Redefining the Hamburg – Le Havre range in maritime networks

Plasschaert, K.; Derudder, B.; Dullaert, W.; Witlox, F.

In: Proceedings of the BIVE-GIBET Transport Research Day 2011. Zelzate, University Press, p. 240-244, 2011.

Redefining the Hamburg – Le Havre range in maritime networks

Katrien Plasschaert[1]
Ben Derudder[1]
Wout Dullaert[2]
Frank Witlox[1]

Abstract: *This paper analyses to what degree closely located ports function as an integrated economic-geographic entity. The empirical setting of this study is the Hamburg – Le Havre (H–LH) range, arguably the most well-known region for analyzing the spatial and relational proximity of ports. This range is usually defined as consisting of the ports of Hamburg, Bremerhaven, Amsterdam, Rotterdam, Antwerp, Zeebruges, Dunkirk and Le Havre, although sometimes smaller ports (e.g. Ghent, Terneuzen) are included. So far, few studies have focused on the issue whether or not all these ports can in reality be considered to be a fully integrated maritime area. To this end, we apply various network analysis methodologies to real-life network data to assess port connectivity, concentration and interdependencies in the H–LH range. Our results show strong interdependencies between the ports of Tilbury and Felixstowe (UK) and those of the H–LH range. This indicates that these two ports could be included in the definition of the H–LH range.*

Keywords: Hamburg – Le Havre, maritime range, connectivity, network analysis, Alphaliner

1. Introduction

This study aims to measure the structure of maritime networks. The empirical setting to this purpose is the Hamburg – Le Havre (H–LH) range which is usually defined as all ports between Hamburg (Germany) and Le Havre (France), consisting of some smaller and larger ports. Most research (Wiegmans et al., 2009; Notteboom, 1997) indicates that all of these ports are strongly integrated. The purpose of this research is to verify if the notion of a 'maritime range' for these ports is valid, by using different network methods. This research question can be split into three distinct parts. First a rough sketch of the properties of this range is given, based on several network analysis methods. Second, we will verify if some of the UK ports – which are normally not considered as being part of the range – (Wiegmans et al., 2009; Notteboom, 1997), could be added to this range. Third, we will also examine whether or not the smaller ports between Hamburg and Le Havre should be maintained in the definition of this range.

We approach these questions from a geographical network perspective; the economic aspects will not be included in the analysis and the definition of a maritime range. As a result, other possible definitions of a maritime range such as ports having overlapping hinterlands, shared historical impacts, integration of commercial activities, etc (Lemarchand and Joly, 2009) are disregarded. Vigarié (1979) defined a maritime range as a fully integrated maritime front. This means that the ports of a maritime range are not scarcely linked to each other and that there are strong interdependencies between them. This implies that geographic proximity is not enough to establish such a range. Since the implementation of network theories by geographers, there is a renewed interest in maritime ranges, which resulted in a re-conceptualization of the maritime range. Due to emerging strong horizontal transnational

[1] Ghent University – Geography Department – Krijgslaan 218 (S8) – 9000 Gent – Belgium
katrien.plasschaert@ugent.be, ben.derudder@ugent.be, frank.witlox@ugent.be
[2] University of Antwerp-ITMMA – Keizerstraat 64 – 2000 Antwerpen – Belgium
wout.dullaert@ua.ac.be

relations between ports, the vertical relations between ports and their hinterland are outmatched (Veltz, 1996). Lemarchand and Joly (2009) describe the maritime range as the networking of port cities, based on the definition of Vigarié (1997). Hence, a maritime range is a network of ports benefiting from scale economies and resulting in a strongly integrated port hierarchy.

2. Data description and handling

To analyze the level of connectivity of the H–LH maritime network, we used data stemming from Alphaliner (http://www.alphaliner.com). Alphaliner is an information platform, represented by AXSMarine, providing strategic market intelligence for the liner shipping industry (http://www.axsmarine.com). The specific dataset used in this study contains information on the worldwide liner shipping services on all maritime routes in 2007. The most significant information is the capacity (expressed in number of TEU) of the ships on all routes, the duration and frequency (in days) of the sailings and obviously the sequence of the ports that are called at. This detailed information makes the dataset very useful for the network analysis in this research.
Using data on transport capacity rather than the actual number of TEU transported also implies an important drawback as the actual transport volumes between the ports of the H–LH cannot be discerned. However, as we are only considering the capacity and the structure of the network of the H–LH range, and not the economic impacts, this dataset is adequate for our analysis.
The complete dataset consists of 703 files, each representing one liner shipping service's maritime route. Twenty percent of all these files contains at least one port of the H–LH range and were thus used for our analysis. Different sub-datasets are derived: both binary and valued or weighted networks. In the valued networks, the number of TEU that represents the capacity of each link will be taken into consideration. We also derived undirected and directed graphs. In an undirected or symmetric graph, all ports will be treated as connected if they are in the same rotation of a liner shipping service. In the directed or asymmetric networks, the direction of such a rotation between ports will be considered. We used two versions of these datasets, containing on the one hand only the H–LH ports and on the other hand also other Western European ports and other worldwide regions as defined in the Alphaliner dataset.

3. Maritime network of the H–LH range

3.1. Degree centrality

The Freeman's degree centrality is a basic measure for the centrality of ports in a maritime network, based on the strength of links that ports have to each other. The degree centrality is applied to the sub-datasets containing only the H–LH ports. With regard to the binary undirected data the degree centrality is computed as the number of connections of a port. For the valued network, the degree centrality considers the total capacity through which a port is served, in this study measured in TEU. For directed data a distinction is made between in-degree (incoming links) and out-degree (departing links) (Hanneman and Riddle, 2005). So if a port receives many ties, it will have a high in-degree. In the network of the H–LH range this could mean that this port receives many European links and sends out links to outside Europe. In contrast, a port with a high out-degree will receive many containers from outside Europe and distribute these inside the H–LH range. Table 1 presents the degree centralities of all H–LH ports. At the one hand, we only consider the number of intra – H–LH links (binary asymmetric graph; columns a and b) and, on the other hand, also the number of TEU between this ports is considered (valued asymmetric graph; columns c and d).

In 2007, the most central ports in the weighted network were not equally dominant in the network without the inclusion of the capacity. For the binary graph it is obvious that Rotterdam has the highest out-degree whereas it does not have the highest in-degree. Antwerp and Le Havre display the opposite: the in-degree is higher than their out-degree. This means that these ports receive a lot of links from other ports, more in comparison to Rotterdam which has mostly departing links. These results might indicate that in 2007 Rotterdam received a lot of foreign (i.e. non-European) links and that this import was distributed over the H–LH range by feeder services. Indeed, by looking at the data, most liner services coming from Asia to Europe, first called at Rotterdam. Most services to Africa departed from Antwerp. The results of the valued network are similar. The in-degrees of Antwerp and Le Havre are considerably larger than their out-degrees. However, Hamburg comes first in this ranking because the capacity is included.

Ports	Binary degree		Valued degree		Betweenness (e)	n betweenness (f)
	In-degree (a)	Out-degree (b)	In-degree (c)	Out-degree (d)		
Hamburg	6	6	7643247	9838452	17.333	13.131
Rotterdam	5	7	7805297	9345230	28.583	21.654
Antwerp	7	5	5930645	4447608	15.917	12.058
Bremerhaven	3	4	3990127	4120848	0.833	0.631
Le Havre	6	4	5281819	3321498	6.250	4.735
Zeebruges	3	3	2333391	1952748	1.250	0.947
Dunkirk	3	3	911999	321713	2.333	1.768
Amsterdam	2	3	462868	924348	0.500	0.379
Emden	0	1	0	44973	0	0
Boulogne	0	1	0	28125	0	0
Ijmuiden	0	1	0	36500	0	0
Vlissingen	1	1	228125	20075	9.000	6.818
Moerdijk	1	0	14600	0	0	0

Table 1: Results of the network analysis measures

3.2. Betweenness centrality

Freemans's approach for betweenness centrality views a port as central in a network if it falls on the geodesic path between other pairs of ports in the network (Hanneman and Riddle, 2005). This measure can only be applied to binary graphs (Tranos, 2011). So the more liner services are depending on a certain port to make a connection between other ports, the more central this first port is in the network, resulting in a higher betweenness centrality. This measure fits the structure of the maritime network as containers are frequently reshipped onto other vessels through so-called hubs. The normalized betweenness is expressed as the percentage of the maximum possible betweenness that a port could have (Hanneman and Riddle, 2005). Both the results of the Freeman and the normalized betweenness are shown in Table 1 (column e and f).

The betweenness centrality measure shows some remarkable results. Flushing and Dunkirk are two small ports in the Hamburg-Le Havre range, with a respective annual capacity throughput of 70.000 and 250.000 TEU (Wiegmans et al., 2009). Nevertheless they exhibit a large value for the betweenness centrality. Dunkirk is rather strongly connected in comparison to its total throughput capacity and Flushing is an important connecting node for the port of Boulogne. Without Flushing, Boulogne would not be connected to the Hamburg-Le Havre range for the period under consideration. As the betweenness centrality can only be applied to binary links, we can compare these results with those of the degree centrality of the binary links. The results are similar: Rotterdam, Hamburg and Antwerp are the most central ports in the network, followed by Bremerhaven, Le Havre and Zeebruges. The difference in connectivity between the larger and smaller ports in the range appears more clearly than in the degree centrality measure.

3.3. Clique Analysis

To verify whether or not the Hamburg – Le Havre ports could be labeled as one maritime range, a clique analysis is applied to the dataset. Therefore, also the UK-ports and South-Europe ports are included. The Mediterranean ports are not included because they form a rather distinct cluster of ports, as is also verified by the dataset. A clique is defined as a sub-set of a network in which the ports are more closely and intensely tied to one another than they are to other ports of the network (Hanneman and Riddle, 2005). A clique as such is the maximum number of actors who have all possible ties present among themselves (Tranos, 2011).

To perform the clique analysis, a minimum of ten ports per clique is set. The results indicate that there are forty cliques in the dataset. Twenty-three of them contain the five large European ports which we identified earlier in this research. Half of these twenty-three cliques contain Tilbury, the other half contain Felixstowe. None of them however contains both Tilbury and Felixstowe. This makes sense because Tilbury is one of the smaller UK ports, and Felixstowe is one of the larger ports and cliques are dependent on the size of the ports. Surprisingly Thamesport, also one of the larger UK ports, does only appear once together with the larger Hamburg-Le Havre ports. Furthermore, none of the smaller ports in the Hamburg-Le Havre range consistently belong to the same clique as the larger ports. This is due to the fact that the difference in connectivity between the ports in the Hamburg-Le Havre range might be too large. The overlap between these twenty-three cliques is rather large, mostly Tilbury and Felixstowe are the only difference between any two cliques, accompanied by some smaller European ports. This indicates that all these ports can be considered as belonging to the same clique.

4. <u>Conclusions and further research</u>

Based on the dataset and the results (Table 1) we could argue that the ports in the H–LH range are strongly interconnected. Six ports display a high value for their in- and out-degree and betweenness: Bremerhaven, Hamburg, Rotterdam, Antwerp, Le Havre and Zeebruges. This indicates that these ports are central in the network, although, depending on the measure, also some smaller ports seem to be central or important in the network topology (e.g. Flushing according to the betweenness centrality). This addresses the first research question we formulated.

A clique analysis was applied in order to answer our second research question. These results indicate that Tilbury and Felixstowe could be considered as part of the H–LH range because they consistently belong to the same cliques as the six central ports in this range. Together they thus form a strongly integrated network of ports; our working-definition of a maritime range. The large degree of overlap between the cliques confirms this conclusion. This does however not mean that all smaller ports should not be retained in the definition of the H–LH range (see question number 3). On the one hand, we should consider the smaller ports of the range because some of them are strongly integrated to the larger ports. On the other hand, none of these ports belong to the same cliques as the five large Hamburg-Le Havre ports.

These preliminary results can be widened in the future to other regions and to investigate the similarities between these regions. Also a longitudinal analysis of the Hamburg-Le Havre range can be conducted to study the network dynamics, including the consideration of other aspects of a maritime range such as the overlapping hinterlands.

Bibliography

AXSMarime, http://www.axsmarine.com, 06/05/2011

Alphaliner, http://www.alphaliner.com, 06/05/2011

Hanneman R.A. and Riddle M., **Introduction to social network methods**, University of California, Riverside, CA, http://faculty.ucr.edu/~hanneman/nettext/

Lemarchand A. and Joly O., *Regional integration and maritime range,* In: Notteboom T., Ducruet C. and de Langen W., **Ports in proximity: competition and coordination among adjacent seaports**, pp. 87-98, Ashgate, 2009

Tranos E., *The topology and the emerging urban geographies of the Internet backbone and aviation networks in Europe: a comparative study,* **Environment and Planning A**, 43, pp. 378-392, 2011

Notteboom T., *Concentration and load centre development in the European container port system*, **Journal of Transport Geography**, 5 (2), pp. 99-115, 1997

Veltz P., **Mondialisation, villes et territoires**, PUF, Paris

Vigarié A., **Du Havre à Hambourg: la première façade maritime du monde**, Paris: La documentation Française, 1979

Wiegmans B.W., Konings R. and Priemus H., *Critical mass for the development of a new container port in Vlissingen*, **Maritime Economics and Logistics**, 11 (4), pp.399-417, 2009