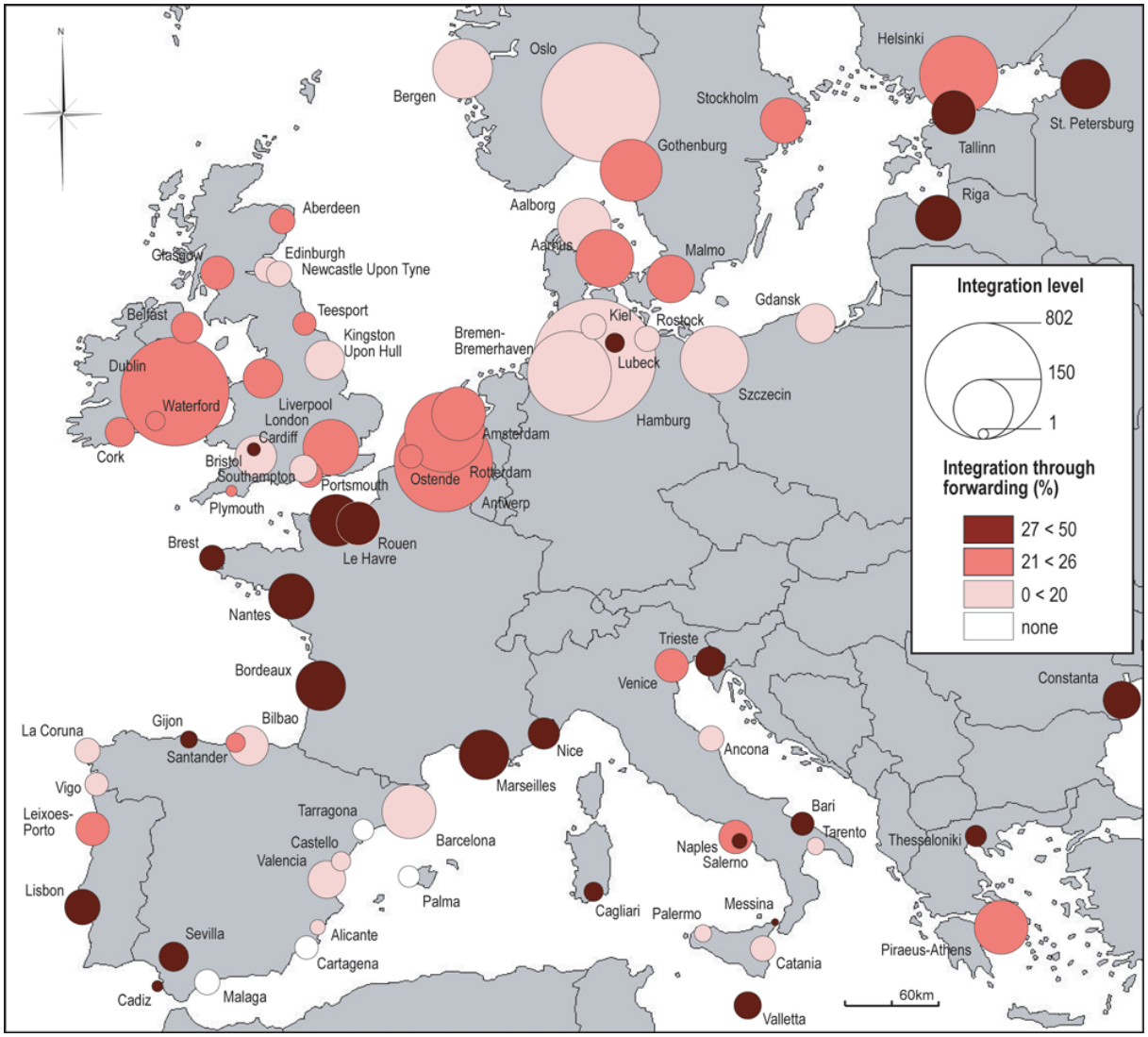

Figure 5. Weight and nature of transport integration at European ports
Source: realized by authors based on data from Kompass (2005)

The distribution of integration levels by port city is combined to the share of forwarder-related integration in Figure 5. Darkest colors indicate ports where the influence of forwarders is the

strongest, while lightest colors are better explained by the role of intermodal operators. Integration levels concentrate at northern ports, with Hamburg at the top of the hierarchy, followed by Oslo, Dublin, Rotterdam, Bremen, Antwerp, and Helsinki. Only Piraeus-Athens, Barcelona, and Marseilles show a good concentration of integration in the South. Such picture confirms the north-south imbalance with regard to transport integration at European ports. The share of forwarders provides complementary evidence about the spatial logics of transport integration. In fact, it seems that this distribution is country-specific, and much resembles to the distribution of the rail freight liberalization level[9], despite some exceptions. Overall, transport integration at ports located in countries with a low or medium liberalization index much depends on forwarders (e.g. France, Estonia, Latvia, Greece, Italy, Portugal, and Spain). Conversely, the share is generally low for ports located in countries with a high liberalization index (e.g. Germany, Norway, Netherlands, Poland, UK, and Belgium).

In the end, the relative importance of forwarders may be better explained by the inefficiency - rather than by the efficiency - of transport chains. Indeed, the liberalization index indicates a degree of openness to international competition, the opportunity for new competitors entering the domestic market and, in turn, a stronger insertion of the latter in global transport and supply chains. Therefore, the relative importance of forwarders seems to be more a remedy to a lack of integration, than an outcome of effective transport integration. It confirms the national role of forwarders as opposed to the international dimension of intermodal operators. Conversely, it is possible to advocate that the presence of intermodal operators has higher significance with regard to transport integration in ports. While many forwarders are still traditionally bound to national territories, intermodal operators are more international and have emerged more recently in the market. Yet, an examination of the relationships between types of firms, transport integration levels, and port-city characteristics is necessary in order to verify the hypothetical interplay between port performance and transport integration.

4.2 Transport integration and port performance

In the end, the new indicator of integration level based on the firms' portfolios provides useful insights on port performance (Figure 6). Transport integration positively impacts container throughputs, but the statistical relationship remains lower than expected. In fact, the model is distorted by different regional characteristics within Europe. Northern range ports - that are also Europe's biggest ports - cumulate traffic size with high integration levels: these gateways are the backbone of Europe's maritime trade as a whole. Ports with higher integration than traffic locate principally in the Scandinavia-Baltic, and Atlantic regions. Ports with lower integration than traffic are dominantly located in the Mediterranean region (except for Southampton, UK). Again, this shows to what extent the Northern range takes advantage from - but also contributes creating - the European core-periphery spatial pattern. The separation between North and South stems from specific regional factors where physical geography (e.g. elevation, location of rivers), traditional management practices, and development imperatives remain drastically different.

[9] See the recent study by IBM GBS (2007)

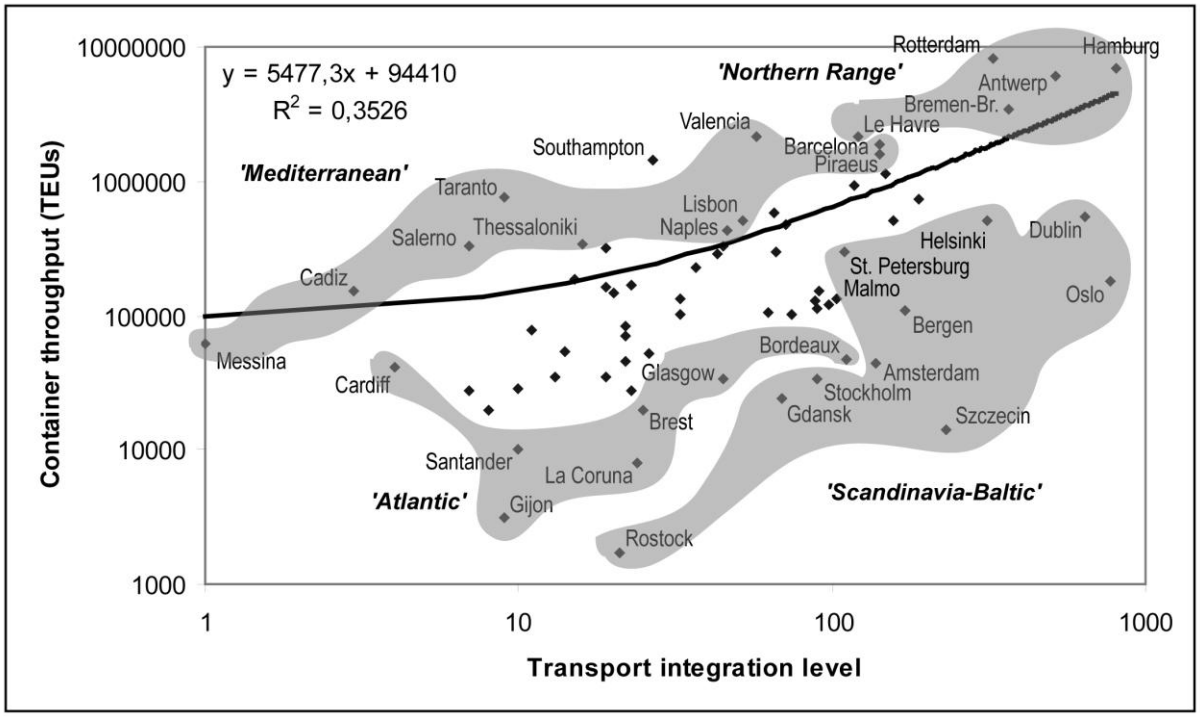

Figure 6. Transport integration and port performance, 2005
Source: realized by authors based on data from Kompass (2005) and Containerisation International (2007)

Because our measurement of transport integration is an absolute index, which is influenced by the size effect (e.g. number of firms), we applied two other indexes to the distribution of transport employment (e.g. sea, road) and to the distribution of transport integration (e.g. air-sea, rail-road) within each port (Table 6). The first index is a widespread measure of urban performance (Duranton and Puga, 2000): it is the inverse of Isard (1960)'s specialization coefficient that corresponds to the sum of the differences in employment shares compared to the European average. The second index is the Gini coefficient that is extensively applied to the distribution of traffic among port systems (Notteboom, 2006): it is more robust than the diversity index and can be considered as a measure of specialization. Both indexes measure the local width of firms' portfolios within port cities.

Results based on modal employment show that major gateways are less diversified. This can be explained by the lack of urban functions (e.g. Le Havre, Southampton) except for Bremen-Bremerhaven, compared with national capitals (e.g. Dublin, Helsinki), and by the dominance of few main industries: more than half of employment relates to road and sea transport in Rotterdam and Hamburg. Such trend is accentuated by remoteness and a north-south effect, as seen with the higher modal diversity of southern ports such as Valencia, Barcelona, Marseilles, and Piraeus. Such ports locate within large urban agglomerations providing a wider diversity of transport functions. In terms of employment concentration, only a few top ports outreach the European average: Hamburg, Le Havre, Barcelona, Taranto, Lisbon, and Thessaloniki. This confirms recent results about the relationship between commodity variety and seaport performance in Europe (Ducruet et al., 2009).

Table 6. Diversity and concentration at top 20 European container ports

Port hierarchy (2005)	Transport employment (9 categories)		Transport integration (36 categories)	
	Diversity index	Concentration index (Gini)	Diversity index	Concentration index (Gini)
Rotterdam	1.17	0.42	**2.13**	0.58
Hamburg	1.27	**0.57**	**3.41**	0.42
Antwerpen	1.24	0.45	**2.79**	0.54
Bremen-Bremerhaven	**2.65**	0.26	**3.66**	0.41
Le Havre	1.02	**0.57**	**1.74**	**0.71**
Valencia	**1.93**	0.48	**2.19**	0.50
Barcelona	**1.47**	**0.57**	**1.63**	0.64
Piraeus	**1.58**	0.54	1.31	**0.74**
Southampton	1.19	0.52	1.21	**0.68**
Marseilles	**1.73**	0.40	1.54	**0.77**
Taranto	0.92	**0.64**	0.75	**0.80**
Gothenburg	**1.79**	0.39	**2.81**	0.63
Liverpool	**1.46**	0.51	**1.59**	0.59
Dublin	**5.25**	0.37	**2.82**	0.60
Lisbon	1.28	**0.62**	1.35	**0.71**
Aarhus	1.26	0.46	**2.66**	0.58
Helsinki	**2.02**	0.54	**3.13**	0.56
Bilbao	**1.54**	0.49	**1.97**	0.40
Naples	**1.42**	0.52	1.33	**0.75**
Thessaloniki	0.97	**0.60**	0.99	**0.85**
European average	*1.32*	*0.56*	*1.56*	*0.68*

Source: realized by authors based on data from Kompass (2005)
N.B. bold values are higher than European average

What becomes clear is the closeness between integration diversity and port performance. All major gateways have higher values than European average, with Hamburg and Bremen-Bremerhaven as the highest. Le Havre's score is explained by its lower intermodal efficiency, as seen in Figure 5. Only Spanish ports enjoy a high diversity among southern ports that are badly represented in general. The concentration index shows that only Southampton and Le Havre underperform among northern ports, probably due to their proximity to the global cities and transport hubs of London and Paris, respectively. All other high concentration values go to southern ports, highlighting their weakness in terms of transport integration, which depends on a few possibilities. Again, Spanish ports seem to attract more integrated firms than other southern ports.

As seen in Appendix 2, while the correlation between container traffic and integration diversity remains moderately significant (0.38), logistics, forwarding, road and warehousing are the most likely to be associated with integration diversity. It confirms that transport integration is a key component of port performance, and is intimately related with value-adding and hinterland accessibility. Other significant correlations in Appendix 2 indicate the strong role of

containerization in enhancing transport integration, as seen with the number of container-related firms (0.57), but also the role of the physical layout of transport nodes through highway (0.56), railway (0.34) connections, and the spatial extent of the urbanized area (0.43) compared with other port and urban characteristics.

5. Conclusion

Based on conceptual insights about the interplay between transport integration and port performance, this paper provides empirical evidence that may be considered as a base for further research. The portfolios of firms constitute a rich and easily accessible source of information that has been much ignored so far by transport specialists. A simple and original methodology overcomes the difficulty measuring transport integration, while it clarifies the different types of firms involved in this complex process (transport firm, intermodal operator, and forwarder), although their functions tend to overlap nowadays precisely because of transport integration itself.

Main results are threefold. First, the location of intermediaries relates to hinterland size and accessibility. Especially, there is a good correlation between employment in forwarding, integration level, and container traffic, compared with other local characteristics of the port cities. Second, the relative importance of forwarders in enticing transport integration levels in port cities better reflects the weaknesses, rather than the performance, of some ports located in countries that are not well opening their transport industries to foreign competition. Therefore, the role of intermediaries is double. On the one hand, they improve the efficiency of disjointed transport chains, but on the other hand, their weight reveals coordination problems among transport firms. Ports attracting intermodal operators are, therefore, more likely to be well integrated in international transport chains than ports attracting forwarders. Third, the statistical relationship between transport integration and port performance is significant, but it is influenced by different regional legacies and contexts. Northern gateways connecting the European heartland combine strong traffic volumes and higher integration, while Southern ports are weaker due to the dominance of transport firms. In addition, the diversity and concentration of modal employment and transport integration locally reveal the limitations of transport chain insertion of some large container ports.

Given the importance of efficient organized hinterland chains as key factor in port competition and the role of intermediaries as 'bridging tie' in establishing coordination, more research is needed in several directions. An in-depth qualitative analysis of the incentive structure of transport firms, intermodal operators and forwarders would give a better understanding of their double role with regard to the efficiency of port-related transport chains. A better differentiation of the functional and legislative diversity of intermediaries would allow a more precise classification of ports.

Given the fact that intermediaries are relatively footloose, another promising line of research would be to extend the study to inland cities and regions for highlighting the specificity of ports as opposed to non-port cities. Finally, the comparison of our results with more recent data from Kompass would allow analyzing the evolution of transport integration, notably through the looking glass of global strategies and local policies.

Acknowledgements

This research has benefited from Marie Curie financial support under the EIF-FP6 action programme and is made possible with support of Transumo. Transumo (TRANsition SUstainable MObility) is a Dutch platform for companies, governments and knowledge institutes that

cooperate in the development of knowledge with regard to sustainable mobility. The authors also would like to thank the four blind reviewers for their useful comments on an earlier version of this paper.

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Appendix 1. Selected examples of firm types

Maex	
Date established	1986
Number of employees (total in the company)	22
Legal Form	S.A.R.L.
Address	BP 5077, 76071 LE HAVRE CEDEX France

Key products and services

Code		Kompass code description
72460		**Road transport services classified by type of freight**
7246001	**S**	Handling and road transport of exceptional loads
72420		**Road haulage, part loads**
7242010	**S**	Road haulage services, isothermal container

Example of a Transport Firm
Source: Kompass (2005)

Samskip BV	
Date established	1940
Number of employees (total in the company)	1400
Legal Form	BV
Address	Postbus 54143, 3008 JC Rotterdam The Netherlands

Products & services

Code		Kompass code description
72100		**Rail transport services**
7210001	**S**	Container transport services, railway
7210005	**S**	Rail transport services, controlled temperature
7210013	**S**	Transport services, combined, road-rail
72400		**Road haulage, bulk**
7240010	**S**	Transport services, bulk freight containers
72420		**Road haulage, part loads**
7242002	**S**	Road transport services, international, part loads
7242005	**S**	Groupage services, freight containers or trailers
72460		**Road transport services classified by type of freight**
7246003	**S**	Road transport services, refrigerated
7246010	**S**	Road transport services, foodstuffs
7246011	**S**	Road transport services, plants and flowers
7246012	**S**	Road transport services for works of art and other valuable items
7246014	**S**	Road transport services for pharmaceuticals
7246019	**S**	Road transport services, machinery
7246021	**S**	Road transport services, industrial equipment
7246023	**S**	Road transport services, agricultural machinery and equipment
7246024	**S**	Road transport services, furniture industry
7246025	**S**	Road transport services, international, for perishable goods
74100		**Shipping services, passenger and freight**
7410008	**S**	Container transport services, ocean
7410020	**S**	Shipowners, ocean-going ships
74450		**Inland waterway transport services**
7445007	**S**	Barge transport services, inland waterway

Example of an Intermodal Operator

Source: Kompass (2005)

Gebr. Hirdes GmbH	
Date established	1871
Number of employees (total in the company)	70
Legal form	GmbH
Address	Heidenskampweg 100, 20097 Hamburg Germany

Products & services

Code		Kompass code description
76200	**E**	**Shipping and forwarding agents**
7620001	**S**	Shipping and forwarding agents, national
7620002	**S**	Shipping and forwarding agents, international
7620007	**S**	Forwarding agents, air transport
7620010	**S**	Freight brokers for sea transport
77100	**E**	**Warehouses and storage sites**
7710001	**S**	Warehouses, general storage
84970	**E**	**Materials management (logistics) consultants**
8497001	**S**	Warehousing and distribution logistics services, international

Example of a Forwarder

Source: Kompass (2005)

Appendix 2. Correlations among main variables

Category	Variable	Modal diversity index	Modal concentration index	Integration diversity index	Integration concentration index
Firm employment	Transport firm	0.23	0.02	**0.53**	-0.29
	Intermodal operator	0.35	-0.19	0.36	-0.25
	Forwarder	0.35	-0.28	**0.60**	-0.41
Employment by industry	Rail	0.27	-0.01	0.22	-0.13
	Road	0.29	-0.06	0.41	-0.23
	Port	0.32	-0.33	0.38	-0.31
	Air	0.22	0.05	0.37	-0.19
	Sea	0.10	-0.07	0.36	-0.28
	River	0.03	-0.21	0.20	-0.20
	Forwarding	0.28	-0.23	**0.52**	-0.37
	Logistics	0.15	-0.05	**0.71**	-0.29
	Warehousing	0.27	-0.18	0.39	-0.29
Port characteristics	Container traffic	0.09	-0.28	0.38	-0.31
	Total tonnage	-0.01	-0.21	0.22	-0.26
	No. of liner direct calls	0.05	-0.28	0.33	-0.26
	Container terminals' length	0.04	-0.25	0.35	-0.27
	Container terminals' depth	0.03	-0.18	0.16	-0.20
	Total quay length	0.03	-0.25	0.34	-0.28
	No. of container-related firms	0.21	-0.40	**0.57**	-0.39
	No. of logistics agents	0.23	-0.31	0.39	-0.27
Urban characteristics	City centre population	0.14	-0.24	0.28	-0.24
	Suburban area population	0.15	-0.26	0.19	-0.16
	Metropolitan area population	0.17	-0.26	0.28	-0.23
	Urban area surface	0.33	-0.26	0.43	-0.26
	No. highway connections	0.27	-0.35	**0.56**	-0.37
	No. railway connections	0.17	-0.32	0.34	-0.29
	Air traffic (passengers)	0.18	-0.17	0.27	-0.17
	Air traffic (freight)	0.06	-0.09	0.18	-0.04

Source: realized by authors based on data from Kompass (2005), Helders (2008), Aéroports Magazine (2004), Containerisation International (2008), International Transport Journal (2008).
N.B. values over 0.3 and -0.3 are highlighted in grey and values over 0.5 are in bold for better clarity