An exploration of the inland terminal markets in the EU

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ABSTRACT

This paper analyses structures of the inland terminal markets that constitutes one of the main parts of the intermodal freight transport supply chains markets, by developing two different heuristic approaches to define the market. The main questions that this paper will answer are: 1. how can the terminal market be defined, 2. how can limited data about terminals be used to analyse the market structure, and 3. what are the structures of different terminal sub-markets in the European Union. Although a lot of work has been done on intermodal freight transport, little has been done on quantitative analysis of intermodal markets, especially intermodal terminal markets.

This paper develops two different approaches comparatively to define inland terminal markets. The first approach segments the market using the distance of terminals from central points of demand, while the second approach uses the aggregate trade in each of the demand areas. The results of the two different approaches have been used to validate the approaches, and show that the both approaches could be used in situations we have limited data. By using concentration indexes to calculate the market structures of 18 main areas in the European Union, we find that the inland terminal markets in EU are oligopolistic markets, characterized mainly by high concentration. The north of EU shows less concentration than the central & southern regions. According to the second approach, the terminal markets have higher degree of concentration, in comparison to the first approach. In some market areas, barge terminals also play a role which results in lower concentration levels.

The structure of terminal markets suggests that terminals have a favorable negotiation power in the intermodal freight transport supply chains, which could be used as an important parameter to construct coordinated intermodal freight transport supply chains, because coordination in supply chains can be achieved by creating incentives for the parties in the chain. However, the negotiating power of supply chain actors plays a role as well.

1. INTRODUCTION

The use of intermodal transport solutions involving rail and inland waterways is believed to provide an attractive alternative to road transport. For instance, the European Commission has run many research programs that are designed to stimulate intermodal transport[1]. Nevertheless, the market share of intermodal freight transport (IFT) has not grown significantly[2].

Although the scientific community has growing interest in intermodal freight transport, the study of IFT markets is lagging behind. Only a few studies are dedicated to the topic ([3], [4], [5]).

In this paper, we argue that the structure of IFT markets is complex. First of all, one may divide IFT in pre-haulage, main haulage, end haulage, and transhipment activities. We will further structure the market by considering its geographical aspects. In this paper, in order to illustrate the complexity of the IFT market and discuss the methodological aspects, we will focus on the geographical nature of inland terminal markets. The main questions that this paper will answer are: 1. how can the terminal markets be defined, 2. how can limited data about terminals be used to analyse the market structure, and 3. How are the different terminal sub-markets in the European Union structured. The present paper aims to provide two approaches to characterize inland terminal markets by means of a set of indicators. We will also elaborate on the methodological considerations regarding the limited availability of good quality data.

2. INTERMODAL FREIGHT TRANSPORT MARKET

2.1.Relevant Market

In competition literature, the term ‘relevant market’ is used to describe markets where competition takes place[3]. This relevancy lies both in the product/ service and the geographic dimensions. The European commission[6] defines it as follows: “The relevant product market includes all substitutable products/ services with respect to their characteristics or prices”, and the relevant market as[6]: “*the area where the undertakings concerned are involved in the supply and demand, in which the conditions of competition are sufficiently homogeneous and which can be distinguished from neighbouring areas because the conditions of competition are appreciably different in those areas*”.

2.2.Intermodal Freight Transport Market

In the various regions and corridors of the EU region, different IFT supply chains compete with each other, and they are represented by different players in the respective sub-markets. In other words, sub-markets are found in regions and corridors, and in functional areas such as long-haul transport (main haulage), short-haul transport (pre and end-haulage), and terminal operations. IFT operators and forwarders/ LSPs are players who manage the total or main part of IFT supply chains.

As you could see in Figure1, in order to define the IFT market, first terminals, pre/ end haulage operators, and forwarders/ LSPs who are near to each other regard to the final customers (Receiver/ Sender) construct their market areas, then based on them, main-haulage operators who are active in different corridors connecting respect market areas, shape the main-haulage operators markets. the integration of these markets, depict the IFT supply chain market.

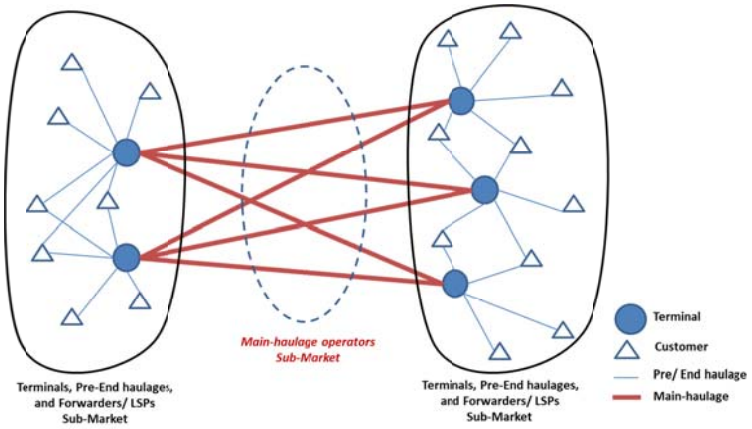

FIGURE 1 IFT market definition from a geographical perspective.

2.3.Intermodal Freight Transport Sub-markets

Figure 2. depicts how intermodal supply chains establish their paths which consist of various services, sourced from the various sub-markets. Different combinations of players from these different sub-markets form an IFT supply chain which delivers the IFT service to the final customer. In this paper, we focus on the sub-market of terminal operators. Although the methods could be applied to Pre/End haulage and Forwarder/ LSPs sub-markets as well. Intermodal terminals facilitate the transhipment of containers between road, rail, and inland waterways. We will restrict main part of our numerical study to rail transport within the EU.

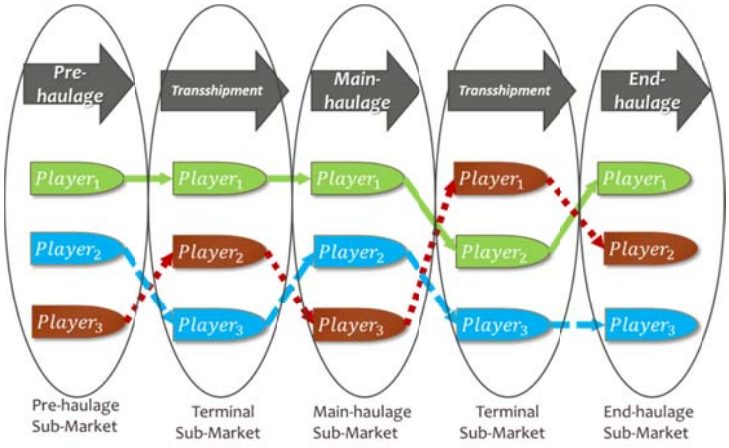

FIGURE 2 Sourcing of intermodal services from sub-markets by IFT supply chains.

As is well-known, coordination in supply chains can be achieved by creating incentives for the parties in the chain. However, the negotiating power of supply chain actors plays a role as well [7]. In order to understand the power relations in the supply chain, we will use the concentration in sub-markets as a proxy. The structure of sub-markets can be used to analyse the coordination of IFT supply chains, in the future researches.

3. METHODOLOGY TO ANALYSE THE TERMINAL MARKET STRUCTURE

3.1.Literature Review

There are only a few contributions dedicated to analysis the IFT supply chain market and its sub-markets. Wiegmans et al. [4] analysed the freight terminal market in EU qualitatively with the help of Porter's

model in order to identify the stakeholders in the terminal market and to find the potential for economic benefits. Makitalo[5] investigated the Finland rail industry market using Delphi techniques and illustrated the biggest market entry barriers. Nierat [8], studied the area around demand where IFT competes with unimodal truck transport. He also established factors that influence these areas. Sys[3] has studied whether the liner shipping industry as a unimodal freight transport system is an oligopolistic market or not. To answer this question, she analysed the market structure using concentration indexes, and on the basis of the degree of concentration made judgments about the market type. In this paper, we shall build on her research method, but we shall introduce market segments as a new element. None of the previous works focus on the structure of inland terminal sub-markets and analyse it quantitatively.

3.2.Market Structure

In economic theory, there are traditionally four main categories of market structure: perfect competition, monopolistic competition, oligopoly and monopoly[9]. In perfect competition there are large numbers of buyers and sellers with no barriers to entry and full access to information. In a monopoly market, there is a single seller who has control over price and output, and tends to be heavily regulated to protect customers[10]. Oligopoly and monopolistic competition markets lie between these two extremes.
Sometimes, the oligopoly market is divided into sub-categories, for example Shepherd[11] categorized oligopoly into loose oligopoly, tight oligopoly, super tight oligopoly, and dominant player. In industrial organization literature, based on the degree of concentration, the structure (type) of the market will be determined[11].

3.3.Theory about concentration Indexes

Concentration refers to a situation in which a few producers or service providers represent a large share of economic activity expressed in terms of, for example, capacity[10]. There are many indexes to measure the degree of concentration and the most useful and well-known ones are the concentration ratio index and the Herfindahl-Hirschman index [12]. We apply these indexes to IFT sub-markets to calculate the degree of concentration in different IFT sub-markets in the EU, and to determine the type of market as an important decision-making parameter to construct integrated IFT supply chains.
The concentration ratio index CR_x, is the sum of the market shares of the X largest IFT companies. Typically, the concentration index is calculated for the 4 largest companies (CR_4). This index has its disadvantages. For example, two markets with the same high CR_4 levels may have structural differences because one market may have few companies while the other may have many companies.
The next index is the Herfindahl-Hirschman index (HHI) which is the sum of the squares of the market shares of all companies in each IFT sub-market. It is given by, $HHI = \sum_{i=1}^{n}(s_i)^2$, where the market shares (s_i) satisfy $\sum_{i=1}^{n} s_i = 1$.

3.4.Data Description

IFT services are offered on a network, where areas are connected through corridors, and where inland terminals act as hubs, either for pre-/end-haulage or between main haulage links. Inland terminals compete as soon as they act as hubs for the same area (pre-/end- haulage) or when they represent nodes in alternative main haulage paths. The relevant markets should be defined around demand points and should include inland terminals to compete and absorb demand. In order to describe the terminal market quantitatively, we use data from *the study on IFT infrastructure in EU*[13] .There are main 18 corridors in the EU where most of the IFT is performed. These 18 corridors connect 34 areas where about 85% of the total IFT demand occurs. These 34 areas comprise the 25 largest areas and 9 end-of-corridor areas.
The study makes use of the following data sources. We included the 25 largest areas in our study and gathered market data from Inlandlinks website (www.inlandlinks.com). For each region, we identified the most important inland terminals by using the Inlandlinks website, and we gathered further data from other sources such as the intermodal-terminals website (www.intermodal-terminals.eu), the homepage of different terminals and emails received from terminal operators.

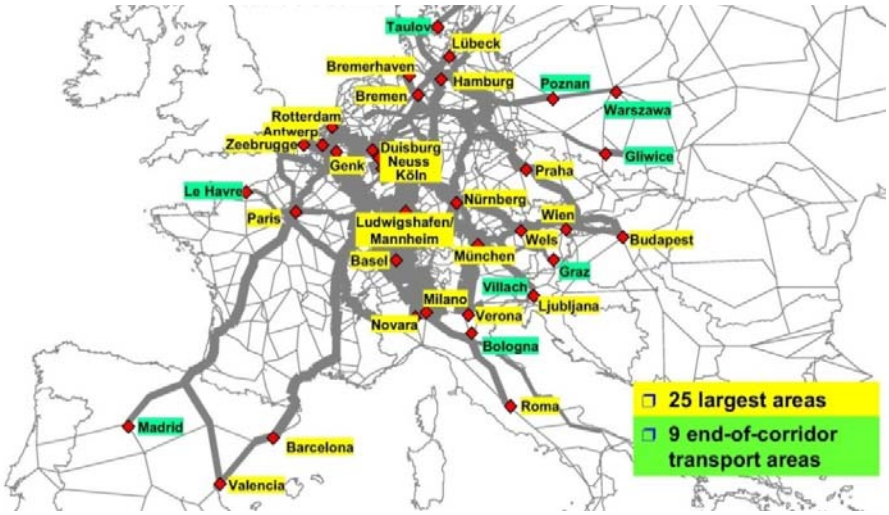

FIGURE 3 EU main transport areas link to main corridors[13].

In the study on IFT infrastructure in EU report[13], there were data about the aggregate demand for 25 main market areas for 2002 and the estimated data for 2015. Based on these data, the aggregated demand data have been estimated. The data is based on Tonnes. To convert the data from tonnes to TEU, the data of unaccompanied CT by market segment in 2011[18] was used. Based on combined transport as given in the EU report[18], the companies of European unaccompanied CT carried a total of 18,116,920 TEU on domestic and international combined transport services in 2011. This volume, in terms of tonnes, is a total of 191,842,030 gross tonnes. By dividing these two numbers, we have a good approximation for tonnes to TEU, that is 10.6 (Table 1).

TABLE 1 Top 25 Market Areas with Respect to Their Total IFT Trade in 2012

Transport Area	Total trade		Growth rate		Total trade (1000 ton)	Estimated Total trade (TEU)
	2002	2015	2002/2015	p.a.	2012	2012
Milano	9310	24043	158%	7.6%	19,367	1,827,118
Rotterdam	6626	14677	122%	6.3%	12,206	1,151,538
Köln	5522	12681	130%	6.6%	10,463	987,103
Verona	4765	11747	147%	7.2%	9,550	900,959
Antwerpen	4857	11289	132%	6.7%	9,290	876,408
Hamburg	4625	10920	136%	6.8%	8,929	842,400
Novara	3915	10244	162%	7.7%	8,220	775,502
Praha	2429	4857	100%	5.5%	4,149	391,423
Mannheim/Ludwigshaf	1925	4591	138%	6.9%	3,752	353,917
Zeebrügge	1683	4290	155%	7.5%	3,469	327,237
Paris	1589	3870	144%	7.1%	3,155	297,655
Basel	1960	3786	93%	5.2%	3,254	306,978
Barcelona	1179	3507	197%	8.7%	2,715	256,155
Valencia	1145	3042	166%	7.8%	2,427	228,922
Genk	1112	2986	169%	7.9%	2,379	224,395
Nürnberg	1153	2733	137%	6.9%	2,247	211,983
Neuss	1239	2584	109%	5.8%	2,177	205,410
Bremen/Bremerhaven	1086	2517	132%	6.7%	2,077	195,960
Roma	887	2300	159%	7.6%	1,845	174,077
München	874	2189	150%	7.3%	1,768	166,803

Transport Area	Total trade		Growth rate		Total trade (1000 ton)	Estimated Total trade (TEU)
	2002	2015	2002/2015	p.a.	2012	2012
Duisburg	1045	2169	108%	5.8%	1,836	173,248
Wien	934	2048	119%	6.2%	1,704	160,800
Wels	874	1868	114%	6.0%	1,565	147,660
Budapest	961	1800	87%	4.9%	1,551	146,276
Lubeck	984	1576	60%	3.7%	1,415	133,499
Other 9 transport areas	24940	56811	126%	6.5%	46,816	4,416,586
Total	87619	205125	134%	6.8%	168328.121	15880011.42

Assumptions

While building a comprehensive database in terms of the unique and comparable data contained, also for the sake of simplification, it was necessary to make certain assumptions:

- To calculate the distances between 25 areas and terminals, the Inlandlinks website measures the distance between the center of the area and the terminal, so it is presumed that the total demand in each area is centralized in the center of each area.
- The relevant market in each area is defined as a circle around its demand center. Based on Nierat[8], the intermodal relevant market area could be part of a family of Descartes' ovals. Kim[14], in his thesis, considers 4 different shapes for markets where the market area is either circular or ellipsoid, and where the intermodal terminal is either located in the center or not. In the present paper, the circle-shaped market is centralized around the demand.
- The relevant market area is a closed system where the total demand and supply are equal. In reality there are situations where one terminal competes with several other terminals to absorb demand A while at the same time competing with some other terminals to absorb demand B. To analyse such a situation the disaggregated throughput of each terminal for different market areas should be available. Because of the data limitations and for the sake of simplicity, it is supposed here that the market areas are closed systems where terminals only compete with each other within these areas.
- The radius was supposed to be 70km. for some special cases it is 160km. In the break-even distance of IFT literature, the drayage distance is an important parameter. Drayage distance means the acceptable distance of the truck pre-post haulage that within it, IFT will able to compete with unimodal road transport. Kim[14] in his PhD thesis mentions that different authors reported or assumed different quantities for R as the drayage distance. These quantities are 160km, 50-70km, 57km, 50km and 25km as average drayage distances. For example, Kreutzberger[15] reports that most Pre/Post haulage distances are 25 km or shorter in Europe, and Janic [16], [17] argues that the drayage distance (collection/ distribution distance by road, as he calls) is 50-70km. In this paper a distance of 70km is considered for the radius of the relevant market with a tolerance of +5km. If within 70km no terminal exists, then a radius of 160km was applied. Here it could be argued that in these areas demand is spread out over a larger (metropolitan) area, so that the drayage distance considered is longer.
- The utilization of terminals is considered to be 100%, so the capacity and throughput of the terminals is assumed to be equal. It was presumed that all the terminals capacity is utilized, because for some terminals capacity data was available and for others throughput data.
- For some terminals the data for 2012 was missing. We therefore used logical trends and expert judgment methods to make our calculations.
- For the terminals which presents both rail and barge services, it is assumed that the barge service share is very small in comparison to its total IFT service, because disaggregated data was not available.

- The terminal capacities/ throughputs are only dedicated to the pre/post haulage, not to the main-haulage. In reality, most of the terminals act as hubs, both for pre-/end-haulage and between main haulage links. Here it is supposed that they act as pre/ post haulage hubs only.

4. TERMINAL MARKET ANALYSIS

4.1.Defining Different Markets

There is no explicit method to define the relevant market area, so we have applied two different approaches comparatively to check the validity of our research. To define the relevant market area, two different approaches were applied. In the first approach, the radius of the market area is fixed and terminals in that area are considered to be market players. Sensitivity analysis is done by extending the radius. As above mentioned, in this paper a radius of 70km is considered for the radius of the relevant market with a tolerance of +5km, and in special cases if within the 70km area no terminals exist, the radius of 160km was applied. Using this radius to define the relevant market, the market share of different terminals was calculated and the market structure was determined.

In the second approach, which needs more data in comparison to the first approach, because of the need to total demand of different market areas, the radius of the market area was extended until the cumulative capacity of the terminals in the area was equal to demand. The corresponding terminals are considered as relevant market players. In the next sections, we will show how these two approaches lead to almost the same results.

Table 2, shows a sample of how the calculations have been done. The calculations are for the Genk area. Terminals were sorted according to distance. In the first approach, terminals within 70km were selected and based on their capacities, the market share was then determined. For the sensitivity analysis these calculations were done for terminals within 90km. In the second approach, after sorting the terminals, the aggregate capacity was calculated (See the aggregate capacity column in Table 4) up to 280,000 TEU which is the first point more than the total trade level (224,395 TEU) in that area. It is a stop point and the terminals included in this aggregation (3 terminals in table 4) were considered as market players and their market shares were computed respectively.

TABLE 2 Market Share of Terminals in Genk Area

Total trade (TEU)	Terminal	Distance (km)	Capacity per annum (TEU)	Market share Approach-1	Market share Approach-1 sensitivity analysis	Aggregate capacity (TEU)	Market share Approach-2
224,395	Haven Genk N.V.	2	100,000	8.08%	3.99%	100,000	35.71%
	Genk Euroterminal	4	80,000	6.46%	3.20%	180,000	28.57%
	Container Terminal Stein	18	100,000	8.08%	3.99%	**280,000**	35.71%
	Barge & Rail Terminal Born B.V.	24	520,000	42.00%	20.77%	800,000	
	Liege Container Terminal S.A.	39	50,000	4.04%	2.00%	850,000	
	Beverdonk Container Terminal	60	40,000	3.23%	1.60%	890,000	
	TCT	65	288,000	23.26%	11.50%	1,178,000	
	Dry port Muizen	**70**	60,000	4.85%	2.40%	1,238,000	
	Rail & Barge Terminal Tilburg B.V.	73	300,000		11.98%	1,538,000	
	Cargovil Container Terminal	75	40,000		1.60%	1,578,000	
	Neuss Trimodal	88	10,200		0.41%	1,588,200	
	Neuss Intermodal Terminal GmbH	89	100,000		3.99%	1,688,200	

Total trade (TEU)	Terminal	Distance (km)	Capacity per annum (TEU)	Market share Approach-1	Market share Approach-1 sensitivity analysis	Aggregate capacity (TEU)	Market share Approach-2
	Oosterhout Container Terminal	90	260,000		10.39%	1,948,200	
	Osse Overslag Centrale B.V.	90	150,000		5.99%	2,098,200	
	DCH Düsseldorfer Container-Hafen	90	250,000		9.99%	2,348,200	
	Inland Terminal Cuijk	90	48,000		1.92%	2,396,200	
	Krefelder Container Terminal	90	107,403		4.29%	2,503,603	

4.2.Structure of Different Terminal Relevant Markets

Different analyses of the market structure (type), based on the concentration indexes, have been carried out on the data. We applied the CR_x for x=1,2,3,4, and the HHI indices on the data. Martin[19], in his book says that if the CR4 ratio is more than 40%, the market is an oligopoly. Based on this criterion, the terminal operators market in the EU could be an oligopoly, because the CR4 in all the relevant markets and in both approaches is more than 40% given our assumptions. To understand which market has what type of oligopoly, a detailed analysis should be done. According to Shepherd[11], if CR4 is less than 25% of the total market, the market could not termed an oligopoly. If the CR4 is between 25% and 60% and the HHI index is less than 1000, it would be a loose oligopoly. If the CR4 is more than 60% and HHI is more than 1500, the market is a tight oligopoly. If CR2 is bigger than 80% or CR3 is bigger than 90% the market is a super-tight oligopoly, and if the CR1 is more than 40% to 90% the market has a dominant player.

The U.S. Department of justice convention in its 2010 report “Horizontal Merger Guidelines” [12] which is designed for analysing mergers suggests that any HHI index below 1500 reflects un-concentrated markets, an HHI index between 1500-2500 means moderate concentration, while an HHI index above 2500 means that the markets are highly concentrated. In Table 3, one can find the concentration indexes of different terminal market areas, based on the two different approaches.

TABLE 3 Concentration Indexes of 18 Terminal Market Areas

Market Area	Approach-1						Approach-2					
	No.	CR1	CR2	CR3	CR4	HHI	No.	CR1	CR2	CR3	CR4	HHI
Hamburg	4	42.82%	68.06%	85.19%	100%	2983	6	29.98%	47.66%	65.33%	83.32%	1399
Bremerhaven/ Bremen	6	27.13%	47.48%	63.76%	79.76%	1877	3	58.82%	88.24%	100%	-	4464
Rotterdam	9	22.89%	45.79%	59.52%	71.43%	1582	5	35.09%	70.18%	84.21%	92.98%	2786
Antwerp	9	31.15%	49.84%	66.04%	78.50%	1849	8	27.15%	50.68%	71.36%	83.10%	1982
Zeebrugge	2	78.43%	100%	-	-	6617	3	83.06%	96.35%	100%	-	7088
Genk	8	42.00%	65.27%	73.34%	81.42%	2528	3	35.71%	71.43%	100%	-	3367
Duisburg/ Neuss/ Köln	17	22.40%	35.19%	44.79%	52.79%	1070	6	47.72%	74.98%	92.02%	95.57%	3333
Praha	4	65.06%	84.45%	98.77%	100%	4816	3	65.87%	85.50%	100%	-	4935
Nurnberg	2	92.35%	100%	-	-	8587	1	100%	-	-	-	10000
Paris	3	86.42%	96.30%	100%	-	7580	1	100%	-	-	-	10000
Munchen	4	76.11%	89.43%	95.56%	100%	6027	1	100%	-	-	-	10000
Wels	3	66.61%	99.96%	100%	-	5549	2	99.88%	100%	-	-	9975
Budapest	2	59.46%	100%	-	-	5179	1	100%	-	-	-	10000

Market Area	Approach-1						Approach-2					
	No.	CR1	CR2	CR3	CR4	HHI	No.	CR1	CR2	CR3	CR4	HHI
Lubeck	2	91.51%	100%	-	-	8447	4	63.21%	83.53%	98.60%	100%	4637
Verona	2	70.69%	100%	-	-	5856	3	58.82%	77.33%	100%	-	4016
Milano	6	52.06%	74.78%	86.13%	93.23%	3431	5	56.04%	80.49%	92.72%	97.55%	3916
Novara	6	52.06%	74.78%	86.13%	93.23%	3430	2	76.19%	100%	-	-	6372
Wien	2	70.49%	100%	-	-	5840	2	70.49%	100%	-	-	5840

- Not relevant for calculation

Based on these data Table 4 shows the different market structure (type) of terminal markets. It can be seen that all the markets range from loose oligopolies to pure monopolies. Based on the first approach there is no pure monopoly market, but based on the second approach, 4 markets are pure monopolies. These monopoly markets are Nurnberg, Paris, Munchen and Budapest.

TABLE 4 Different Structures (types) of Inland Terminal Markets

Terminal Market Area	Market type- Approach1	Market type- Approach2
Hamburg	tight oligopoly - Highly Concentrated	loose oligopoly – Un concentrated
Bremerhaven/ Bremen	tight oligopoly - moderately concentrated	Dominant player- Highly Concentrated
Rotterdam	tight oligopoly- moderately concentrated	tight oligopoly- Highly Concentrated
Antwerp	tight oligopoly- moderately concentrated	tight oligopoly - Moderately Concentrated
Zeebrugge	Dominant player - Highly Concentrated	Dominant player- Highly Concentrated
Genk	tight oligopoly- Highly Concentrated	supertight oligopoly - Highly Concentrated
Duisburg/ Neuss/ Köln	loose oligopoly- Unconcentrated	Dominant player- Highly Concentrated
Praha	Dominant player - Highly Concentrated	Dominant player- Highly Concentrated
Nürnberg	Dominant player - Highly Concentrated	Pure monopoly
Paris	Dominant player - Highly Concentrated	Pure monopoly
München	Dominant player - Highly Concentrated	Pure monopoly
Wels	supertight oligopoly - Highly Concentrated	Dominant player- Highly Concentrated
Budapest	supertight oligopoly - Highly Concentrated	Pure monopoly
Lubeck	Dominant player - Highly Concentrated	supertight oligopoly - Highly Concentrated
Verona	Dominant player - Highly Concentrated	Dominant player- Highly Concentrated
Milano	tight oligopoly - Highly Concentrated	supertight oligopoly - Highly Concentrated
Novara	tight oligopoly - Highly Concentrated	Dominant player- Highly Concentrated
Wien	Dominant player - Highly Concentrated	Dominant player- Highly Concentrated

As can be seen from Figure 4, according to the first approach, 8 terminal markets (45%) are dominant player and highly concentrated markets, and about 39% are tight oligopoly. Based on the second approach about 45% of the terminal markets are oligopolistic markets with dominant players and high concentrations, and about 22% of the markets are pure monopolies. Meanwhile, it can be inferred that, the major inland rail-road terminals in the EU based on the first approach are active in oligopolistic markets with dominant players or tight oligopoly markets, and based on the second approach in pure monopoly and dominant player oligopolistic markets.

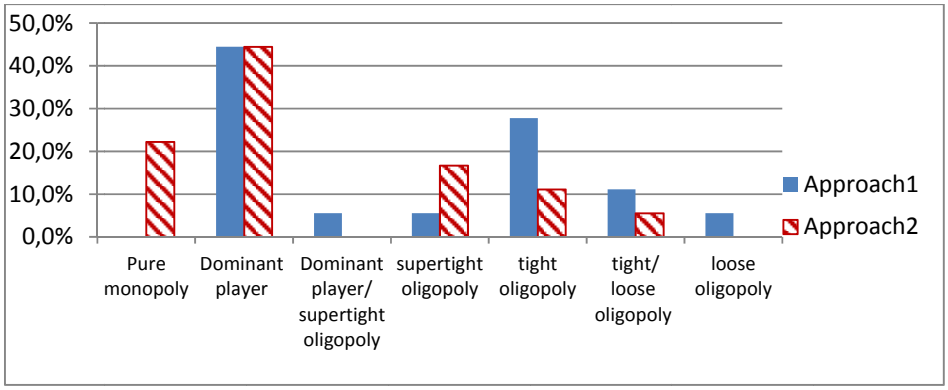

FIGURE 4 Distribution of different terminal market types.

In Figure 5, different terminal market types based on both approaches are depicted on the map. It can be concluded from this map that the inland terminal markets in northern areas are relatively more competitive than in central & southern areas. In the second approach, however, northern areas are more concentrated than in the first approach.

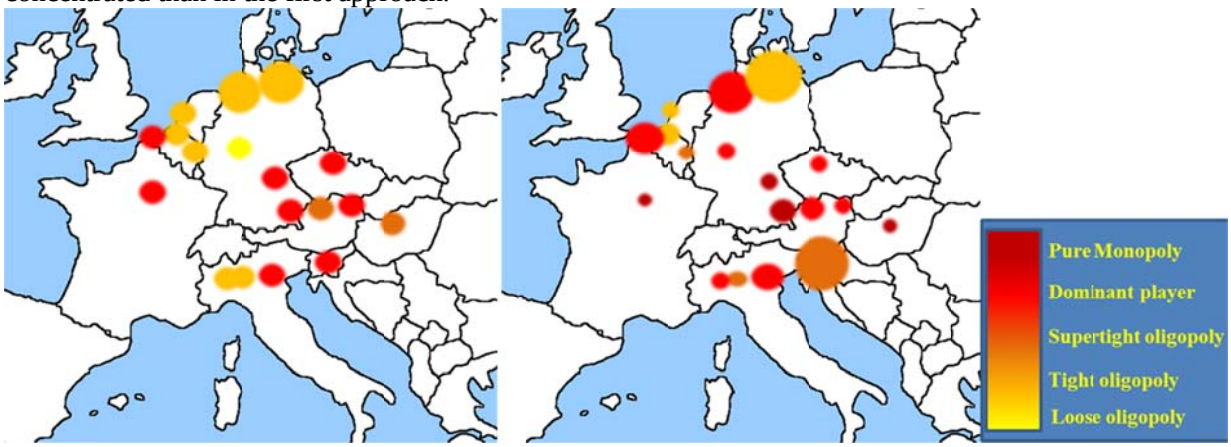

FIGURE 5 Map of structure of terminal market areas based on first approach (Left) and second approach (Right).

To analyse the impact of the specific radii chosen in the first approach, we performed a sensitivity analysis. The radii of 70km (and 160km) was extended to 90km (and 200km). The sensitivity analysis shows that in 13 cases (72%) the structure of the market is not sensitive to the radius and for only 2 cases (Genk and Bremerhaven/ Bremen) the structure change is significant. In Hamburg the market type is fixed but the concentration has decreased. In Bremerhaven/ Bremen, we see a structured change from tight oligopoly with moderate concentration to loose oligopoly without concentration. In Rotterdam and Antwerp, the situation moves from tight oligopolies with moderate concentrations to loose oligopolies with less concentrations, and in the Genk from tight oligopoly with high concentration to loose oligopoly without concentration.

TABLE 5 Sensitivity Analysis of Market Structure in Terms of Radius of Market Area

Market Area	Market type with Fixed Radius 70km (and 160km)	Market type with Fixed Radius 90km (and 200km)
Hamburg	Tight oligopoly - Highly Concentrated	Tight oligopoly - moderately Concentrated
Bremerhaven/ Bremen	Tight oligopoly - moderately concentrated	loose oligopoly- Unconcentrated

Market Area	Market type with Fixed Radius 70km (and 160km)	Market type with Fixed Radius 90km (and 200km)
Rotterdam	Tight oligopoly - moderately concentrated	Tight / loose oligopoly- Unconcentrated
Antwerp	Tight oligopoly - moderately concentrated	Tight / loose oligopoly- Unconcentrated
Zeebrugge	Dominant player - Highly Concentrated	Dominant player - Highly Concentrated
Genk	Tight oligopoly- Highly Concentrated	loose oligopoly- Unconcentrated
Duisburg/ Neuss/ Köln	loose oligopoly - Unconcentrated	loose oligopoly-Unconcentrated
Praha	Dominant player - Highly Concentrated	Dominant player - Highly Concentrated
Nurnberg	Dominant player - Highly Concentrated	Dominant player - Highly Concentrated
Paris	Dominant player - Highly Concentrated	Dominant player - Highly Concentrated
Munchen	Dominant player - Highly Concentrated	Dominant player - Highly Concentrated
Wels	supertight oligopoly - Highly Concentrated	supertight oligopoly - Highly Concentrated
Budapest	supertight oligopoly - Highly Concentrated	supertight oligopoly - Highly Concentrated
Lubeck	Dominant player - Highly Concentrated	Dominant player - Highly Concentrated
Verona	Dominant player - Highly Concentrated	Dominant player - Highly Concentrated
Milano	Tight oligopoly - Highly Concentrated	Tight oligopoly - Highly Concentrated
Novara	Tight oligopoly - Highly Concentrated	Tight oligopoly - Highly Concentrated
Wien	Dominant player - Highly Concentrated	Dominant player - Highly Concentrated

We now include barge terminals to observe what happens to the market structure. In seven market areas there are barge terminals. If these terminals are added, and market concentration indexes are recalculated according to the first approach, then the market structures will change. As can be seen from Table 6, in 4 areas (Bremerhaven/ Bremen, Genk, Duisburg/ Neuss/ Köln, and Paris) the market structures do not change significantly. In Rotterdam and Antwerp, the market structures change from tight oligopolies with moderate concentrations to loose oligopoly markets without concentration, because there are a lot of barge terminals there, and the number of players in the market doubles. In Zeebrugge area, the market structure change from dominant player to supertight oligopolistic market.

TABLE 6 Comparing Terminal Market Structures After/ Before Considering Barge Terminals

Market Area	Market Structure without Barge Terminals	Market Structure with Barge Terminals
Bremerhaven/ Bremen	Tight / loose oligopoly - moderately concentrated	Tight oligopoly - moderately concentrated
Rotterdam	Tight oligopoly - moderately concentrated	loose oligopoly- unconcentrated
Antwerp	Tight oligopoly- moderately concentrated	loose oligopoly - Unconcentrated
Zeebrugge	Dominant player - Highly Concentrated	Supertight oligopoly- Highly Concentrated
Genk	Tight / loose oligopoly - moderately concentrated	Tight / loose oligopoly - moderately concentrated
Duisburg/ Neuss/ Köln	loose oligopoly - Unconcentrated	loose oligopoly - Unconcentrated
Paris	Dominant player - Highly Concentrated	Dominant player - Highly Concentrated

Other investigations in the terminal market areas involve analysing the distribution of the market area radius based on the second approach. As is depicted in Table 7, 50% of the market areas are defined in a circle with a 25km radius, about 17% are between 25km to 50 km radius, about 11% within the 50-90 km radius, 11% in the 90-160km radius, whilst 11% is in the more than 160km radius. It could be concluded that most of the terminal market areas (more than 72%) are defined in the neighbourhood areas with the radius of 70km, which supports the first approach of this research.

TABLE 7 Distribution of Terminal Market Area Radiuses Based on The Second Approach

Radius (KM)	No. of terminal market areas	Distribution (%)
<=25	9	50.00%
25-50	3	16.67%
50-70	1	5.56%
70-90	1	5.56%
90-160	2	11.11%
160>=	2	11.11%

4.3.Challenges

Different challenges encountered when doing research into terminal markets in the EU. Finding approaches to overcome these challenges forms an interesting contribution of this research which shows how one could use limited data to analyse the terminal markets in a reliable way.

Entrance To The Problem

The demand for IFT is scattered around the EU and different terminals supply IFT services for different customers, So the initial impression is that, there are a lot of demand points within the EU which are covered by different terminals. Finding criteria to segment the total EU market is an important issue in this research. Finding areas where most of the IFT demand has originated from these areas was the first step. The second step was to find good criteria to define the market around these demand points.

Total Volumes

One of the big challenges was to find data on aggregate demand or the supply of IFT services in different areas. Using the trade data for different areas is an interesting approach, and that was adopted in this research. The total import and export of freight which is handled with rail-road IFT services was used but these data were in terms of tonnes. Companies data were in TEU unit, so finding a way to convert tonnes to TEU was another challenge. The best way to deal with this challenge was to find a good estimation of total amount of goods carried in IFT service in terms of tonnes and TEU.

Criteria To Define Market Areas

Another challenge involves finding criteria to define the market borders. There is not much literature in this field, so we focused on finding relevant issues in other fields to deal with this challenge. In the break-even distance literature the term “drayage distance” was found which is relevant to the present research.

Terminal Data

Another big challenge involves gathering data on terminals capacity or throughput. Most terminal operators consider these kind of data, especially throughput data, to be confidential. When there is no comprehensive data bank this challenge will become more critical. We used data sources from the internet, and from personal communication with individual terminal operators. We also used proxies, such as capacity, instead of throughput, and estimations, for the cases we did not have data for in 2012.

5. CONCLUSION

We develop two heuristic approaches to define the inland terminals market areas, and for the EU case, we analyse the structure of these markets as one of the main sub-markets of intermodal freight transport supply chains. In particular, we identify demand regions and use those to segment the market on the basis of its geography by taking two different approaches. Next, we applied these two approaches to analyse the

structure of the inland market areas in the EU by computing concentration indexes. From this analysis, we draw the following conclusions:

- Two different approaches support each other respect to results, which means both approaches are valid, and based on the data availability we could use them.
- The 70km (for some cases 160km) is good estimation of radii of the inland terminal markets in the EU.
- In general, Inland terminal markets in the EU are oligopolistic markets, and most of them are highly concentrated;
- The Northern areas of the EU are less concentrated than the central & southern areas;
- Based on the first approach, Inland terminal markets are less concentrated than with the second approach, because in most cases, the radii in the second approach is less than the assumed radii in first approach;
- When we include the barge terminals, the concentration degree will decrease in certain areas;
- Considering the structure of the terminal markets, we may conclude that the negotiation power of the terminal operators in IFT supply chains seems relatively high.

The methods explored in this paper are generic, and it would be interesting to apply them to regions outside the EU, for instance the rail terminal market in the US, or other IFT sub-markets such as the Pre/ End haulage operators and Forwarders/ LSPs sub-markets.

The findings of this research could be used in situations that we want to make coordinated decisions in IFT supply chains.

6. FURTHUR RESEARCH

Further research could be done on this issue in various directions. New research could consider more areas in the EU market. It could include main-haulage and corridors when defining the market areas and making calculations. Other methods and indexes can be used to analyse the terminal markets. The main constraint in this research was in relation to data availability. Doing research based on a larger dataset or applying other methods of data-gathering could be another direction for further research. Applying these approaches to pre/ post haulage operators or forwarders/ LSP sub-markets could be another interesting option.

REFERENCES

[1] COMMISSION OF THE EUROPEAN COMMUNITIES, “White Paper-European transport policy for 2010: time to decide,” Brussels, 2001.

[2] N. S. Kim and B. Van Wee, “The relative importance of factors that influence the break-even distance of intermodal freight transport systems,” *Journal of Transport Geography*, vol. 19, no. 4, pp. 859–875, Jul. 2011.

[3] C. Sys, “Is the container liner shipping industry an oligopoly?,” *Transport Policy*, vol. 16, no. 5, pp. 259–270, Sep. 2009.

[4] B. Wiegmans, “Intermodal freight terminals: an analysis of the terminal market,” *Transportation Planning and Technology*, vol. 23, no. 2, pp. 105–128, Dec. 1999.

[5] M. Makitalo, “Market entry barriers in Finland’s rail freight transport,” *World Review of Intermodal Transportation Research*, vol. 3, no. 1/2, pp. 181–195, 2010.

[6] EU, “Commission Notice on the definition of the relevant market for the purposes of Community competition law,” *Official Journal C*, 1997.

[7] S. Tayur, R. Ganeshan, and M. Magazine, *Quantitative Models for Supply Chain Management*, vol. 17. Boston, MA: Springer US, 1999.

[8] P. Niérat, “Market area of rail-truck terminals: Pertinence of the spatial theory,” *Transportation Research Part A: Policy and Practice*, 1997.

[9] P. Kotler and G. Armstrong, *Principles Of Marketing (13th Edition)*. Prentice Hall, 2009, p. 744.

[10] OECD, “GLOSSARY OF INDUSTRIAL ORGANISATION ECONOMICS,” 1990.

[11] W. Shepherd, *The Economics of Industrial Organization*. Illinois: WavelandPress, 1999.

[12] US Department of Justice and the Federal Trade Commission, “Horizontal Merger Guidelines,” 2010.

[13] International Union of Railways (UIC), “study on Infrastructure Capacity Reserves For Combined Transport By 2015,” no. May, 2004.

[14] N. S. Kim, “Intermodal freight transport on the right track?,” TUDelft, 2010.

[15] E. D. Kreutzberger, “Distance and time in intermodal goods transport networks in Europe: A generic approach,” *Transportation Research Part A: Policy and Practice*, vol. 42, no. 7, pp. 973–993, Aug. 2008.

[16] M. Janic, “Modelling the full costs of an intermodal and road freight transport network,” *Transportation Research Part D: Transport and Environment*, vol. 12, no. 1, pp. 33–44, Jan. 2007.

[17] M. Janic, “An assessment of the performance of the European long intermodal freight trains (LIFTS),” *Transportation Research Part A: Policy and Practice*, vol. 42, no. 10, pp. 1326–1339, Dec. 2008.

[18] International Union of Railways (UIC), “Combined Transport in Europe,” Paris, 2012.

[19] S. Martin, *Industrial Economics, Economic Analysis and Public Policy*. Oxford: Blackwell Publishing Company, 2002.