An explorative study to inland waterway transport: the Rhine market

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Abstract

In transport literature very little attention is paid to inland waterway transport (IWT). Aim of this paper is to enlarge insight into the IWT market on the river Rhine. As a guideline to describe the market Porter's five forces model is applied. It turned out that the IWT sector itself has a very fragmented character. In contrast, the demand side consists of relatively large shippers that sometimes make use of intermediates to contact bargemen. Demand for IWT originates from the intensity of activities in the basic industries. The main suppliers for the IWT sector are those of fuel and capital and labor. It seems that there are no factors that raise high barriers to enter the IWT market. Compared to other transport modes IWT is an attractive alternative if transport distances are large. However, if the loading and unloading sites are close to the water, IWT (with pre- and end haul by truck) can also be the cheapest option for short distances. From an analysis of the importance of transport nodes for IWT became clear that the Port of Rotterdam is responsible for about 1/3 of all cargo that is shipped by IWT from The Netherlands further land inward. The government influences IWT by supplying infrastructure and setting regulations on the environment and market functioning.

Key words: Porter, inland waterway transport, bargemen, shippers, Rhine

JEL Codes: R41

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0 Introduction

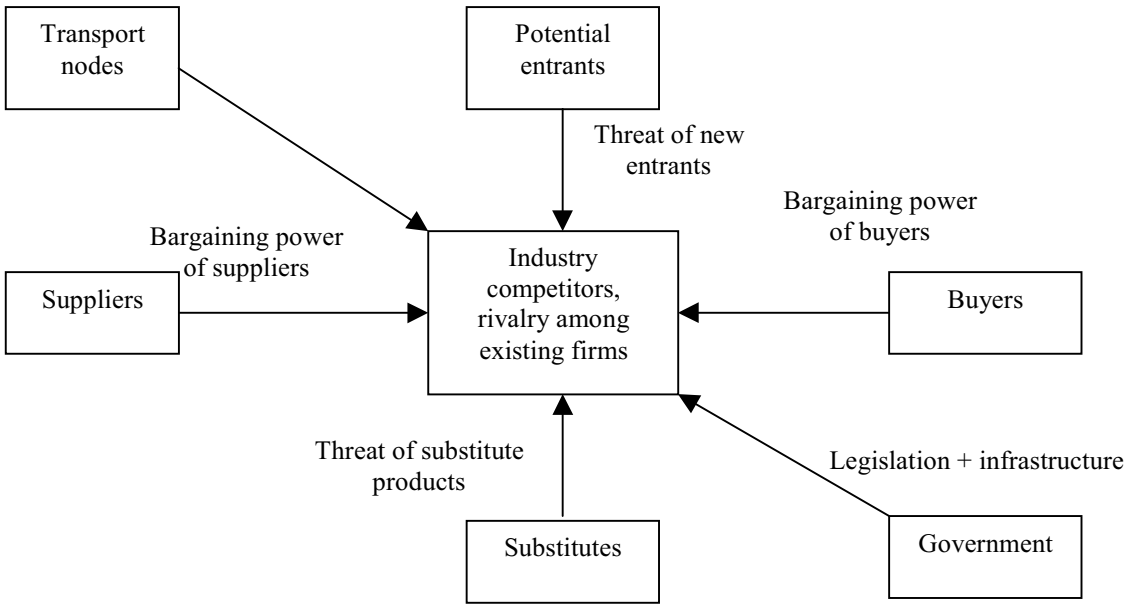
Inland waterway transport has played an important role in the economic history of northwestern Europe, and it still is important today. In this paper an overview of the IWT market on the river Rhine is lined out. The five forces model of Porter will be used as a guide for the structure of the paper. In this framework a sixth force (the government) and a seventh force (transport nodes) are added to the basic five forces. These extra forces are included because the government sets legislation and provides infrastructure. Major transport nodes are large transshipment points in the transport chain in which different modes of transport can function as complements of each other. The structure of this paper is as follows. The first section describes the theory of the Porter model. Then, the next sections will each deal with one of the forces of the model.

1 Porter's five forces model

The market will be analyzed using the five forces model of Porter. This model assumes that the key aspect of the firms' environment is the industry or industries in which it competes. The state of competition in an industry depends on five basic competitive forces: threat of new entrants, threat of substitute products, the bargaining power of suppliers, the bargaining power of buyers and rivalry among existing firms. As additional sixth and seventh forces the 'government' and 'transport nodes' are added (see figure 1). The collective strength of these forces determines the ultimate potential profit in the industry. Not all industries have the same potential. They differ in their ultimate profit potential as the collective strength of the forces differs (Porter M.E., 1998).

A company has to find a position in the industry where the company can best defend itself against these competitive forces or can influence them in its favor. The competitive forces reflect the fact that competition in an industry goes well beyond the established players (the industry competitors). Competition in this broader sense might be termed 'extended rivalry'. A number of important economic and technical characteristics of an industry are critical to the strength of each competitive force. So, it is important to identify these key structural features of industries that determine the strength of the competitive forces and hence industry profitability (Porter M.E., 1998). In the context of this paper the five forces model of Porter is used as a guide to describe the IWT market.

Figure 1: Porter's five forces model



Source: Porter, M.E., 1998

2 Industry competitors: the IWT sector

The IWT sector is formed by the bargemen and shipping companies that offer cargo hold. In this section attention will be paid to different types of ships and the amount of cargo that is transported by the IWT sector. Also the market segment of container transport will be commented on.

2.1 Ship types

To distinguish between ship types the following division is made. First, there are solid cargo ships. These ships are suitable for transportation of metal ores, grain, scrap etc. Second there are liquid cargo ships. These ships transport oil, chemical liquid products etc. And third there are ships for special purposes. These ships are fit out for dedicated transport of cars e.g. (CBS and Min. V&W, 2002).

Ships for container transport are not mentioned separately in the consulted statistical sources. Generally container ships are included in the category 'solid cargo ships'. In table 1 the amount of ships in every category for the Rhine fleet is mentioned. A ship belongs to the Rhine fleet if it has the documents for navigation on the Rhine at its disposal.

Note that in the publication of the CCR where table 1 is derived from, ships for special purposes were not mentioned.

Table 1: number of ships of the Rhine-fleet 1 January 2002

Ship type	Active fleet
Solid cargo ships	5.538
Liquid cargo ships	962
Ships for special purposes	-
Total	6.500

Source: CCR, 2002, Table 12, p. 59.

It has to be mentioned that a ship belongs to the registered fleet and not to the active fleet if:

- the ship is not used for transport purposes (but for storage e.g.)
- the ship has participated in types of transport not registered by the CBS
- the ship was demolished or sold to a foreign country without indicating this in the archive

The discussed types of IWT generally can be divided into two types of ownership:

- Owner operators: this is transport of goods against payment by another company than the company that produces or uses the goods. Owner operators can be one-ship enterprises or shipping companies (CBS and Min. V&W, 2002).
- Own account transporters: haulage of goods with inland waterway ships only destined for or originating from the own company (CBS and Min. V&W, 2002).

Most IWT enterprises are owner operators. The difference between one-ship enterprises and shipping companies is the scale. Shipping companies own several ships and have personnel. A trend that can be seen over the last years is that shipping companies get rid of their own ships and then charter one-ship enterprises. In this way they avoid the risk of responsibility (ERBS, 2002). Then there are the commercial co-operatives. More on this will be described later.

2.2 Amount of IWT

Figures on the performance of the IWT sector are shown in table 2.
Growth in ton-kilometers for total IWT on the traditional Rhine between 1997 and 2002 is 4,88% while growth in tons is 1,33%. This means that the distance over which the cargo is transported increased only slightly in those 5 years.
IWT on the traditional Rhine is defined as freight transport over water that totally or partially took place on the Rhine between Rheinfelden and the Dutch-German border, the Dutch-German border-crossing traffic included.

Table 2: IWT on the traditional Rhine (incl. containers)

Year	Tons (x 1000)	Tonkms (x 1000)	Capacity	Utilization rate tons	Utilization rate tonkm
1997	195.943	41.781.000	-	-	-
1998	198.528	42.883.000	9.891.288	20.07	4335.43
1999	191.882	41.170.000	9.609.781	19.97	4284.18
2000	206.999	44.501.000	8.561.916	24.18	5197.55
2001	201.206	44.235.000	8.329.105	24.16	5310.89
2002	198.547	43.818.000	8.423.735	23.57	5201.73

Source: CCR, 2002a; CCR, 2001; CCR, 2000; CCR, 1999; CCR, 1998a tables 1, 12.
Note column 3: number of ton-kilometers transported on the traditional Rhine, all flags
Note column 4: loading capacity in tons of all **registered** ships (before 2000) and all **active** ships (after 1999) on the traditional Rhine.
Note column 5: column 1/ column 3
Note column 6: column 2/ column 3
Note: for 1998 and 1999 it appeared that it was not possible to use the new definition “active fleet”. So, to calculate the values in the columns one to three for 1998 and 1999 the registered fleet was the basis and for 2000 to 2002 the active fleet was the basis.

The utilization rate in tons was highest in 2000. In these years for IWT on the traditional Rhine every ton loading capacity was used 24,18 times. The ton-kilometer rate for IWT on the traditional Rhine was highest in 2001. In this year with every ton loading capacity one ton of cargo was transported 5310,89 kilometers. To make judgements about the performance of the IWT sector it is best to look at ton-kilometers (instead of tons) because this indicator corrects for distance.
Compared to other rivers The Rhine has a large basin. As a result, on average cargo is shipped over larger distances compared to, for instance, IWT within The Netherlands. For 2002 the average distance over which cargo was shipped on the traditional Rhine was 221 kilometers.

The best indicator, if one would like to say something about the degree of usage of capacity of the IWT sector on the Rhine, would be: the quantity of shipped cargo in ton-kilometers of all Rhine ships divided by the maximum quantity of ton-kilometers loading capacity of all Rhine ships. So, this means that one has to calculate the maximum capacity of the Rhine inland navigation fleet in ton-kilometers.
Theoretically this capacity is determined by: the quantity of ton-kilometers shipped if all ships would navigate on maximum power and with fully loaded cargo holds for one entire year 24 hours a day. In practice the maximum capacity is restricted by waiting times, time for loading and unloading, navigation with the cargo holds only partially loaded and restrictions due to volume instead of weight.

2.3 Container transport in IWT

A market segment in IWT is the market for container transport. This market distinguishes itself from the dry and liquid bulk market because the cargo is not transported in bulk-form but in standardized units called TEU's (twenty equivalent unit). The transported goods are characterized by a higher value-density than the bulk goods.
A remarkable growth in the production of semi-finished and finished products in industries like food products, machines and vehicles has been observed over the last ten years.
This caused new requirements for transport, like door-to-door transport, short transportation times and JIT. Traditionally IWT did not serve these markets but container transport is expected to be able to fulfill these requirements (EMCT, 1999).

IWT was mainly seen as a point-to-point transport mode for large amounts of goods. For many bulk goods this still holds true but for container shipping this is different. Now for container IWT changes lie in becoming part of the supply chain and even becoming coordinator of this chain.

Table 3: container traffic on the Rhine and its tributaries

Year	TEU	Empty	Loaded	% loaded - total
1999	1.018.681	361.468	657213	64,52%
2000	1.233.670	445.965	787.705	63,85%
2001	1.196.866	428.872	767.994	64,17%
2002	1.289.424	458.119	831.305	64,47%

Source: CCR, 2002, table 4b, p.24

Table 3 shows the amount of container traffic on the Rhine. In four years the amount of shipped TEU increased by 26,58%. The proportion between empty and loaded container space remained more or less the same.
Did container traffic on the Rhine show an increase of 26,5%, total transport on the traditional Rhine only increased by 1,33% (compare tables 3 and 2). This implies a considerable growth of the container sector relative to the dry- and liquid bulk sector.

2.4 The industry structure

Table 4 illustrates the industry structure. The majority (> 60%) of the IWT companies are 1-ship companies. The table represents the situation in The Netherlands. ECMT (1999) reports that the IWT sector in Western Europe is a highly fragmented industry. Hence, the situation in table 4 is also representative for Western Europe.

Table 4: Dutch enterprises in inland navigation (active fleet), 2002

Size of the enterprise	Number of enterprises	Number of ships	% cumulative (ships)
1 ship	2.930	2.930	61,41%
2 ships	230	460	71,05%
3 ships	73	219	75,64%
4 ships	35	140	78,58%
5 ships	21	105	80,78%
6 – 10 ships	39	301	87,09%
10 – 20 ships	28	371	94,86%
> 20 ships	9	245	100,00%
Total	3.365	4771	

Source: CBS en Min. V & W, 2002, p. 47

From the situation stressed in table 4 it becomes clear that the supply side of the market can be characterized by a large number of small enterprises with a small number of vessels and tonnage (the owner operators), and a small number of large enterprises with more vessels and tonnage (the shipping companies). As a result, generally, one-ship IWT enterprises (for dry and liquid cargo) have little market power. Shipping companies are in a better position due to their organizational capabilities (ERBS et al, 2002).

To improve their position bargemen organize themselves in the earlier mentioned commercial co-operatives. This is mainly seen in the dry cargo market. In a commercial cooperative individual companies jointly approach their clients via one single organization.
It is able to offer to the demand side the same services as larger shipping companies, while maintaining entrepreneurial freedom for its members. The co-operation can close contracts, develop marketing activities, collect the wishes and needs of shippers, and coordinate transport tasks (ECMT, 1999).
In the liquid cargo market the majority of the IWT is executed by shipping companies on the basis of long-term contracts and less by one-ship enterprises. Shippers prefer the shipping companies above the one-ship enterprises because of the larger scale and organizational power of the shipping companies (ERSB, 2002).

3 Buyers; the demand side

Transport demand for IWT is determined by the economic activities of industries that require goods like fuels, metal ores, crude, building materials, oil products etc. Actually it can be said that demand depends on the development of production and consumption and thus on the ups and downs of the world economy.
Because the IWT enterprises operate within the basic industries, they are very sensitive for fluctuations in the economic climate. Transport of some goods is also subjected to seasonal fluctuations.
The next paragraph will describe what are the perpetrators of demand. Then, the position of the bargemen relative to the shippers will be studied.

3.1 Perpetrators of demand

Table 6 breaks down the amount of IWT in 2002 by commodity group for the traditional Rhine.

Table 6: commodity traffic on the traditional Rhine, 2002 (x1000 tons)

Commodity Group	Tons	%
6 Raw minerals; building materials	40.009	20,15%
3 Oil and oil products	34.374	17,31%
4 Ore and metal residue's	34.170	17,21%
2 Solid mineral fuels	24.217	12,20%
8 Chemical products	14.843	7,48%
9 Other	14.424	7,26%
5 Metals, metal unfinished products	11.680	5,88%
1 Food and animal food	11.653	5,87%
0 Agricultural products; life animals	8.251	4,16%
7 Fertilizers	4.925	2,48%
Total	198.546	100,00%

Source: CCR, 2002a, p. 20 - 23

To be able to interpret the figures better most commodity groups will be commented on.

Agricultural sector (food and animal food, fertilizers, life animals)

Demand from this market segment is fairly diffuse and the size of transport fluctuates considerable over time. These fluctuations depend on the size of the agricultural area, the destinations of the products (export or Europe) and the size of the harvest.

An important factor herein is the competitive position of the European agricultural sector on the world market. IWT is a very important transport mode for this commodity group. From 1992 to 2002 the volume (tons) increased by about 15% and the performance (tonkms) by about 20% (CCR, 2002).

Steel industry

The European steel industry improved the production level of 160 million tons of 2001 slightly in 2002. The decline of the performance in this commodity group is caused by the decreased share of IWT in transport to the steel industry area in Saarland. Transport of steel products from the hinterland to the seaports also decreased considerably in 2002 (CCR, 2002).

Building materials

This commodity group suffers from a structural decrease over the last few years. Especially supply to destinations in the middle and upper-Rhine and export from the upper-Rhine to regional destinations seem to decrease. The performance decreased at a slower pace than the volume (CCR, 2002).

Oil products

Demand for oil products seems to remain stable or, for some products, reduce slightly. New (energy-saving) technologies contribute to this although mobility of the population is still increasing. Demand for the IWT sector concerning this commodity group is mainly being determined by the capacity of the refineries in the region of the Rhine basin on the one hand and the stock-holding policy on the other hand.

The stockholding policy of large oil companies and oil trade companies depends on (ERBS, 2002):

- Oil prices on the world market
- The expected demand which fluctuates seasonally
- Political developments

Temperatures in winter also affect demand for IWT for oil and oil products. The decrease of IWT in 2002 is caused by the decrease of stock. As a result less oil had to be imported. The volume and the performance both decreased by 5% and 7% respectively (CCR, 2002).

Solid mineral fuels

As a result of the weak economy in Germany in 2002 demand for coal decreased to the same extent as the total use of primary energy sources (- 2%). Users of coal are the steel industry (14,7 mill. ton), district heating (3,6 mill. ton) and electricity companies (50,5 mill. ton). The latter was responsible for the cut back of the use of coal. Also the decrease of extraction and import of coal are negative developments. Although these negative developments, the IWT sector transported more solid mineral fuels. The explanation for this is that the IWT sector gained market share in this commodity group relative to other modes of transport with a 5% increase in volume and performance. The increase in demand of 20% for IWT of coal in the North-Eastern part of France was the main perpetrator (CCR, 2002).

Chemical products

The European chemical industry increased its production in 2002 by about 5%. IWT for the sub-market of basic chemicals only increased by 1% as a result of more transport from industries situated around the downstream Rhine. The performance in 2002 recovered from 2001 and increased by 5% (CCR, 2002).

Other

This segment is being dominated by transport of consumer products and half products in containers. For years this commodity has been showing an increase, in 2002 mainly caused by more IWT to the seaports (about 11%). Upstream the volume only increased slightly. Compared to 1993 almost three times the amount (tons) was transported in 2002. The performance was almost four times higher. The average annual growth was 10,6% and 15,7% respectively (CCR, 2002).

3.2 Position determining factors

There are some factors that determine the bargemen's position relative to the shippers.
Concentration of the buyers or the scope of the purchased volumes: the clients of bargee's (shippers or the intermediates) are considerable bigger than the average IWT enterprise. Shippers work with long term contracts or offer onetime or more-time shipments. For execution of the long-term contracts shippers often hire shipping companies.
Shipping companies have a larger scale than one-ship enterprises and are better able to comply with the requirements on safety, manning and information systems of the shipper. So, shipping companies have a certain scale concerning the organization of the transport and thus have considerable power compared to the shipper they work for.
For the onetime shipments one-ship enterprises are asked to transport the cargo. For this type of transport the shipper (or intermediate) offers the daily tariff. Scale of the organization of one-ship enterprises is small compared to that of the shippers and thus his position is weak (ERBS, 2002). Concerning the intermediate, it is said that the problem is often the fact that bargemen see them as a friend and do not negotiate enough to get a good price. The intermediate chooses the side of the shipper because the importance of the shipper for the intermediate is bigger than the bargeman. So, relative to the intermediate, bargemen also have a minor position.

Homo- or heterogeneous product: IWT can be divided into several types of ships (solid and liquid cargo ships, ships for special purposes and container transport) and three different geographical markets (Dutch domestic, Rhine and North-South market).
If for instance demand on the Rhine market rises, for bargee's active in the North-South market it is possible to navigate to the Rhine and offer its services there. So concerning geographical scope IWT is a homogeneous product.
Concerning the type of ship it is not possible for a liquid cargo ship to transport dry cargo. So here is more heterogeneity. However, within each submarket (liquid or dry cargo market) there is still a considerable number of players. Only for the dedicated transport segment there exists a heterogeneous market.
Switching costs: in BCI et al., (2004) it is said that shippers only want to close short-term contracts because price levels fluctuate a lot. So, in practice a shipper is not locked to a certain bargeman for a long time and can switch after the expiry of the contract. It hardly occurs that shippers or bargemen redeem a contract. As a result the bargemen have to deal with economic insecurity. But in the same publication it is also stated that many bargemen have entered into contracts with large shippers so that fixed prices for the long run are agreed. These agreements deter switching of shippers.
Then there are some industries (chemical, steel, building materials, oil, and agricultural industries) that have their own installations to load and unload the ships. Their switching costs (to other modes) are high because they have fixed costs for the special installations.
The fraction of costs IWT is for the buyer: IWT is not the major fraction of costs for the buyer. Especially for low value goods like coal and steel IWT is only a very small part (1 or 2%) of the total production costs for the buyer (Frederic Harris, 1997). So buyers are not very price sensitive.
The extent to which the 'product' inland navigation is important for the quality of the buyers' product: reliability is the most important factor for shippers, especially for shippers whose production process is very sensitive for deviance's in delivery-time.
Frederic Harris (1997) found the duration of delay that threats the continuity of the production process of several client groups:

- Oil depots: 2 months
- Energy companies and steel industry: 2 to 4 weeks
- Chemical industry: 1 to 2 weeks
- Containers: 0,5 days (often JIT is required)

So, for containers transport by IWT half a day is already threatening for the competitive position of IWT. If, for some reason, container transport is structurally delayed clients of IWT can decide to choose another transport mode or to pay a lower price.

4 Suppliers

The information in this section and the next one is mainly based on interviews with two experts in the field of IWT.

To determine who are the main suppliers of the IWT sector it is helpful to investigate what the main cost drivers of running an IWT enterprise are. For a dry cargo ship of one respondent as the main costs drivers fuel (about 20%), personnel (about 20%), interest and capital payments (about 25%) and reparations (about 10%) of the annual turnover were mentioned. Considering the main cost drivers, the main suppliers for the IWT market are suppliers of fuel, credits and, spare-parts and labor.

One of the respondents said that for delivery of ship materials, lubricants and fuelbargemen often have a friendly relationship with the suppliers of so-called bunker stations. It is said that this kind of relationship is sometimes to the detriment of the price.

Not for every country prices of different products are the same. E.g. in Germany fuel is 15% - 20% higher. Another respondent had an opposite meaning and said thatbargemen become more and more business-wise and first investigate where the price is lowest and then buy a certain product.

Concerning receiving credit the situation is said to be as follows. There are several banks that hand out credits (Rabobank, ING, ABN-AMRO, SNS). If one has a good company-plan and a lot of company capital, banks are willing to hand out a loan andbargemen have a good bargaining position. But at the same time the bank has a lot of power when things go wrong because the contract is full of conditions. The position of abargeman is also dependent on the height of the investment. If one wants to buy a new, big, modern ship it is necessary to loan more and thus one is more dependent of the bank.

Often, the bunker stations and credit facilitators are large companies. In general, suppliers are willing to keep their clients but at the same time they will certainly not regret it when they lose one client. On the other hand, bunker stations andbargemen are also dependent of each other.

It is also said that it is hard to get well-skilled labor. The average level of education is poor and as a result often employees with limited capacities come into the sector. One of the respondents also mentioned that often cheap labor from countries like Czech, Hungary and Poland is hired and that this is not good for the national IWT labor market.

5 Potential entrants

There are several factors that determine if it is easy to enter a market:
Economies of scale (number of ships): because the majority of the IWT enterprises are one-ship enterprises, economies of scale are not a restriction to potential one-ship entrants. Besides, being large is not always an advantage relative to potential entrants. In times when the loading capacity can not be fully utilized (and these situations happen more and more often), big ships are confronted with lower earnings while having higher fixed costs.
Product differentiation: generally speaking IWT is a homogeneous product. Current one-ship enterprises do have little opportunities to build up customer loyalties or an own brand. One way of differentiating is to install a crane on the ship to load and unload it. But the best way of differentiating is to be reliable and honest. If one is known for this he has an advantage.
Access to distribution channels/ clients: in principle it is easy for everybody to get freight. Only for a newcomer it will be uncertain which shippers are reliable and have enough work. A newcomer almost always has experience in the IWT sector like a former employee of a ship of another person and as a result he knows the business to a certain extent.
Cost disadvantages independent of scale: every year of experience in the IWT sector is one extra year of knowledge. A bargeman who has a lot of experience can e.g. anticipate faster to certain developments that a newcomer. If a bargeman can get a bad price for the outward journey but he knows that there is freight for the return journey for which he can get a good price (not everybody knows this) he will do it.
And, it is also a matter of knowing the best navigation routes in the different seasons. If one does not has experience in the sector it is probable he will be influenced quickly by a shipper or intermediate who often represent the physical situation better than it actually is.
Government policy: at the moment entering the market is relatively easy. Being a bargeman is a free accessible profession. There are no establishment requirements. Everybody who has its certificate of proficiency and a good company plan can start as a bargeman. Formerly this was different (Polak, 2005).

In the western European countries there existed (and still there is) a disproportionality between supply and demand for several decades. As a result IWT was regulated and a restriction to entry to the industry was introduced.
Eastern European bargemen: so far 'potential entrants' are only considered as newcomers in a sense that they do not have much experience yet in the IWT sector. But, a new entrant to the Rhine market can also come from another geographical market. Eastern Europeanbargemen that originally operate on the Danube market are such entrants.
Capital: capital requirements to start an IWT enterprise are said not to be very demanding. It is said that for someone from outside of the IWT sector with a certain amount of money who can prove that he can deal with money it is not very difficult to enter the market. For about 60.000 to 70.000 EUR of which 30.000 to 40.000 EUR is equity capital one can already buy a 'Spits' (a small ship).

6 Substitutes

Substitutes can be described as other products that can perform the same function as the product of the industry (Porter, M.E., 1998). In this case the product is IWT. So, substitute products of IWT are other modes, mainly road and rail transport and, to a lesser extent small sea-ships. There are several forces that can influence the competitive position of IWT relative to the other modes.

6.1 Forces that influence the competitive position of IWT

The choice of a shipper to use a certain (combination of) mode(s) depends on different aspects. The following four are repeatedly cited as being important: cost, time, prevention of damage, and reliability (Konings, R., et al., 2000). BCI, et al. (2004) also mention flexibility as being one of the most important factors.
However in practice shippers also select their choice on subjective criteria (tradition, experience and recommendation) without having sufficient knowledge about alternatives, because in general transport markets are not very transparent (BCIet al., 2004).
IWT's advantages over the other modes are on the area of vessel size, basic reliability and safety.

IWT will be better able to compete with the other modes if the following factors can be improved (BCI, et al., 2004):

- sufficient infrastructure conditions
- technical adaptation of vessels and infrastructure (including transshipment)
- better communication techniques
- the discovery and development of niche markets
- reforming the arrangements needed to construct logistic chains at lower overall costs

6.2 The position of IWT

The following table shows what the position of IWT is compared to its substitutes in the Rhine-countries (the Netherlands, Germany, Belgium, Luxembourg, France and Switzerland).

Table 7: goods transported in ton-kilometer in the Rhine countries by different modes

Year	IWT		Road		Rail		Total
1995	111.603	13,39%	585.406	70,23%	136.517	16,38%	833.526
1996	108.756	13,04%	588.976	70,60%	136.455	16,36%	834.187
1997	115.379	13,20%	621.096	71,03%	137.906	15,77%	874.381
1998	117.770	12,96%	651.530	71,69%	139.524	15,35%	908.824
1999	117.560	12,47%	689.538	73,12%	135.971	14,42%	943.069
2000	121.569	12,66%	694.200	72,30%	144.388	15,04%	960.157

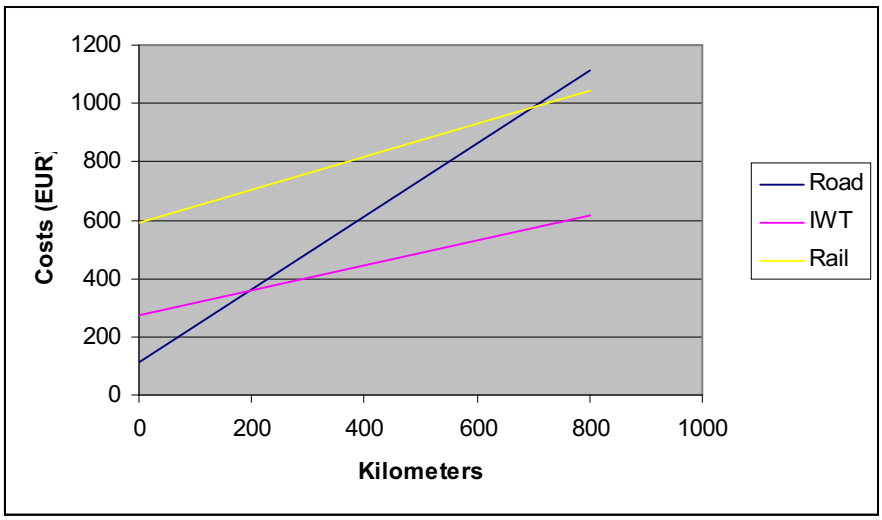
Source:http://epp.eurostat.cec.eu.int/portal/page?_pageid=1090,30070682,1090_30298591&_dad=portal&_schema=PORTAL

It appears that in the Rhine countries IWT lost market share between 1995 and 2000.

6.3 Break-even points

For transport from A to B over short distances road transport is often the cheapest option. But if loading and unloading sites are close to the water, a combination of road transport and IWT often is the cheapest solution (BCI et al., 2004).
Road transport is required in a transport chain for pre haul and end haul. In combined transport (rail-road or IWT-road), to determine what mode of transport is cheaper break-even points are assumed. These points determine a natural market for the modes. This is shown in figure 3.

Figure 3: break-even distances for transport of maritime containers by road, rail and IWT.



Source: INRO-TNO (1995) in, de Wit en van Gent (1998)

The break-even points lie at 200 and 738 kilometer. For IWT and rail transport the transshipment costs and pre- and end haul costs are not included. So, if these costs are also included the break-even distances will be higher. Second, rail-road or IWT-road transport can only be competitive relative to road transport if there is cargo for the return trip. Finding cargo for the return trip can be hard considering the fact that the return cargo has to be found in the service area of the inland terminal (de Wit en van Gent, 1998).

BCI et al. (2004) found that the average distance of domestic and international IWT within the former 15 EU member states is approximately 280 kilometers. For rail this is only slightly lower with 250 kilometers and the average road trucking distance is considerable lower, 110 kilometers. The distance for IWT corresponds quite well with the estimation made by Dings et al. (1999). In Harms and Willigers (2002), Dings et al. (1999) mention that IWT is profitable from 250 kilometers.

BCI et al. (2004) made some comparisons for different types of transport over different distances. For transport of containers from Rotterdam to Heidelberg (about 600 kilometers) the following table was constructed:

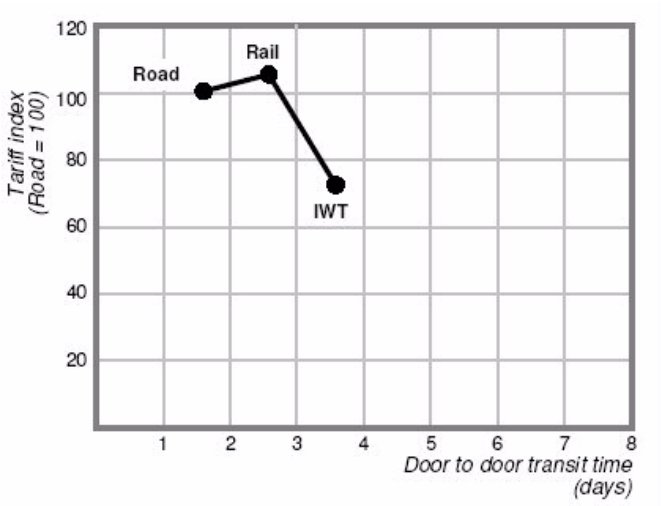
Table 8: cost analysis of modal alternatives (in EUR)

Chain element	road	inland navigation	rail
Sea-terminal	41	55	41
Truck & overhead	455		
Ship & overhead		141	
Rail & overhead			314
Inland terminal		45	45
End-haulage by road		123	123
Total	496	364	523

Source: NEA (1995) in BCI et al. (2004)

The IWT solution is 30% cheaper than rail and 27% cheaper than direct road transport. When the costs are compared with the time performance of the various modes, figure 4 can be constructed. It can be seen the good position of IWT is negatively affected by the cost and waiting times of the processes at the inland terminal and the end-haulage by road.

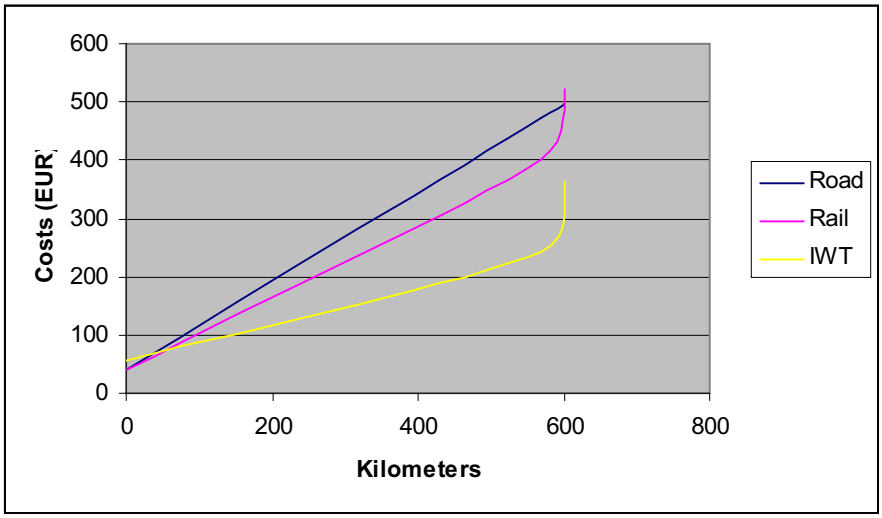
Figure 4: modal comparison for one container from Rotterdam toHeidelberg (1)



Source: BCI et al., 2004

The journey can also be displayed otherwise. Therefore it is assumed that the last 30 kilometers have to be transported by road (for the rail and IWT alternative). For the rail and IWT alternatives costs rise enormously for the last 30 kilometers when transshipment and end-haulage are necessary to deliver the cargo to its destination. Compare figure 5 with figure 3 to note the difference if transshipment and end-haul costs are included.

Figure 5: modal comparison for one container from Rotterdam toHeidelberg (2)



For container transport, compared to road transport, IWT can offer a considerable lower tariff per TEU transported. The limiting factor however, is the distance between the inland terminal and the destination or loading place. The maximum distance is 15 kilometer in the Netherlands. Is the terminal situated further from the cargo, then it can only run profitable with transshipment volumes of more than 30.000 TEU a year. In Germany this distance is larger. There a radius of 50 kilometer is still cost-effective (Informatie Binnenvaart, 2004). It may be the case that the average service area in Germany is much larger than in The Netherlands and that therefore a larger radius is still cost effective in Germany.

7 Transport nodes

As is already said in the introduction, transport nodes function as transshipment points in the transport chain. For the IWT sector the port of Rotterdam and inland terminals such nodes.

7.1 The port of Rotterdam and IWT

In the port of Rotterdam a lot of transshipment takes place between different modes. Therefore it can be said that the port of Rotterdam enables transport modes to serve as complements of each other and thus also of IWT.
The share of haulage of goods for IWT to the land-side is about 50% compared to the other modes.

About 60% of the IWT to and from the port concerns dry bulk cargo and about 30%is liquid bulk. But not only for bulk goods IWT is a suitable mode of transport for haulage out of the port of Rotterdam. Inland ships transport over 50% of all containers in the port of Rotterdam (Port of Rotterdam, 2005). To stress the position of IWT in the Port of Rotterdam, table 9 can be presented:

Table 9: haul from and to the port of Rotterdam in 2002 (x 1000 tons)

2002	Total	Sea	River	Road	Rail	Pipeline
Unloaded	273.154	246.229	19.252	4.690	2.984	0
Loaded	222.880	73.649	78.517	6.958	10.041	53.716

Source: http://www.portofrotterdam.com/NL/

It can be seen that the amount of tons loaded into IWT ships in the port of Rotterdam is about four times the amount of tons unloaded at the port. This implies a large imbalance in the ingoing and outgoing transport flows. It can be reasoned then that inland ships have to navigate to Rotterdam with empty cargo space and containers sometimes.
It is also observed that the outgoing flow of inland ships is larger than that of maritime ships. About 35% of all outgoing transport is done by inland ships. The role of IWT in the supply of cargo to the port of Rotterdam is modest with about 7%.

It is interesting to say something about the dependency of IWT on sea-transport. Therefore we should find out how many tons from incoming sea-vessels into the port are transshipped into inland vessels. But it turned out that these figures do not exist. A second best indicator was available.
If the amount of tons transported by IWT from the port of Rotterdam to a certain destination is compared with the total amount of IWT that has its loading place in The Netherlands and its unloading place in The Netherlands or abroad, we can say something about the importance of the port of Rotterdam for IWT. In 2002 total IWT with its place of loading in The Netherlands and place of unloading within or outside The Netherlands was 225.182.000 tons (CBS, 2005). The IWT cargo flow from the port of Rotterdam to the hinterland was 78.517.000 tons.
Thus, for about 35% IWT with its loading place in The Netherlands and its destination anywhere else can be related to the port of Rotterdam in 2002.

7.2 Inland terminals

While in the port of Rotterdam all kinds of cargo (dry, liquid, general and containers) are being handled, inland terminals are almost exclusively equipped to handle containers. Inland terminals form the physical and informative connection between different parties in the transport chain. The functioning of the inland terminals is of great interest of the logistical efficiency of IWT for containers. The establishment of inland terminals is quite a new development and the aim of the IWT sector for containers is to establish a network of inland terminals. Then, within this network services of different operators can be adjusted and cargo flows can be combined. It is thought that within a certain time-span IWT can play an important role in the distribution of goods from and to multi-modal distribution centers at the edge of the cities (A&S, 2003).

8 The government

The government (national and European Union) also plays a crucial role in the field of forces that have impact on the IWT market.
In the past the government regulated the market (until 1998 in the Netherlands and until 2000 in the EU). Besides this the government provides the infrastructure for the IWT sector and it sets legislation and environmental standards.

8.1 Infrastructure

In the European context the CEMT division is applied for the division of waterways into categories.
This division is based on the capacity of the waterways formed by the Conference of the European Ministers of Traffic in Paris, 1954 (see table 10).

Table 10: dimensions of ships and waterways

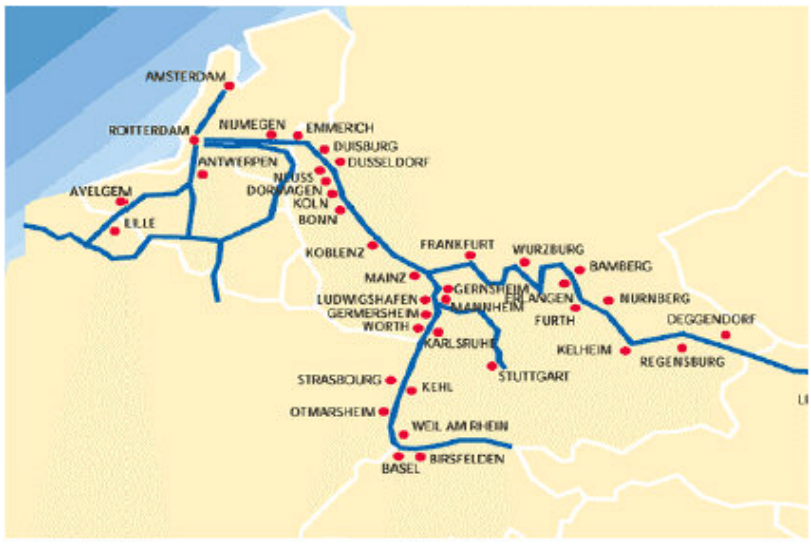
Self propelled ships							
Class	Tonnage	Length/m		Width/m		Draught	
I	300	38.50	x	5.05	x	2.20	
II	650	55.00	x	6.60	x	2.50	
III	1.000	80.00	x	8.20	x	2.50	
IV	1.500	85.00	x	9.50	x	2.50	
Va	2.500	110.00	x	11.40	x	2.80	
Vib	6.000	140.00	x	15.00	x	3.90	
Tug boats							Barges
IV	1.500	85.00	x	9.50	x	2.80	1
Va	3.000	110.00	x	11.40	x	4.50	1
Vb	6.000	185.00	x	11.40	x	4.50	2
Via	6.000	110.00	x	22.80	x	4.50	2
Vib	12.000	195.00	x	22.80	x	4.50	4
Vic	18.000	270.00	x	22.80	x	4.50	6
Vic	18.000	195.00	x	34.20	x	4.50	6

Source: A&S (2003)

The Waal (the Dutch part of the Rhine) is the connection to the German inland waterway network. Total length of the navigable waterway network for ships on the river Rhine is about 950 kilometer (total length of the Rhine is 1320 kilometer). By this route, cargo is transported between the ports of Rotterdam and Antwerp and the ports and inland terminals situated along the Rhine and its tributaries. The main tributaries of the Rhine are theNeckar (367 kilometer), the Moezel (544 kilometer) and the Main (524 kilometer).

In figure 6 the different terminals that belong to the Rhine navigation system are shown.

Figure 6: schematic representation of the Rhine navigation area



Source: A&S, 2003

8.2 Policy on IWT

IWT regulations for the Rhine market are largely determined by those issued by the CCR (resulting from the Treaty of Mannheim) and EU legislation, mainly in the form of Directives requiring to be implemented by national measures (BCI, et al., 2004). Besides these sources, for each country the national policy on IWT is determining.

The main principles that originate form the Treaty of Mannheim concern (CCR, 2005):

- freedom of navigation,
- equal treatment of all boatsmen and fleets,
- exemption from navigation duties,
- simplification of customs clearance,
- obligation of member states to maintain the waterway,
- uniform regulations for the safety of vessels and navigation,
- uniform jurisdiction in navigation affairs,
- navigation courts for the Rhine,
- Central Commission to supervise the principles of the Convention.

The EU-legislation is pointed at the functioning of the market, access to the profession and safety and technical requirements (EU, 2005).

8.3 Environment, safety and emissions

In the Rhine area, a large proportion of dangerous goods, mostly chemicals and fuels, is transported on the waterways. IWT's safety record for transporting these goods by barge is said to be excellent. Double hulls have been introduced, sophisticated monitoring systems put in place, and professional safety training programs implemented. Rules and regulations for transporting hazardous cargoes have been raised to international standards (NEDECO, 2004). But, the IWT sector does not only have an advantage on the area of protection of the environment. Compared to road transport IWT also has advantages on the area of energy use, emission out of fuel use, noise and use of space. The majority of these advantages will hold for the future. However, the advantage on the area of emissions will decrease due to fast environmental technical innovation in the road transport sector.

The main cause for this is that for new diesel engines for inland ships there was no regulation on the area of emissions until 2002 (CCR, 1998b). Since 2002 there exists legislation for emissions for exhausts (CCR, 2002b). The energy use and emissions out of fuel use of three different transport modes are shown in the table below.

Table 11: energy use and emissions per transport mode in 1998

Transport mode	Performance (tonkms)	Energy use (mlnJ/ tkm)	CO2 (g/ tkm)	CO (g/ tkm)	Nox (g/ tkm)	SO2 (g/ tkm)	VOS (g/ tkm)
Road	44,6	2,9	235	0,89	2,04	0,067	0,30
Rail	3,8	0,4	26,3	0,10	0,39	0,026	0,026
IWT	40,7	0,6	46,7	0,14	0,86	0,049	0,047

Source: RIVM, 2000

Besides the emission norms for fuel use there are regulations on the emission of gasses out of the cargo hold (liquid cargo ships). To air leftovers form the cargo hold there is a voluntary agreement (CCR, 2002b). From 1 January 2006 it will be forbidden for inland ships to air gasses.

9 Conclusion

In this paper the IWT market for the Rhine is analyzed in a broad perspective using the Porter model. Not only the IWT sector itself, but also the forces that influence the sector are studied. Developments in the basic industries situated in the Rhine basin are determining for demand for IWT for the Rhine market. Shippers from these industries are often very large and they use intermediates to arrange transport by barge. For the supply of services and products to the IWT sector bargemen do business with smaller parties. With these parties it is possible for bargemen to shop for the cheapest products. Barriers to enter the IWT sector are not said to be very high. Capital requirements are relatively low and bargemen who enter the market usually already have experience. An advantage for IWT over road and rail transport is that on long distances IWT is often the cheapest option. However, the other side is that IWT usually needs more time to carry out the transport. Transport nodes offer the opportunity to IWT to operate more within transport chains with other transport modes. Finally the government influences IWT by providing infrastructure and setting regulations. Seeing the pinpoints of the policy, it seems the goal is to offer equal circumstances to everybody in the market.

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