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Bremen's and Hamburg's port position: Transport infrastructure and hinterland connections within the North Range[2]

The quality and efficiency of the northern German ports' hinterland connections define their competitive potential. The assessment of gross domestic product achieved within a certain travel period via rail, road, inland waterways and intermodal freight transport provides a major indicator for the competitive positioning of the northern German ports. To measure this potential, we use simple travel time matrices for different modes of transport. The achievable purchasing power of the hinterland territories is thereby a prime determinant of port competitiveness. The European Union's Trans-European Transports Network programme (TEN-T) may advance Hamburg and Bremen/Bremerhaven ports' competitive situation by improving their hinterland accessibility, removing cross-border bottlenecks and upgrading infrastructure and streamline transport operations throughout the EU.

Pozycja portów w Bremie i Hamburgu – infrastruktura transportowa i połączenia z krajem w obrębie North Range

Jakość i wydajność połączeń między portami północnych Niemiec a resztą kraju definiują ich potencjał konkurencyjny. Ocena produktu krajowego brutto, którą można uzyskać w określonym czasie podróży koleją, drogą lądową, wodami lądowymi oraz transportem intermodalnym zapewnia główny wskaźnik konkurencyjnego położenia ww. portów. Aby zmierzyć ten potencjał stosuje się proste macierze podróży z informacją o czasie podróży różnymi środkami transportu. Osiągalna siła nabywcza terytoriów śródlądowych jest tym samym głównym wyznacznikiem konkurencyjności portów. Program transeuropejskiej sieci transportowej mógłby wspierać sytuację konkurencyjną niemieckich portów północnych w Hamburgu i Bremie/Bremerhaven, aby utrzymać ich dostępność dla portów śródlądowych, a co więcej by uniknąć opóźnień na granicach, zmodernizować infrastrukturę i zoptymalizować transport w Unii Europejskiej.

Keywords: German ports, hinterland connections, trade, port competitiveness

JEL classification: R1, R410, O240

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Introduction

The quality and efficiency of the northern German ports' hinterland connections define their competitive potential. Transport infrastructure is a key determinant of transportation accessibility to sales and procurement markets, which is an important requirement in location selection for companies in numerous industries [Niebuhr, Stiller, 2004]. The regional competitiveness is influenced by the achievable market potential, which is, in turn, largely determined by the spatial distribution of the population, its income, as well as the transport infrastructure conditions. The attractiveness of a location increases along with its market potential, i.e., the achievable purchasing power; thus, agglomeration areas usually have a location advantage over less populated regions – they attract companies, suppliers and potential customers, by that promoting the economic growth of a region. Empirical analysis based on the new economic geography shows that the level of market potential positively affects the per capita income and the density of economic activity [Redding, 2010]. Moreover, transportation and transaction costs can be reduced by means of high quality waterways and road and rail networks. The ports' competitive advantage and potential can be increased by investing in the infrastructure, which can further expedite the economic progress and improve their competitive position [Oosterhaven, Knaap, 2003].

To measure the ports' competitive potential, we use simple travel time matrices for different modes of transport. The achievable purchasing power of the hinterland territories is thereby a prime determinant of port competitiveness. The assessment of gross domestic product achieved within a certain travel period via rail, road, inland waterways and intermodal freight transport provides a major indicator for the competitive positioning of the northern German ports.

The European Union's Trans-European Transport Network programme (TEN-T) may advance the German ports' competitive situation by improving their hinterland accessibility.

In the first section of this paper, some statistical facts about the main modes of transport and transport weights are presented, emphasising the ports' relevance for the German economy. Section two shows the results of travel time calculations for different modes of transport. In the third section we discuss some aspects of infrastructure development. The paper is closed by a conclusion and some remarks on UE's TEN-T programme.

1. Some statistical facts

The northern German seaports of Bremen/Bremerhaven and Hamburg hold a special significance for the German economy. Of nearly 300 mn t of goods han-

dled by the German ports in 2014, the share of the North Sea ports amounted to approximately 82%. Although the overall shipment was still well below the pre-crisis level, high growth rates can be observed after the significant decline in 2009, in the case of both shipped and received goods (see Figure 1). In 2014, the ten largest ports in northern Germany handled around 282 mn t of goods, indicating a 2.6% increase compared with the previous year.

In 2014, the ports of Bremen/Bremerhaven and Hamburg accounted for over 71% of total seaborne shipment in Germany. The Port of Hamburg experienced an increase in the handling of goods of 6.2% in 2013 and another 2.3% in 2014. To the contrary, the Port of Bremen/Bremerhaven experienced a 6.6% decline in throughput in 2013 and a further decrease of 0.9% in 2014. The observed growth and decline patterns result from the ports' specialisation in different goods and shipping areas. The Port of Hamburg specialises in container handling, in particular in Asia-Europe and Baltic feeder traffic. The Port of Bremen/Bremerhaven focuses on container handling with the United States as well as on the import and export of vehicles.

The influence of port specialisation is evident. In 2014, the Port of Hamburg received more goods (71,297,000 t) as compared to shipping (54,707,000 t). In contrast, both shipping and receiving of goods in the Port of Bremen/Bremerhaven remained at a quite similar level in 2014 (33,316,000 and 33,127,000 t respectively), but were considerably lower than the Port of Hamburg's throughput [FSO, 2014].

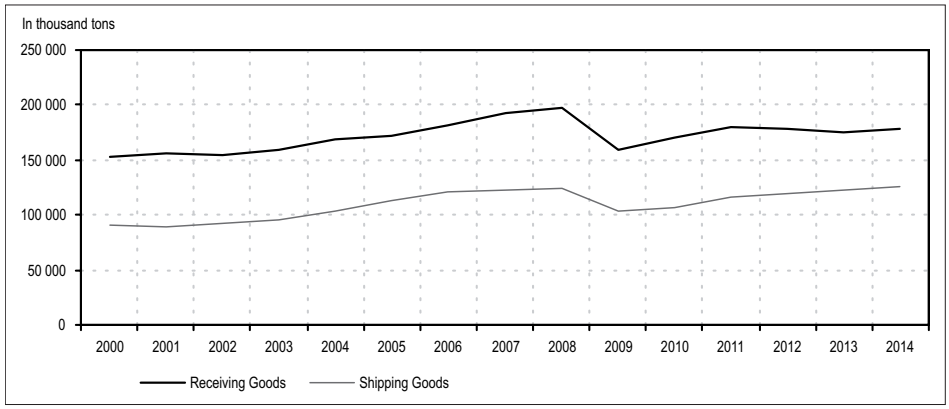

Figure 1. Cargo throughput in German ports, 2000–2014
Source: [FSO, 2015a].

The northern German ports' hinterland network relies mainly on roads, rail transport and inland waterway, as the ports' modal split indicates (see Table 1). The air traffic does not constitute any portion of the port hinterland traffic, and

pipelines make up an insignificant proportion (i.e., 2%). To assess the extent to which roads are utilised in northern Germany, the share of transshipment must be subtracted. In Bremerhaven and Hamburg, TEU transshipment share is around 64%.

Table 1. Modal split in container handling, % of total hinterland transport

Port / Cargo type	Rail	Road	Inland waterway
Bremen/Bremerhaven, 2013 (2005)	47 (37)	50 (60)	3 (3)
Hamburg, 2014 (2005)	39 (30)	59 (68)	2 (2)

Source: [Hamburg Port Authority, 2015; Bremen Ports, 2015].

Due to Hamburg's relatively large automotive quota, the truck traffic percentage there is higher than in Bremerhaven. Although transportation between the ports and their immediate hinterland is dominated by road, the share of rail and inland waterway transport increases along with the transportation distance. Transportation modes differ in their transport distance advantage. Rail transport dominates long-haul transportation, with a share of container hinterland traffic of 39% in Hamburg and 47% in Bremerhaven – and its advantage rises significantly with distance. It is of strategic importance for the examined German ports to have an efficient access to rail freight transport; of all the goods transported via rail from Bremen, 64% was sent to various distant locations in Germany, mainly to Bavaria (14%) and Baden-Wuerttemberg (9.6%), and 36% was sent abroad, mostly to the Czech Republic (11.9%) and Italy (7.6%). The share of goods received from foreign countries, mainly Austria (7.8%) and the Czech Republic (9.4%), was 26.8%. From Hamburg, most goods transported via rail were sent to neighbouring Lower Saxony (35.2%) and Brandenburg (11.9%). Bavaria and Baden-Wuerttemberg also received and sent substantial shares of goods (9.6% and 12.6%, and 5.8% and 6.5%, respectively). Hamburg received 19.6% of the foreign transports, mainly from Austria (4.7%), and sent 14.2% (see Table 2, which also presents the distances from Bremen and Hamburg to various region's economic centres).

The statistics on international rail transport from the loading country to the reporting country indicate the significance of rail mode in the distant hinterland connections. For example, in 2013 a considerable volume of goods from the Netherlands was transported via railway to Germany, and from Belgium, by the same means of transport – to Germany, France and Italy [Eurostat, 2015a]. The statistics on international rail transport from the reporting country to the unloading country are again demonstrative for Germany's dominant share. In 2013, the major proportion of rail transport to the Netherlands, Italy, Poland, Czech Republic, Sweden, Switzerland, Slovakia and Hungary was handled by Germany. The Netherlands accounted for much of the international rail transport in Germany,

and, to a lower extent, in Italy and the Czech Republic; Belgium constituted a rather larger proportion of international rail transport in France [Eurostat, 2015b].

Table 2. Rail transport of goods to and from Bremen and Hamburg, 2014

Receiving and shipping regions / State	Shipping region (%)		Receiving region (%)		Air-line distance (km)	
	Bremen	Hamburg	Bremen	Hamburg	Bremen	Hamburg
Total (t)	5,800,000	26,560,000	13,035,000	19,150,000	.	.
Germany	64.0	85.8	73.2	80.4	.	.
Baden-Wuerttemberg	9.6	5.8	13.7	6.5	492	546
Bavaria	14.0	9.6	16.7	12.6	512	540
Brandenburg	2.0	11.9	2.2	9.6	316	268
Bremen	5.9	1.9	2.6	2.6	.	95
Hamburg	8.5	0.5	3.9	0.7	95	.
Hesse	2.8	2.1	1.5	10.9	271	328
Lower Saxony	4.3	35.2	5.4	4.7	85	103
North Rhine-Westphalia	7.7	5.6	16.5	4.8	249	340
Saxony-Anhalt	0.9	1.9	3.7	13.2	231	212
Foreign countries	36.0	14.2	26.8	19.6	.	.
EU27	34.4	12.8	24.8	17.3	.	.
Italy	7.6	1.6	1.7	1.9	1,277	1,313
Austria	3.1	2.3	7.8	4.7	740	744
Poland	0.6	1.5	1.5	0.9	711	642
Czech Republic	11.9	6.9	9.4	7.6	586	561

Source: [FSO, 2015b; Distance.to, 2015].

The statistics on annual road freight transport by regions of loading exposes the importance of the hinterland for North Range ports. In 2013, Hamburg accounted for a significant portion of road freight transportation in Germany, and beyond its domestic hinterland – also for a share of Poland's road freight transport. The ports of Bremen and Bremerhaven also constituted a major share of Germany's road transportation. Likewise, the Belgian port of Antwerp transported the largest proportion of goods via road to Belgium itself. Groot-Rijnmond alone accounted for the majority of road freight transport in the Netherlands [Eurostat, 2015c]. The statistics on road freight transport by regions of unloading follow a pattern quite similar to those on road freight transport by regions of loading: in 2013, Hamburg accounted for a major share of the EU road transport, mostly within Germany itself; Bremen and Bremerhaven accounted for the second most significant portion of road freight transportation in Germany, Antwerp – in Belgium, and Groot-Rijnmond – in the Netherlands [Eurostat, 2015d].

In a European comparison, Germany is one of the few countries with a share of inland waterway transport higher than 10% [Bräuninger et al., 2013]. Western and northern German waterways provide important transport routes for freight shipments to customers at home and abroad. In 2014, Hamburg had a shipping surplus, shipping about 6.4 mn t of goods while receiving 5.2 mn t. In contrast, Bremen received more goods than it shipped [FSO, 2015c]. Nevertheless, the development of inland waterway transport runs below the average, and its share in the modal split continues to decline.

2. The model

Despite its well-connected hinterland infrastructure, northern Germany is not a major market; and the goods need to be reloaded onto trucks and rail cars in order to reach larger ones. Thus, a port located in a region with higher purchasing power has a competitive advantage over other ports – for example, the North Range ports of Antwerp, Rotterdam and Amsterdam have the best location in Europe, as they are within or close to rather densely populated regions (Belgium, Netherlands and North Rhine-Westphalia) with relatively high incomes and are part of one of the world's highest concentrations of people, the Blue Banana [Hospers, 2002]. The northern German ports are spatially similarly favourable but have less compact hinterland territories, and thus – lower potential purchasing power.

Vanoutrive modelled the linkages between port competitiveness and population density within the hinterland territories, starting from the idea that 'if hinterland accessibility is the main determinant of port throughput, we should be able to measure it' in terms of GDP [2012: 688]. We have chosen a similar approach, represented by Evangelinos, Hesse, Püsche and Gröschko [2012], to research the extent to which the North Range ports can contribute to GDP, using different transport modes. The attractiveness of a port location increases with its market potential, i.e., with the achievable purchasing power. Agglomerations and high-density regions thus usually have a location advantage.

The model for evaluating the hinterland access of the ports of Bremen/Bremerhaven and Hamburg takes into account four transport modes: intermodal freight transport, freight trucking, rail freight transport and inland waterway/short sea shipping.

The scenarios for intermodal freight transport are modelled based on several assumptions, e.g. that switching between transportation modes only occurs at certain nodes. The calculations on the truck travel times take into account rest periods in accordance with driving rules and regulations. The scenarios for rail freight

transport include assumptions on stopovers at train stations (to be overtaken by fast trains), connections between marshalling yards, indirect connections via backup lines, etc. The ship travel times for all goods on rivers and channels as well as important short-sea shipping connections are taken into consideration, factoring in, i.a., waiting time at the locks.

The model includes means of potential transportation to all NUTS 3 regions in the EU27 as well as to the members of the European Free Trade Association, and it will seek to evaluate the contribution to GDP within two and nine hours of travel time in the case of intermodal transport, freight trucking, rail freight transport and inland waterway/short sea shipping.

Figure 2 shows the ports' contribution to GDP within two hours. The absolute differences of the GDP result from the different travel speeds of particular transportation modes, illustrating the range of benefits of intermodal freight transport. Among the northern German ports, Bremen is the one which contributes the most to GDP, which can be explained by its relative proximity to North Rhine-Westphalia (see Table 2) – using intermodal transport, in two hours a contribution to GDP of about EUR 291.9 bn can be made.

By means of intermodal, truck and rail freight transport, Hamburg's and Bremen's average contributions to GDP are significantly lower than their competi-

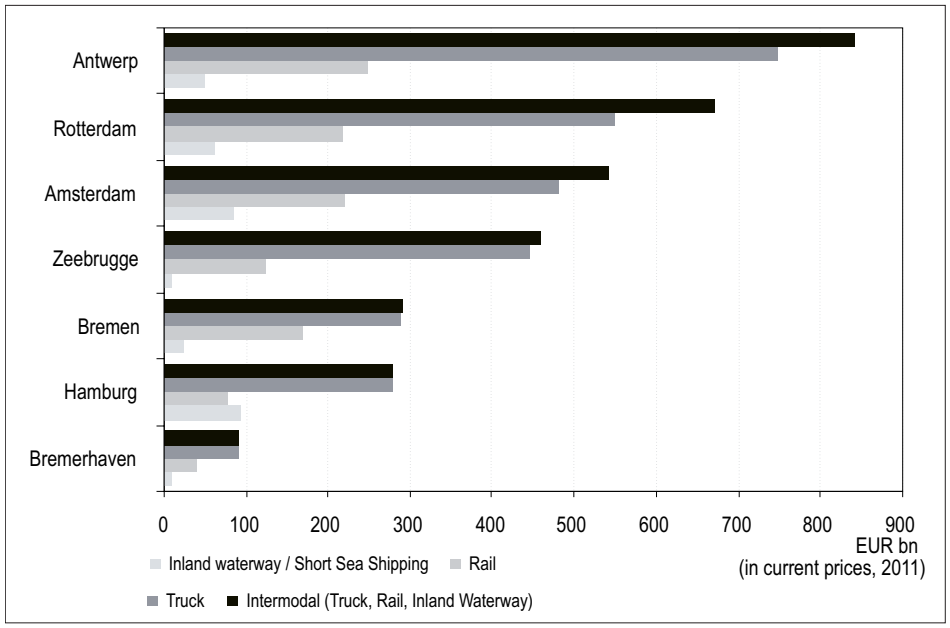

Figure 2. GDP contribution by different modes of transport (achievable within two hours)
Source: [OSRSPG, 2012; 2015; Eurostat 2015e].

tors' within the North Range. In the case of Bremerhaven, this is due to its relatively peripheral location; in comparison, the ports of the Netherlands and Belgium – Rotterdam, Antwerp and Amsterdam – are better connected to the main centres of Europe, and thus their contributions to GDP are much higher.

Within nine hours, very strong economic regions can be reached especially by intermodal freight transport (see Figure 3). In relative terms, the differences between the ports' contributions to GDP are much smaller than in two hours; in the case of Hamburg, the increase is lower than in the case of Bremen, since a comparatively higher contribution can be made within a rather short travel time due to the high population density in the Hamburg Metropolitan Region, implying a higher relative competitiveness of truck transport on short distances.

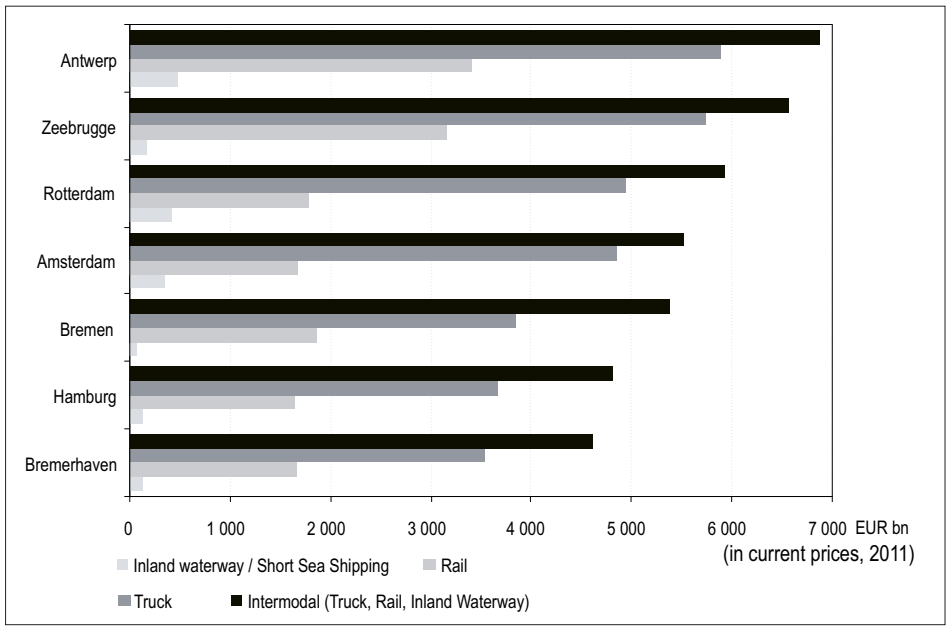

Figure 3. GDP contribution by different modes of transport (achievable within nine hours)
Source: [OSRSPG, 2012; 2015; Eurostat 2015e].

The relative contribution to GDP changes significantly depending on the hinterland connections: via rail from Bremerhaven (EUR 1,612 bn) and Hamburg (EUR 1,562 bn), via truck from Bremerhaven (EUR 3,344 bn) and Bremen (EUR 3,548 bn), and via intermodal transport from Bremerhaven (EUR 4,526 bn) and Bremen (EUR 5,095 bn); maximal contributions can be made in the case of Antwerp – via rail (EUR 3,150 bn), Zeebrugge – via rail (EUR 2,940 bn), Rotterdam – via

intermodal (EUR 5,358 bn), Amsterdam – via inland waterways/short see shipping (EUR 3,26 bn), Bremen – via intermodal (EUR 5,095 bn), Hamburg – via rail (EUR 1,562 bn) and Bremerhaven – via intermodal (EUR 4,526 bn).

These results confirm the assumption that truck transports are generally more efficient on short distances; on long distances, the productivity of rail freight and intermodal transport is higher, as the transportation volume of rail transport systems is also much higher.

3. Transport infrastructure

Of crucial importance to the northern German ports is therefore also the quality of transport infrastructure, and not only the location itself. The ports of Hamburg and Bremen/Bremerhaven handle a significant number of container shipments, with Bremen/Bremerhaven also being one of the leading auto hubs. However, nearly all northern German ports, with the exception of Hamburg, are located in peripheral regions which have neither a dense population nor a high GDP. This is in contrast to the North Range ports of Antwerp, Amsterdam and Rotterdam, embedded in metropolitan areas with a compact hinterland. Thus, for the northern ports, the cost and competitiveness of hinterland transport depends highly on the quality of the pre- and post-sea transport infrastructure.

The prioritisation of expanding the existing infrastructure and starting new construction projects leading to an efficient (and environmentally friendly) distribution of traffic can potentially relieve bottlenecks. The TEN-T aims at strengthening the trans-European routes; its key objective is to remove cross-border bottlenecks, upgrade infrastructure and streamline cross-border transport operations. For instance, the completion of the A20 motorway – whose purpose is to enhance the road sector's capacity – is one of the priority transport infrastructure projects for the relief of traffic-related problems of the northern Germany ports.

Regardless of the port location, rail is vested with an ever-increasing importance in the hinterland transport system, as in certain areas a growing proportion of road transportation is no longer politically desirable or possible. A variety of goods are transported by a few main corridors to or from the South. In Bremen, the freight rails come from Bremerhaven to flow along with the freight rails from Brake, Wilhelmshaven/JadeWeserPort and Nordenham; the shipments continue with the goods coming from Bremen via Verden and Rotenburg (W.) to Hanover/Wunstorf [Ninnemann et al., 2013]. The North-South and East-West rail corridors face bottlenecks due to the geographical location of the northern German ports. Moreover, railway transport in the East-West corridor comprises, i.a., the Betuweroute Rotterdam-Amsterdam-Rhine/Ruhr, the German axis Dortmund-Hanover-Berlin-Frankfurt/Oder and the Polish mainline from the German border

via Poznan and Warsaw to the Lithuanian border (North Sea-Baltic corridor). In Frankfurt/Oder, the rail traffic from the Bremen/Bremerhaven, Hamburg, Antwerp and Rotterdam ports canalises to cross the border to Poland. The strategic nodes of Bremen, Hamburg and Hanover, as well as the node of Frankfurt/Oder, are heavily overloaded [Ninnemann et al., 2013]. To ensure the competitiveness of rail freight for the northern German ports, rail infrastructure development should continue. The rapid implementation of the planned infrastructure projects in this area, such as the long-discussed Y-line, or their alternatives, is of great relevance. Furthermore, to strengthen the competitiveness of rail transport in cross-border regions it is also important to establish a single, shared traffic management system (European Train Control System, ETCS).

Of the northern German ports, Hamburg and Bremen/Bremerhaven occupy central locations on navigable rivers. A chief characteristic of inland navigation in this area is the access to the Midland Canal. The Elbe is the longest river in the region of both ports; yet although the lower Elbe is fully navigable, the middle and, in particular, the upper Elbe is in need of modernisation due to the partially insufficient depth of the fairway, inadequate chamber lengths and long waiting times, as well as the low bridges which have made it impossible for ships transporting multilayer containers to use the waterway. This need is all the more urgent as it is found that barges are much more environmentally friendly compared to trucks or trains [Bräuninger et al., 2013].

Conclusions

The ports of Bremen/Bremerhaven – unlike the Port of Hamburg – are located in peripheral regions; thus, of great importance is not only the location itself, but also, most of all, the quality of transport infrastructure. The competitiveness of these ports is highly relevant for increasing population and income, which makes them strongly dependent on the quality and efficiency of their hinterland connections. By using simple travel time matrices we show that the northern German ports have relatively good access to transport infrastructure in comparison with the other North Range ports. Thence, the achievable purchasing power of their hinterland territories increases rapidly along with travel time – and in the case of long-distance transport, intermodal and rail freight transport seem to be the most productive. A functioning hinterland transport network is an important determinant of the economic growth. The Trans-European Transports Network (TEN-T) aims at strengthening Europe's international competitiveness by improving the accessibility of certain regions. The basic idea of the TEN-T core network is to bridge the gaps between different national transport systems and concentrate on

the main transport routes, which could improve the competitive position of the ports of Bremen/Bremerhaven and Hamburg, as both of them are part of the North Sea-Baltic, the Orient/East-Med and the Scandinavian-Mediterranean corridors of the TEN-T – intended to contribute to the development of the accessibility of these markets by northern German ports.

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