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DOI
10.4233/uuid:5b8551b1-f12a-463d-97e5-5f3ca4473557

Publication date
2016

Document Version
Final published version

Citation (APA)
van der Horst, M. (2016). *Coordination in hinterland chains: An institutional analysis of port-related transport*. [Dissertation (TU Delft), Delft University of Technology]. TRAIL Research School. https://doi.org/10.4233/uuid:5b8551b1-f12a-463d-97e5-5f3ca4473557

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To cite this publication, please use the final published version (if applicable).
Please check the document version above.

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Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus Prof. ir. K.C.A.M. Luyben,
voorzitter van het College voor Promoties,
in het openbaar te verdedigen op donderdag 3 november 2016 om 15:00 uur
door Martijn Robbert-Jan VAN DER HORST
Doctorandus in de Economische Wetenschappen,
Erasmus Universiteit Rotterdam,
geboren te Rotterdam

Dit proefschrift is goedgekeurd door de:
promotor: Prof. dr. J.P.M. Groenewegen

Samenstelling van de promotiecommissie:

Rector Magnificus	voorzitter
Prof. dr. J.P.M. Groenewegen	promotor

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TRAIL Thesis Series no. T2016/19, the Netherlands Research School TRAIL

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2600 GA Delft
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ISBN: 978-90-5584-211-7

Printed in the Netherlands

Contents

1 Introduction

The thesis is concerned with the way economic actors in seaports and in port-related transport chains (hinterland chains) establish coordination in order to make container transport from and to the port more efficient. The first section of this introductory chapter provides the background of the study. The second section will then present the research goal, while the third section will discuss the research domain of port economics and management, where we position the subject of this thesis. The fourth section will discuss the research philosophy. The fifth section will provide an overview of the chapters of the thesis and the research design. From this chapter both the societal, as well the academic relevance of the study becomes clear. The chapter ends with a declaration of contribution of the author of this thesis and other parties to the different chapters.

1.1 Background: Why is studying coordination in hinterland chains a relevant issue?

In the present era of containerisation…

This thesis focuses on hinterland transport of containerised cargo. In 1966, the decade after the container first came into international use, the volume of international trade in manufactured goods grew more than twice as fast as the volume of global manufacturing production, and two-and-a-half times as fast as global economic output. Containerisation accelerated the growth of trade despite weak economic expansion (Levinson, 2006). Although broad evidence of the effect of containerisation on economic growth is lacking and difficult to quantify (Levinson, 2006, p.8), the container became an important type of cargo commodity in global trade, worldwide transportation and in seaports.

Table 1.1 International seaborne trade, selected years (millions of tons loaded) (Source: UNCTAD, 2015)

	1980		1990		2000		2005		2010		2014	
		%		%		%		%		%		%
Containers	102	3	234	6	598	10	969	14	1275	15	1631	17
Other dry bulk	1123	30	1031	26	1928	32	2009	28	2027	24	2272	23
5 Major bulks	608	16	988	25	1295	22	1709	24	2335	28	3112	32
Oil and gas	1871	51	1755	44	2163	36	2422	34	2772	33	2826	29

The growing importance of the container in global trade by sea is mirrored in table 1.1 Container trade in 1980 was only 3 percent of the total world trade by sea, which at the time was dominated by crude oil products. In 1980 more than the half (51%) of international seaborne trade was oil and gas. Twenty years later the share of containers in international seaborne trade increased to 10%, representing 598 tonnes. The share of crude oil decreased between 1980 and 2000. In recent years, oil and gas as well as the 5 major bulks (iron ore, grain, coal, phosphates and bauxite) have a share of about 1/3 of the total international seaborne trade. More than 1.6 billion tons of goods loaded in containers were traded in 2014. This is 16 times the amount of tonnes loaded in 1980.

Table 1.2 Share of containers in total throughput in 6 major European ports (Source: Port authorities, adapted by author)

	2000	2005	2010	2011	2012	2013	2014
Antwerp	36%	47%	56%	56%	56%	53%	54%
Bremerhaven	62%	68%	75%	77%	77%	77%	76%
Hamburg	53%	66%	64%	68%	68%	68%	69%
Le Havre	21%	28%	33%	32%	36%	37%	39%
Rotterdam	20%	25%	28%	29%	28%	28%	29%
Zeebrugge	33%	46%	48%	48%	45%	47%	48%

Containerisation also affected ports worldwide. We could even argue that containers are the most important type of cargo in seaports. Most of the worldwide port expansion projects are related to the development of additional container terminals (e.g. Maasvlakte 2 in Rotterdam, JadeWeserPort in Bremen, London Gateway). Table 1.2 gives the container throughput as a share of total throughput in six important Northwest European ports from 2000 onwards. While in the port of Hamburg, containers account for roughly two-thirds of the total throughput from 2000 onward, in the ports of Antwerp the share container throughput of the total share increased from 36% in 2000 to 56% in 2012. In the port of Rotterdam the share of containers is relatively small, but has also seen an increase from 20% in 2000 till 29% in

2014. In absolute terms, the port of Rotterdam is the largest container port in Europe (see Table 1.3). In 2014 more than 12 million TEU[1] was handled in the port of Rotterdam.

Table 1.3 Top 20 world container ports (ranking based on 2014; millions of TEU)
(Source: several port authorities, via Port of Rotterdam, 2015)

Rank	Port	Country	2009	2010	2011	2012	2013	2014
1	Shanghai	China	25,0	29,1	31,7	32,5	33,6	35,3
2	Singapore	Singapore	25,9	28,4	29,9	31,6	32,6	33,9
3	Shenzhen	China	18,3	22,5	22,6	22,9	23,3	24,0
4	Hongkong	China	21,0	23,7	24,2	23,1	22,5	22,2
5	Ningbo	China	10,5	13,1	14,7	16,8	17,4	19,5
6	Busan	South Korea	12,0	14,2	16,2	17,0	17,7	18,7
7	Guangzhou	China	11,2	12,6	14,4	14,7	15,3	16,6
8	Qingdao	China	10,3	12,0	13,0	14,5	15,5	16,6
9	Dubai	Unit.	11,1	11,6	13,0	13,3	13,6	15,2
10	Tianjin	China	8,7	10,1	11,5	12,3	13,0	14,1
11	Rotterdam	Netherlands	9,7	11,1	11,9	11,9	11,6	12,3
14	Port Klang	Malaysia	7,3	8,9	9,6	10,0	10,4	10,9
15	Kaohsiung	Taiwan	8,6	9,2	9,6	9,8	9,9	10,6
16	Dalian	China	4,6	5,2	6,4	8,1	10,0	10,1
17	Hamburg	Germany	7,0	7,9	9,0	8,8	9,3	9,7
18	Antwerp	Belgium	7,3	8,5	8,7	8,6	8,6	9,0
19	Xiamen	China	4,7	5,8	6,5	7,2	8,0	8,6
20	Tanjung	Malaysia	6,0	6,5	7,5	7,7	7,6	8,5

Nine of the 20 largest container ports can be found in China. These ports also show enormous growth rates in the last years. In 2010, Shanghai took over the title of the world's largest container port from Singapore with a throughput of 29.1 million TEUs. None of the three largest European container ports can be found in the list of the 10 largest container ports. Rotterdam takes the 11th place, while Hamburg and Antwerp take, respectively the 17th and 18th place in the world ranking of container ports.

…port competition has become fierce,
In analysing competition between container ports it is important to clarify the port's customers and the concept of so-called hinterlands. There are three different customers that select a port: the shipping line, the forwarder and the shipper. In general, ports compete for attracting cargo at two levels. First, they compete in attracting ships to the port. At this level of competition shipping lines are the customers of the port. They choose a service schedule for their ships and include a limited number of ports; ports compete to be included in this schedule. Second, ports compete to attract cargo to their port. At this level of competition the forwarder and the shipper are also customers of the port. Even when ports are included in the

[1] TEU = Twenty-foot Equivalent Unit a standard measure used for capacity in container transportation

schedule of shipping lines it does not mean that cargo is loaded or unloaded in this port. Cargo will only be handled in the port if the cargo originated from, or is destined for hinterlands[2]. Hinterlands were first analysed by Sargent (1938). He described hinterlands broadly as 'the areas ports serve'. Morgan (1952) and Weigend (1956) note that this definition is inadequate; a port has a great number of hinterlands. The structure and areal extent of each varies. Already in 1951, Morgan made a distinction between primary hinterlands, the area where the port is exclusively well established, and secondary hinterlands, the area with rivalry among ports. Morgan's distinction is relevant in the more recently used distinction between captive and contestable hinterlands (e.g. Slack, 1993). The region for which a port is geographically well-positioned, and has a competitive advantage because of lower generalized transport costs, belongs to the captive hinterland. The contestable hinterland covers all regions where no single port has a significant cost advantage (De Langen, 2007). The hinterland of ports and the level of port competition differ substantially per type of cargo. In the container market port competition is fiercer than for the other cargo commodities such as dry or liquid bulk. As stated by Slack (1993: 581) 'no longer can container ports expect to attract shipping lines because they are natural gateway to rich hinterlands'. In other words: in container transport there is a large 'contestable hinterland'. This large contestable hinterland can be explained by the fact that containerised cargo involves many origins and destinations that can be reached from different ports. Moreover, an explanation can be found in the relatively low switching cost, being the extra costs made by shipping lines, forwarders and shippers caused by changing from one port to another.[3]

…and puts pressure on the use of scarce hinterland infrastructure.

The introduction of the container was born out of the need to reduce the costs related to labour regarding handling and time. Containers facilitated the physical movements of freight across many transport modes (Mahoney, 1985). The container is a feature of the infrastructure networks of road, inland shipping, and rail. As stated above, containerisation increased international trade; and with this success the increase of containers put direct pressure on the use of port-related infrastructure networks of road, inland waterway and railway transport. In almost every seaport, road transport plays a primary role in reaching the origins and destinations in the hinterland. Both road, inland waterway and railway transport have negative side effects or external costs such as emissions, air pollution, accidents and noise[4].

[2] It is remarkable that in the literature on ports and maritime networks always the Germanism hinterland is used. Whereas foreland is used to express the land areas lying on the seaward side of a port and with which the port is connected by ocean carriers (see e.g. Weigend, 1958), the word inland is not used to express the area a port serves on the other side. Chisholm (1888) transcribed the German word hinterland, as hinderland, and used it to refer to the backcountry of a single port or seaboard. According to Chisholm the word hinterland was first introduced about 1884 in connection with discussion on the occupation of part of the West African Coast. The use of hinterland, in the same context, gained more widespread acceptance by the early 20th century.

[3] It is important to mention that the costs for switching container cargo between ports are low, but friction impedes immediate switching. De Langen (2007), shows that the opening of the Rhine-Main-Donau canal considerably improved the competitive position of the ports of Rotterdam and Antwerp. The increase of market share of both container ports took a whole decade.

[4] Although road transport has made some major reductions in the emission of NOx and PM emission by introducing motors according Euro 4 and 5 standards in recent years, it still has the highest amount of external cost per ton-kilometer. The average external cost for container transport by road is 2,01 eurocent per ton-kilometer. For container barging and rail transport of container this is respectively 0,27 and 1,13 eurocent per ton-kilometer (CE Delft et al., 2011 as cited in BVB, 2013).

Having efficient hinterland connections is an important determinant of port competition.
Table 1.4 provides an overview of the most important factors in port choices from the literature reviewed. Many studies show that having good physical infrastructural access to the hinterland, the availability of transport services, and a good degree of coordination between all the actors involved in port-related transport, are required to be successful in port competition.

Table 1.4 Port selection criteria (compiled by author)

Author	Port client/actor	Port selection criteria
Slack (1985)	Shippers/forwarders	Number of sailings, freight rates, congestion and intermodal links
Nir et al (2003)	Shipper	Travel time between port and company, travel cost, number of available routes and frequency of services
Lirn et al. (2004)	Shipping line	Physical infrastructure, geographical location, port administration, service to deep-sea vessels (port turnaround time) carrier's cost
De Langen (2007)	Forwarders/shippers	Location of port, efficiency of cargo handling, quality terminal operating companies, quality of equipment, quality of shipping services (frequency, first port of call), information services in port, good reputation related to damage and delays, customer focus, connection to hinterland modes, personal contacts in port
Tongzon (2009)	Forwarders	Frequency ship calls, port efficiency, adequate infrastructure, location, port charges, quick response to port users' needs reputation for cargo damage
Wiegmans et al. (2008)	Shipping lines	Availability of hinterland connections, tariffs, immediacy of consumer (large hinterland), feeder connectivity, and environmental

The large attention for the hinterland part of the container transport chain is not surprising. Port-related transport chains are the most vital areas left to cut costs. According to Notteboom and Winkelmans (2001), the portion of inland costs in the total costs of container shipping ranges from 40% to 80%. Stopford (2002) shows that inland transportation, including port costs, accounts for about 54%. Other costs include the costs for deep-sea shipping (23%), which includes operating expenses, capital costs and bunker fuel, the cost for the container itself (18%) including leasing and maintenance costs and 13% for repositioning the empty container. Another point is that having efficient hinterland connections is not only important for attracting more cargo (and ships), but also an important location factor for port-related activities in logistics (e.g. Distribution Centers) and industrial activities. The emphasis on efficient hinterland chains is also reflected in many port strategy documents written by port

authorities. For example, the Port of Rotterdam authority (2011: 5) states: 'in 2030, Rotterdam is the leading European hub for global and intra-European cargo flows. The Global Hub for containers, fuel and energy. Rotterdam forms an integrated network with the hinterland. Rotterdam is leading in sustainable and efficient chains.' According to the port development plan of the port of Hamburg (2012:7) 'reliable infrastructure at the quay wall, in the port and hinterland as well as intermodal, optimized transport chains will ensure the success of the port'.

A similar strategy can be found in the strategy document of the port of Long Beach (2009) where promoting and developing safe and efficient transport systems and implementing solutions for regional port infrastructure needs are important elements. Also in the 2040 Master Plan of the port of Virginia (Virginia Port Authority, 2008) hinterland access is an important issue. Virginia was the first port along the U.S. east coast to extend its reach towards the hinterland through the development of the Virginia Inland Port in 1989. The 2040 Master Plan included plans to expand this inland port and develop additional inland locations. Also in Asian ports inland transport receives attention and is part of port's strategies. For example, the master plan of the port of Hong Kong, the most favourable entry port of South China, a strategy is also proposed to improve boundary-crossing truck transport, and reduce inland transport costs from and to Hong Kong (GHK, 2002).

However, coordination does not always develop spontaneously and needs to be arranged
From above it can be concluded that the container – initially developed as a mean to make the sea-land transfer more efficient, increased the need for a more efficient use of port-related transport chains and increased the attention on port accessibility. This thesis builds on the work of De Langen (2004) who argued that coordination between actors in the port-related transport chains is required, but does not always develop spontaneously. The first step in analysing hinterland access from an inter-organisational perspective was taken by De Langen & Chouly (2004). They introduced the concept of Hinterland Access Regimes (HARs), defined as 'the set of collaborative initiatives, taken by the relevant actors in the port cluster with the aim to improve the quality of the hinterland access' (De Langen & Chouly, 2004: 363). Their work stressed the importance of approaching accessibility of ports from an inter-organisational standpoint as hinterland access depends on the behavior of a large variety of actors and inter-organisational arrangements are necessary to improve port-related transport.

Figure 1.1 provides an overview of the variety of actors in the transport chain of maritime containers. The transport chain consists of several actors such as the container shipping line, the deep-sea terminal operator, the inland terminal operator, transport companies, and the shipper. Each companies has a different set of activities and different business interests. For example, deep-sea terminal operators are mainly interested in optimizing the terminal efficiency at the sea-side. Transport companies are driven by an optimal use of their assets (ships, locomotives and wagons, and trucks). Shippers, the end-user of port-related transport, are mainly driven by reliability and sustainability.

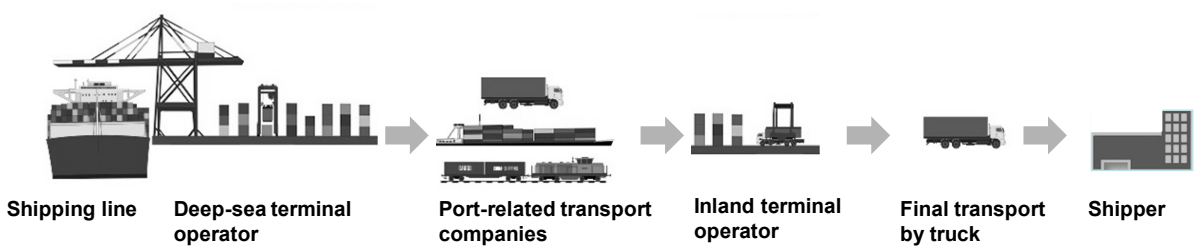

Figure 1.1 Actors is the transport chain of maritime containers

Because coordination amongst actors in port-related container transport chains is needed, different parties, both private and public, are active in improving the efficiency of port-related transport chains. Many initiatives to coordinate activities in hinterland chains (in this research called coordination arrangements) have been undertaken. Figure 1.2 gives a snapshot of some initiatives that have been taken in the port of Rotterdam.

Figure 1.2 Article excerpts from business magazines on coordination initiatives

Truck load match (ECT, 2009)
Under the name Truck Load Match Rotterdam, five Dutch road transporters have jointly set up a company aimed at minimizing the number of empty trips. Using the computerized planning system PARIS, they are able to reduce the number of empty kilometers by 30 percent (...).

Pilot Chain Management Port Railway Line increases capacity (Port of Rotterdam, 2010)
(...) In view of the volumes which will be coming our way in the future – especially after Maasvlakte 2 becomes operational – the handling of container trains in Rotterdam must run like a Swiss clock." About two years ago, Keyrail was therefore requested by all relevant parties to assume the role of chain director and tackle the bottlenecks present on the Rotterdam section of the Betuweroute, the so-called Port Railway Line. (...) "All we have done in the pilot Chain Management is clearly describe the things that should be done to ensure an effective and transparent rail process," (...) "This means basically: timely provision of information and good communications to effectively handle trains, both under normal conditions and in the case of any deviations; unfortunately, it is impossible to fully rule out the latter.

Nextlogic enters new phase (Binnenvaartkrant, 2015)
(…)On behalf of Nextlogic, the Rotterdam Port Authority has signed the contract with Quintiq to build the intelligent planning tool BREIN. (..) An important objective of Nextlogic is to align supply and demand of handling capacity of container barges. From 2017 the planning tool BREIN intends to allocate terminal and depot slots in the port on a neutral basis, makes a neutral planning, and allows for up-to-date changes.

1.2 Research goal

From the previous section, it becomes clear that studying coordination in hinterland chains is a relevant issue. Different coordination problems exist for different reasons. As a response, different actors (both public and private) undertake coordination arrangements to solve coordination problems. The goal of this thesis is to advance our understanding on how public and private actors in port-related transport chains improve coordination. The core of the dissertation consists of five articles that are published (or forthcoming) in different peer-reviewed journals[5]. The articles are connected and held together by an overarching theme (coordination in hinterland chains) and a theoretical lens (inter-organisational theories starting from Institutional Economics). Therefore, this thesis wants to contribute to our knowledge in two ways. Firstly, this thesis will contribute to the theoretical knowledge on coordination in hinterland chains, within the field of port economics, management and policy, by applying insights from inter-organisational theories starting from Institutional Economics. Secondly, from this thesis, recommendations can be made for actors involved in improving coordination in port-related transport chains.

1.3 Port and hinterland transport studies: the research domain

Ports and hinterland transport have gained more and more attention as a research topic for scholars. Bibliographic and content research of seaport journal papers by Pallis et al. (2010a and 2010b) shows that the number of publications on ports is increasing: from 1997 until 2008, 395 journal papers divided amongst 7 research categories were published (see table 1.5). Most of the papers were published on port competition and competiveness. Port policy and regulation is the second most popular research theme. The subject of this thesis belongs to the category ‘ports in transport and supply chains’. The academic interest for this subject has grown from 1997 until 2008 with the amount of papers quadrupling in this period. The growth of this research category can be explained by a stronger focus on supply and value chains, instead of specific parts of the chain. The adoption of the claim that ‘the whole can be greater than the sum of its parts’ has been widely quoted in ‘standard’ logistics textbooks from the early 1990s (see e.g. Christopher (1992)). In port studies research, one of the most cited articles of Robinson (2002) deals with the role of ports in supply chain systems and value chain constellations. This is given through a new environment that can be characterized by globalization, containerisation, and exceptional fluidity and competitiveness of the business environment.

[5] In principle, the chapters can be read as standalone articles which will have some overlap between them.

Table 1.5 Port studies 1997-2008 (Source: Pallis et al., 2010a)

Research category	1997-2001	2002-2006	2007-2008	Total
1. Terminal studies	8	22	10	**40**
2. Port in transport and supply chains	14	20	22	**56**
3. Port governance	23	23	15	**61**
4. Port planning and development	23	24	10	**57**
5. Port policy and regulation	24	24	19	**67**
6. Port competition and competitiveness	9	43	22	**74**
7. Spatial analysis of seaports	14	15	11	**40**
Total	**115**	**171**	**109**	**395**

Pallis et al. (2010a and 2010b) conclude that research in port economics and management and policy is still in its pre-paradigmatic phase. Although the port research community is rapidly growing, the community is localised. Research papers often deal with a specific local port topic. The affiliation of the author strongly influences the empirical material. Having a port in the 'university's backyard' is seen as an advantage. Pallis et al (2010a and 2010b) show that 70% of the papers that deal with a specific port have been written by researchers from the country where that port is located. On the other hand, this causes the existence of relatively small research community, each working on their own problems and a lack of international collaboration; a characteristic of the pre-paradigmatic phase. Furthermore, the research can be characterised as concentrated: 26% of the 395 papers were published in the journal Maritime Policy and Management and 23% in the Journal of Maritime Economics and Logistics. Both journals are affiliated with the International Association of Maritime Economists. This also holds for the research category 'Port in transport and supply chains'; 27 of the 56 articles have been published in the two aforementioned journals. Besides being localised, small and concentrated, the present port research community can be characterized by a lack of data and the use of a wide variety of research methods, theories and concepts.

The use of a wide variety of research approaches and theoretical lenses is shown in the relation between theory and the research subject (Woo et al., 2011)[6]. Between 1980 and 2009deductive research was adopted in 58% of the cases and an inductive approach in 42%. The latter grew from 7.5% in the 1990's to 28% in 2000 and even further to 42% in 2009. With regard to the theoretical lenses used, three disciplines dominated in port studies, namely economics (31.5%), geography (15.7%) and operations research (16.3%). Woo et al. (2011) notice that in 18.8% of the papers were written with eleven other theoretical approaches like strategic management, logistics, organisational studies, and public administration and that in 17.7% of the cases the theoretical lens was not recognizable. Woo et al. (2011) suggest that for the further theoretical development of the research field Port Economics, Management and Policy more application and adoption of methods, theories and concepts from other disciplines is needed. This opinion is shared in the specific field of logistics and supply chain management. Stock (1997:515) state: 'compared to older and more established academic disciplines (...), 'logistics does not have a rich heritage of theory development and empirical

[6] Pallis et al. (2010a) studied a data set of papers from twelve years (1997-2008). Woo et al. (2011) studied trends and themes in seaport research over a longer period, namely from 1980 till 2000.

research'. Woo et al. (2011) argue that, for a young research field, theories from other disciplines can be borrowed, including economics, management, political science and sociology. In addition, Halldorsson et al. (2005) claim that in order to understand coordination arrangements in logistics chains, several theoretical approaches are needed in combination with each other. According to these authors inter-organisational theories like Transaction Cost Economics, Network Perspective, and the Resource-Based View are valuable. The same position is taken by Arshinder and Deshmukh (2008) who classified the literature on supply chain coordination and emphasized the efforts that have been made in using various perspectives and conceptual models. However, it appears that the study of coordination is still in its infancy; 'there is a need to embrace a variety of perspectives on supply chain coordination issues and the means and mechanism to achieve coordination in a holistic manner' (Arshinder and Deshmukh, 2008: p.320). The bibliographic and content research of Woo et al (2011: p.673) also concludes that, 'port research can be seen as a body of knowledge without firm theoretical bases or without original theories. An increasing diversity of adopting and borrowing theories and models observed in the 2000s is a good sign, showing possibilities of not only more involvement of the borrowed theories, but also a mixture or combination among them, which is suggested to better address more complicated research problems'. This thesis aims to contribute to the development of such a more multi-disciplinary research paradigm.

1.4 Research philosophy

In this section, the research philosophy will be discussed. We will shortly review different research paradigms or worldviews in research, followed by the discussion of the position of the research in this thesis. According to Guba and Lincoln (1994), a research paradigm can be defined as the basic belief system or world view (see Creswell, 2009, for the this type of wording) that guides the researcher[7]. A research paradigm deals both with ontological questions about what is the form and nature of reality and, with epistemological questions about what can we know about that reality, what is knowledge, how is knowledge acquired and what is its structure and limits? A research paradigm is a set of beliefs that guides research actions. In general, two major and conflicting philosophical positions can be taken, the positivist paradigm and the constructivist paradigm (Guba and Lincoln, 1994; Creswell, 2009). Positivism has been and still is the dominant research paradigm in physical and social sciences. Positivism claims that scientific research is, in principle, able to generate objective knowledge about reality. The main goal of inquiry is explanation, ultimately enabling the prediction and possibly control of phenomena. This type of research is mainly characterized by the use of quantitative research methods[8], and by the application of a deductive approach. In other words, in a deductive research approach the starting point is a well-established set of theoretical assumptions from which hypotheses are formulated, mostly in the form of a

[7] Kuhn (1962) was the first who used the word paradigm in science. He defines paradigms as 'universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners' (Kuhn, 1962: viii). It tells the researcher about the underlying assumptions and intellectual structure upon which research and development in a field of inquiry is based.

[8] Guba and Lincoln (1994) state that quantitative research methods, with mathematics in its core, is often termed as the 'queen of sciences'. In their work, they criticize the supremacy of the 'received view' of science (positivism). They plea for a continuing dialogue between proponents of paradigms towards a more congenial relationship.

prediction. This is then followed by collecting empirical (often statistical) data that will confirm or rejects the hypotheses (Kovacs & Spens, 2005; Creswell, 2009). The nature of knowledge, as noted by Guba and Lincoln (1994), is verified hypotheses that can be accepted as facts or laws. If a model to test the theory does not lead to the same outcome every time, the model should be modified[9].

The constructivist paradigm stresses that knowledge is subjective: individuals develop meanings, and these meanings are varied and multiple, directing the researcher to look for the complexity of views. It aims at understanding and 'constructing' in a social, cultural, and economical way, real-life observations that actors hold, 'aiming towards consensus but still open to new interpretations, as information and sophistication improve' (Guba and Lincoln, 1994:113). So, knowledge consists of constructions of real-life observations about which there is consensus in the scientific community. The constructs are continuously subject to revision where the researcher interacts with the civil and research community. The researcher generates meanings from the data collected in the field in a largely inductive way by using qualitative or mixed research methods like interviewing, desk research, text analysis, case studies (Creswell, 2009). Table 1.6 provides an overview of the two paradigms. The table is helpful to identify and to explain orientation of our research[10].

Table 1.6 Two conflicting research orientations (Source: Creswell, 2009; Guba and Lincoln, 1994; Van Tulder, 2012; adapted by author)

Positivism	**Constructivism**
Explanation: prediction and control	Understanding; reconstructions
Deductive	Inductive
Survey, statistical analysis	(New) real-life observations; case study
Large number of observations	Small number of observations
Conclusive	Explorative

The aim of this thesis is to enhance the understanding on how public and private actors improve coordination in port-related transport chains. It aims primarily at understanding real-life observations of phenomena. Moreover, as became clear from the previous section, research on the role of ports and port-related transport chains is emerging. The research so far is mainly done by a 'young' academic community, based on mainly 'local' port studies by using a variety of research methods and theories. The research is explorative and undertaken by researchers that want to get grip - or want to understand better - existing and new often unique phenomena into a particular area of research (Van Tulder, 2012). Exploration aims at building new theories in the event that you have many observations of phenomena, but no

[9] Since the middle part of the 20th century, a shift took place away from positivism into post-positivism. In contrast with positivism, post-positivism aims at falsifying a-priory hypotheses, instead of verifying it. By doing so, non-falsified hypothesis can be regarded as 'probable' facts or laws. Post- positivism recognizes that we can only imperfectly and probabilistically know reality.

[10] We acknowledge that there exist many other views on research paradigms, like critical theory, (Guba and Lincoln, 1994), pragmatism and the advocacy or participatory worldview (Creswell, 2009).The presentation of two 'extreme' views is chosen for reasons of clarification (see also Van Tulder, 2007). As noted by Van Tulder (2007) it does not mean that each of the strategies under one research orientation is exclusively related to that orientation (e.g. constructivist's scholars only do inductive research with a small number of case studies).

good explanation (Creswell, 2009, Van Tulder, 2012). Because the research in this thesis is part of the 'young' domain in which no mature theories exists, it is largely explorative and can be best characterized as belonging to the constructivist paradigm.

Primarily, in constructivism the explorative approach starts from real-life observations of phenomena (step 1) and tries to build form there a more general framework (step 2). It is then suggested that the first step is taken with a blank mind-set in which no theoretical constructs guide the researcher view. It can be questioned to what extent the starting point consists exclusively of real-life observations of phenomena. Strictly speaking, this inductive research argues that prior knowledge of a general framework or theory is not necessary (Andreewksy and Bourcier, 2000); only observations will lead to emerging propositions and generalizations in a theoretical framework. In this thesis we recognize and accept the impact of the researcher's own background, experience and theoretical knowledge from prior research[11]. In addition, it is our belief that we cannot fully understand real-life phenomena as it "really" is, and the researcher's construction of the world can never be perfect. In that respect we follow Guba and Lincoln (1994: 107) stating that 'theory and facts are interdependent, real-life observations of phenomena are for the researcher already theory-laden'. In other words, before real-life observations of phenomena (step 1) and theoretical conclusions or a framework (step 2), there is a step 0, namely existing prior theoretical knowledge (Kovacs and Spence, 2005).

In addition, given the theory-ladenness of observations, we discuss below first that theory and the empirical work evolve simultaneously and second that multiple theories can co-exist. The interplay between theory and empirical observation is what Dubois and Gadde, (2002) call 'systematic combining', which is connected to 'grounded theory' (e.g. Strauss and Corbin, 1998), in which theory is systematically constructed from empirical data, using multiple stages of data collection. Additionally, Diesing (1972) stresses the importance of a process with interaction or iteration between theory and empirical observations. He also stresses the importance of the researcher's background and the fact that during the research new data is constantly coming in. Diesing (1972) speaks about 'patterns of discovery' which we see in the approach to research. From this scope research is then fundamentally a process of exploration, theory building, testing, new data and findings, new theory, etc. instead of a positivistic linear road towards revealing the truth about objective facts and laws.

Secondly, we acknowledge that multiple theories can co-exist (see Guba and Lincoln, 1994, in their discussion on the constructivism). We interpret 'theory' as approaches offered to understand better empirical observations. Its main value is about the heuristic value: the ability to ask the right question and understand observations in a systematic manner (Van Tulder, 2012).

The co-existence of multiple theories is guided by the idea that a deeper understanding of real-life phenomena can be enhanced by using different theories instead of one. Combining different perspectives would result in a many-sided picture of the phenomena and

[11] In this respect it is good to mention that the articles have been written in connection to several research projects at the department Regional Economics, Port and Transport Economics, Erasmus University Rotterdam. In section 1.6 we make the connection between these projects and the articles.

consequently to a better multi-dimensional understanding of it. This theoretical pluralism accepts a plurality of theories, based on the idea that a single theory always gives a partial account (Groenewegen and Vromen, 1996). An important assumption here is that theories do not contradict each other, but are complementary. Groenewegen and Vromen (1996) discuss how complementarity can be based on the different research questions the different theories address ('different theories for different issues'), or on the different conditions that different theories assume to exist in the reality they study ('different theories for different conditions'). The former can be illustrated in economics where theories that address comparative static issues can be considered complementary to theories that ask question about the dynamics of economic phenomena. The latter can be illustrated in economics by theories that assume a workable competition in the market that is investigated and theories that assume a monopoly or collusion.

1.5 Chapter overview: research design and contruction of framework

This dissertation consists of five articles preceded by an introductory chapter and followed by a concluding chapter. In this section, every article will be introduced discussing the motivation, research objectives and research methods. This overview is summarized in table 1.7. In the course of this section, we give a description on how a research framework to study coordination in hinterland chains could be constructed. The framework is helpful in identifying the main focus of the different chapters and to gain a better understanding of how coordination issues in port-related transport chains could be systematically explored. Finally, we will discuss the issue of validity and triangulation.

Article 1: Identification of coordination problems and arrangements (Chapter 2)
The starting point of the first article (Van der Horst & De Langen, 2008 and 2015) is threefold. First, it states that many different actors benefit from efficient hinterland transport chains, and that efficient hinterland transport chains are one of the most important determinants in container port competition nowadays. Moreover, creating effective hinterland transport chains requires the coordination of all these actors; it does not come about spontaneously. Thirdly, the article states that limited research has been done from an inter-organisational perspective.

The goal of this article is to identify coordination problems and coordination arrangements. Two research steps are conducted. First, desk research has been conducted through scanning research reports, industry magazines and journals. From the 1990s till 2007 relevant news items on coordination problems and initiatives to improve coordination in port-related transport chains were stored in a database. Second, expert interviews were held with managers in the hinterland transport chain. The interviews led to modifications of the list of coordination problems derived from the desk research. The result is an overview of the most relevant coordination problems in hinterland chains and a database with 76 coordination arrangements. In the empirical part, the article analyses a large number of coordination arrangements in container barging to and from the port of Rotterdam.

Table 1.7 Overview thesis: motivation, objectives and methods

Motivation	Main research objective	Main research methods
Ch.2 Identification of coordination problems and coordination arrangements		
State relevance of studying the topic from an organisational perspective and structure the research by identifying coordination problems and arrangements in port of Rotterdam	To enhance the body of knowledge of coordination issues in port-related transport chains on a empirical basis and propose a typology as a starting point of constructing a framework to analyze coordination in hinterland chains	Literature review, interviews, desk research, building data base, review multiple cases
Ch.3 Further examination of coordination problems and coordination arrangements		
Need to further explore coordination arrangements in port of Rotterdam, by whom and under what conditions.	To identify a set of variables related to the complexity of the transaction and the coordination arrangements. To find causalities between variables in order to improve understanding of coordination arrangements	Literature review, systematic analysis of multiple cases from data
Ch.4 Change of scope by shipping lines and terminal operating companies		
Further theoretical exploration of one type of coordination (changing scope) by shipping lines and terminal operators, and extend the analysis to other European ports	To improve understanding why and how shipping lines and terminal operators enlarge their scope in intermodal transport services and inland terminals by using Transaction Cost Economics and Resource Based View	Interviews, literature review and case study review
Ch.5 Effect of liberalization on coordination in railway chains		
Include the role of the institutional environment and dynamics in the analysis of coordination. Apply this to the liberalized railway sector in the port of Rotterdam.	To use a framework from institutional economics to analyze the effect of liberalization on coordination in the railway in ports, and by utilizing empirical illustrations to adapt the original framework	Literature review and case study review
Ch.6 A multidisciplinary analysis behind coordination problems in container barging		
Explore further the arguments why coordination problem exists. Apply this to container barging in the port Rotterdam, a sector that despite favorable conditions hardly grows.	To provide a multidisciplinary study of context factors that may hinder or stimulate a better performance of inland waterway transport of containers in the future.	Single case study: interviews, apply theoretical framework, review by expert groups

Next to these two goals, the work in the first article can be seen as the first step towards a pluralistic framework of understanding how actors in hinterland chains improve coordination, although, the framework (Figure 1.3) is not explicitly presented in the chapter itself. A framework will help in providing a set of explanatory variables, their linkages and a list of attributes that are of importance to understand efficient coordination in port-related transport chains.

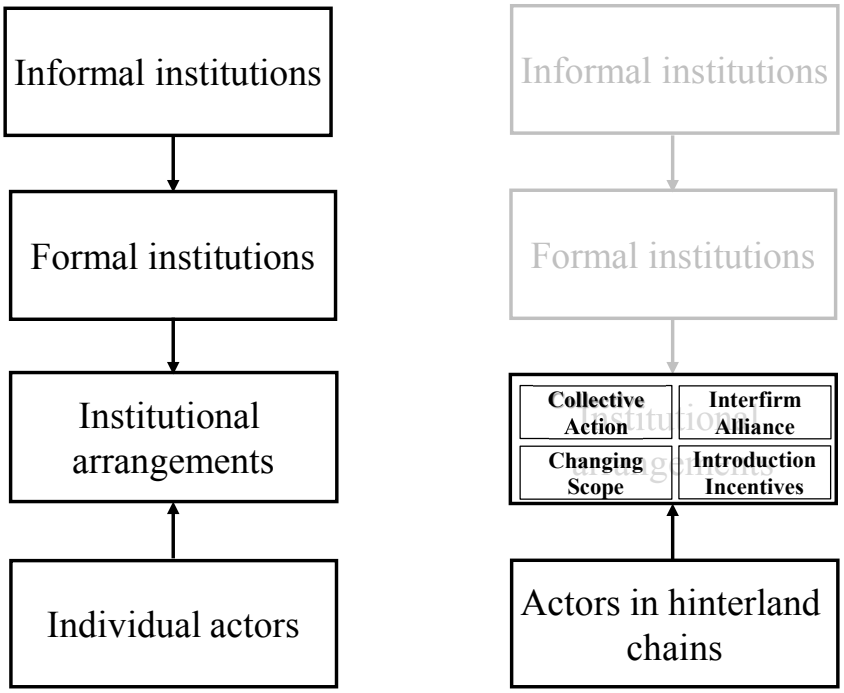

Figure 1.3 Four layer model and focus of 1st article (Source: adapted from Williamson, 1996, 1998)

From an economic point view, we are interested in efficient coordination in port-related transport chains. In the context of the thesis, coordination can be defined as managing interdependent activities between two or more actors with a great deal of operational interdependence to achieve good hinterland accessibility as a collective result[12]. For the developed framework, considerations of New Institutional Economics (NIE) formed the starting point.

In this respect, New Institutional Economics is relevant because it is concerned with studying the efficiency of different modes of governance, or institutional arrangements, or –using the 'wording' in the first article - coordination arrangements[13]. In the world of NIE, individual actors aim at minimizing transaction costs in a setting of bounded rationality and opportunistic behaviour. In this thesis the framework of Williamson (Figure 1.3) with four levels of analysis serves as the starting point. The layers are interrelated in accordance with a certain logic (lower levels cohere with higher levels). Each level is related to a (hypothetical) time period of change.

At the fourth level, we position the actors in port-related transport chains, like container shipping lines, deep-sea terminal operators, inland terminal operators, transport companies, and shippers. All of these actors interact with one another and have different objectives, strategies and power base. The article shows that actors in hinterland chains can have strategic considerations to not invest in better coordination. Besides risk-averse behaviour and a short

[12] This definition is based on the work of Malone & Crowston (1994), and first introduced in chapter 3 of this thesis.
[13] We interpret 'institutional arrangements' and 'modes of governance' as synonyms. In the remainder of the thesis, we use to a large extent 'coordination arrangements'.

term focus, firms in hinterlands chains cannot deal well with the collection and distribution of collective cost and benefits of coordination. The third level is where the 'play of the game' takes place, the core of the first article. Based on 76 cases or "real-life observations" that we discovered in our investigations and inspired by Transaction Cost Economics (TCE), Property Rights (Demsetz, 1967) and Collective Action theory (Olson, 1971) four main categories of coordination arrangements are derived, namely: the introduction of incentives, the creation of an interfirm alliance, changing the scope of the organization, and collective action. Periods of change are quite short: coordination arrangements are initiated or changed between every 1 to 10 years.

Level 1 refers to informal institutions—broad beliefs, values and norms—that influence the behaviour of economic actors. These informal institutions are assumed to be deeply rooted in society and only change over a very long period (according to Williamson, between 100 and 1000 years). Where level 1 focuses on the level of 'embeddedness', referring to economic and social behaviour of actors, level 2 refers to formal or the legal embeddedness. Here, 'the laws regarding property rights – their definition and enforcement – are prominently featured' (Williamson, 1998: 27). Periods of change at this level are between 10 and 100 years. The connection between the layers in the framework is that higher levels constrain the lower level. So, the informal institutions constrain the formal ones and the formal institutions set limitations for the coordination arrangements at level 3.

Layer 1 and 2 are not explicitly part of the analysis in the first article, but are assumed to be given. We are not looking yet between the interaction the (in)formal institutional environment and the coordination arrangements and actors, at respectively layer 3 and 4.Coordination arrangements and actors are studied isolated from the (in)formal institutional environment in the first article[14.] As previously stated, the framework is inspired by the work of Williamson, but it differs from his original Transaction Cost Economics approach. First, the actors are included in the framework along with their strategies as described above. Second, the main categories of coordination arrangements go 'beyond' transaction cost economics and are extended with Theory on Collective Action and Property Rights. As can be seen in the remainder of this section, the framework will give room for extensions and adaptions.

Article 2: Further examination of coordination problems and arrangements (Chapter 3)
The second article (Van der Horst & Van der Lugt, 2011) takes the exploration into port-related coordination issues a step further. In the article, a set of variables is explicated in order to understand when, by whom, and under which conditions and situations coordination arrangements are chosen. The research presented in this article builds on the database and typology of the first article. Three research steps are taken. First, the database with coordination arrangements is extended to 91 coordination arrangements. Second, literature is reviewed in order to select the variables. The choice and operationalization of the variables is based on TCE and the work of Gulati and Singh (1998) by considering the characteristics of

[14] Following North (1990) that institutions are the underlying *rules of the game* and can be divided in formal and informal institutions. In terms of the four layer model North makes a crucial distinction between institutions (layer 1 and 2) and market organization, firms and other institutional arrangements (layer 3). In our research we include market organizations, firms and other institutional arrangements as a form of institution.

the transaction from both an appropriation perspective and an operational coordination perspective. Thirdly, the key characteristics related to the complexity of the transaction and to the coordination arrangements chosen to improve hinterland accessibility, are formulated.

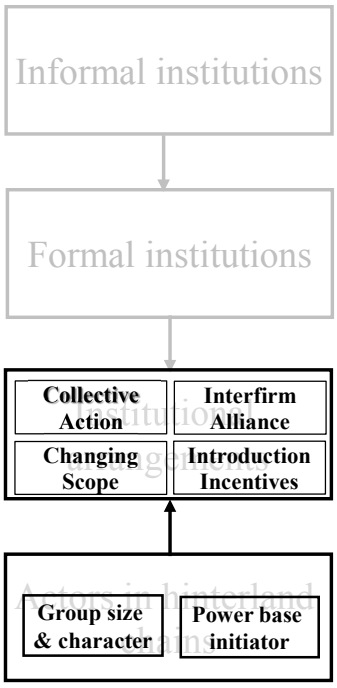

Figure 1.4 Layer model and focus 2nd article

The article specifies, attributes related to the type of interdependency and complexity of transaction and coordination arrangements present in trucking, railway transport, and inland waterway transport. The following characteristics are analyzed: which coordination problem is to be solved, how many actors are involved, is the group homogenous or heterogeneous, what are the functions of the actors involved, what is the function of the initiator as well as their power base to the actors involved, and finally has use been made of information and communication technology. In terms of the framework (Figure 1.4) the focus is on coordination arrangements at layer 3 and actor's attributes at the 4th layer. We include the power relationship of the initiator to the other actors involved in a coordination arrangement.

Article 3: Change of scope by shipping lines and terminal operating companies (Chapter 4)

The next article (Franc & Van der Horst, 2010) aims at developing the category, 'changing of scope' further (see Figure 1.5). It focuses on two actors, namely shipping lines and terminal operating companies, and aims at understanding why and how they enlarge their scope in intermodal transport services and inland terminals. The article reviews Transaction Cost Economics (Williamson 1985) and Resource-based View (amongst other Penrose, 1959; Wernerfelt, 1984; Barney, 2001); both are considered prominent contemporary approaches in Economics and Strategic Management to understand vertical integration.

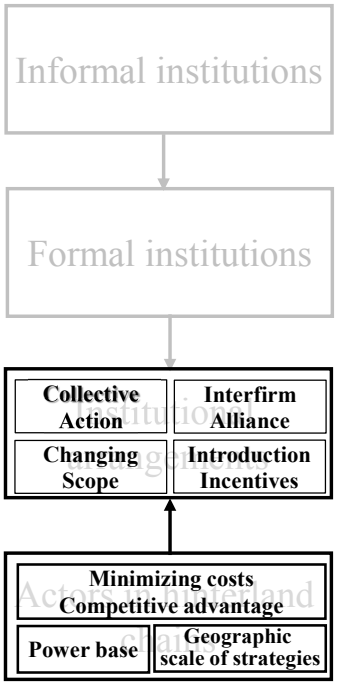

Figure 1.5 Layer model and focus 3rd article

Based on desk research and interviews held with managers of shipping lines and terminals, the article discusses a number of cases from the Hamburg–Le Havre range, where shipping lines and terminal operating companies have changed their scope of activities in ports and hinterland networks. After the theoretical and empirical analysis, the article discusses the explanatory power of the theories in understanding hinterland service integration by shipping lines and terminal operators. The article shows that both TCE and RBV make valuable contributions in studying vertical integration of shipping lines and deep-sea terminal operating companies as institutional arrangements to improve coordination in port-related transport chains. The fundamental principle of the Resource-based View (RBV) is that the basis for a competitive advantage of a firm primarily lies in the application of the bundle of valuable sources at the firm's disposal. In contrast to the TCE-approach where SLs and TOCs are cost minimizing actors, RBV assumes them as value creating actors who use strategic resources. Moreover, this study shows the need for taking into account not only the industry incentives to broaden scopes, but also the geographical scale origin of these industry incentives, origin, tradition as well as power of firms and the institutional environment

Article 4: Effect of liberalization on coordination in railway chains (Chapter 5)
The main motivation for the fourth study (Van der Horst & Van der Lugt, 2013) is to include the role of the formal institutional environment and dynamics in the analysis of coordination in hinterland chains. The study has been applied to coordination issues in the liberalized railway sector in the port of Rotterdam. The goal of the article is twofold. Firstly, it aims at discussing both the positive and negative effects of the liberalization of the European transport market on coordination within port-related railway chains. The liberalization can be seen as a major change in the formal institutional environment of the European transport market. The second goal is to review and to apply a conceptual framework originating from

Williamson's (1996) model of Transaction Cost Economics. This so-called three layer model will provide a core basis for the analysis of the effect that a liberalized institutional environment has had on the way actors in ports and in the railway hinterland chain deal with coordination issues. Whereas the empirical sections of the first two articles are based on a large number of coordination arrangements in the port of Rotterdam, this article contains only a few such cases. The cases illustrated that in addition to liberalization ('more market'), other coordination arrangements are necessary to enable an effective and efficient coordination of railway operations in ports.

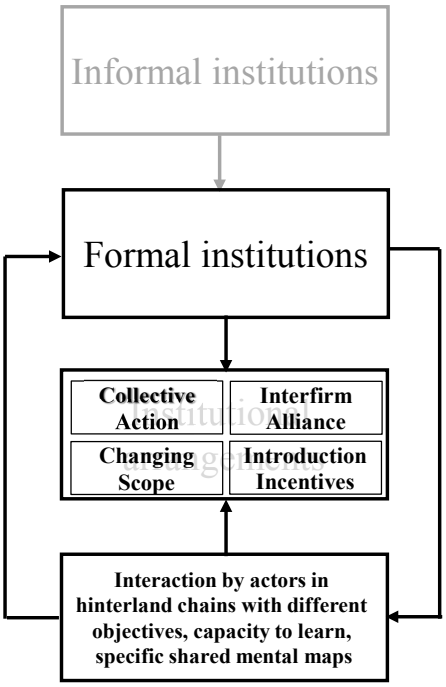

Figure 1.6 Layer model from 4th article

Based on the empirical findings, the initial TCE framework has been adapted towards a dynamic framework as presented in Figure 1.6. This framework was influenced by theory on the economic and institutional change (North, 2005) that can be seen as an extension of the TCE framework. In this framework, the institutional environment cannot only be seen as a constraint, but also be seen as an instrument, because it creates possibilities for coordinating behavior. Moreover, the article stresses the importance of including the issue of "adaptive efficiency" in the analysis, indicating the willingness to invest in skills and learning by doing, attitudes and perception, historical specificity (path dependency) and mental maps which influence all actors in the system.

Article 5: A multidisciplinary analysis behind coordination problems in container barging (Chapter 6)

The main motivation for the fifth article (Van der Horst & Kuipers, 2014 and 2015) is to further explore why coordination problems exist and why it seems difficult to solve coordination problems. It focuses not on how coordination is achieved, but on the underlying causes of the existence of coordination problems. The article builds on the first study where a

general set of reasons have been given as to why coordination problems exist in all hinterland transport markets (trucking, railway transport, and barging). With a single case study this article focuses on port-related container transport by barge in the port of Rotterdam. Although there is a need for sustainable transport and ambition to increase the share of container barging, it is stagnating. Four research steps have been taken. Firstly, 15 semi-structured interviews were held with actors from the industry, representatives of the industry association, as well as industry and academic experts. Secondly, the interviews were used to derive a set of subjects related to the reasons behind coordination problems in container barging as well as to find other, mainly secondary, data sources. Thirdly, desk research was executed, according to the structure of a developed theoretical framework.

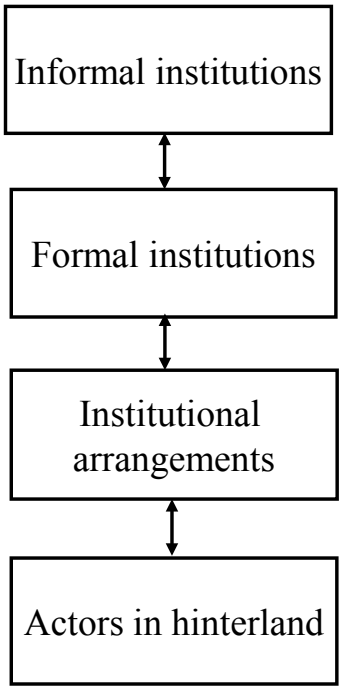

Figure 1.7 Layer model from 5th article

The aim of the article is to analyse possible causes that lie in the institutions (layer 1, 2, and 3) for the facts that actors in container barge deal with coordination problems with stagnating growth of container barging as a result. In this respect, we see institutions as constraints as well as instruments to provide a structure for human interaction that regulates the behaviour of actors. So from the behaviour of actors at layer 4 the result of the sector is stagnation. Because finding causes for this 'market reality' is the main purpose, we also consider the feedback arrows in the four level framework (see Figure 1.7). By doing so, the framework fits in the school of Original Institutional Economics. A central aspect herein is the interaction between the actors and the dynamics of institutions. The framework not only allows for the identification of different types of institutions, but also shows the degree of consistency ('logic') between the four layers. Institutions seem not to develop randomly, but the layers seem to be related according to a certain logic with a time period for change. Thirdly, the results of the desk research were presented in a workshop with the interviewees. The results

were modified and reviewed twice by an external committee. From the results some general conclusions are been derived regarding why it is difficult to solve coordination problems, and why the performance of container barging in Rotterdam is lagging behind, although there is a strong policy willingness to increase the share of this sector in the total modal split.

On validity and triangulation
As described in section 1.4, the research carried out in this dissertation is explorative and mainly qualitative acknowledging that knowledge consists of 'constructions'. Together with the argument that observations of real-life observations of phenomena are already theory-laden triangulation is important in this mainly qualitative 'process of inquiry' (Patton, 1987). Triangulation is about the application of different methods in order to investigate the same topic from different perspectives with the aim to have the findings of the one method being confirmed by the other. The four most common forms of triangulation according to Yin (2008) are applied in this thesis. The four types are methodological triangulation, data triangulation, theory triangulation and investigator triangulation.

Methodological triangulation deals with the use of more than one research method. Data triangulation refers to the use of multiple qualitative and/or quantitative research methods to gather and use data. Data in this thesis were gathered via numerous interviews, desk research (scanning business reports, studies, and industry magazines, journals, etc.), and workshops. A database has been developed to store data about coordination arrangement. Investigator triangulation refers to the use of different investigators in the data collection and analysis process. As will become clear in the next section, parts of this thesis have been co-authored by scholars of different disciplinary backgrounds (article 3 and 5). Furthermore, the articles included in this thesis were presented at different workshops and conferences in the field of Port Economics and Management and Economics of Infrastructure, including feedback from different perspectives. Finally, the four of the 5 articles (1-4) went through the peer-review process in the 'journey of publication' in scientific journals.

1.6 Declaration of contribution

This section describes the contribution of the author of this dissertation to the different articles, published as chapters in this dissertation. It also acknowledges the contribution of other researchers and parties in the research.

Chapter 1 has been written by the author. *Chapter 2, 3 and 4* were written in the context of the TRANSUMO-project ProAccess (2006-2012). TRANSUMO (TRANsition SUstainable MObility) was a Dutch platform for companies, governments and knowledge institutes that cooperated in the development of knowledge with regard to sustainable mobility. One of the main goals of ProAccess was to enhance the knowledge of hinterland accessibility. In this project the author worked together with prof. Dr. Peter de Langen (former Erasmus University Rotterdam (EUR), present Eindhoven University of Technology and dr. Larissa van der Lugt (EUR). The work in *Chapter 2* has been created in collaboration with Peter de Langen. Both held the expert interviews and developed the typology. The author was to a large extent responsible for the desk research and the empirical elements. The author presented earlier versions of the article at two conferences, namely: *Maritime Transport 2006*

Barcelona (Spain), and *International Association of Maritime Economists 2007* in Athens (Greece). The article benefitted from comments made by the anonymous reviewers from the *Journal of Maritime Economics and Logistics*. In 2015 the article was selected to be published in the book *Port Management* (Haralambides, 2015). For the 2015 publication both authors made some permitted amendments in mainly the empirical part of the article.

Chapter 3 has been written with Larissa van der Lugt. The literature review, selection and operationalization of the variables have been conducted by both authors. The database with coordination arrangements has been extended by the author. The author was mainly responsible for the empirical analysis, interpretation of the findings, and the writing of the article. The author of this thesis is the first author. The article benefitted from discussions at the conference of the *International Association of Maritime Economists 2010* in Lisbon (Portugal), and from comments of anonymous reviewers of *Maritime Policy & Management.*
The research for *Chapter 4* was done alongside Dr. Pierre France (INRETS, Paris) who visited the department of Regional Economics, Port and Transport Economics (Erasmus University Rotterdam). Both authors contributed equally to the literature review, desk research, interviews and analysis. The author of this dissertation is co-author of the article. The first author presented the work at the *Annual Conference of the Association of American Geographers 2008,* Boston (USA). The article benefitted from comments of anonymous reviewers of *Journal of Transport Geography.*

Chapter 5 has been written in the context of a research project on improving coordination on the rail track in the port of Rotterdam. This project was executed with Larissa van der Lugt, in cooperation with the Rotterdam Port Authority and several stakeholders from the rail industry in the port of Rotterdam. Findings of this project have been used in the article. The author is the first author. The author formulated the research goals, performed the literature review, developed the framework and conducted the case studies. During the writing process, parts of the article were improved by feedback from the second author. The author presented the work at the 12th *Economics of Infrastructures Conference 2009*, in Delft (The Netherlands) and the conference of the *International Association of Maritime Economists 2009*, Copenhagen (Denmark). The article benefitted from comments of anonymous reviewers of *Transport Reviews.* *Chapter 6* is a spin-off of research done within the research project Impulse Dynamic Vessel Traffic Management, commissioned by Rijkswaterstaat – Centre for Transport and Navigation (DVS) - an executive part of the Dutch Ministry of Infrastructure and the Environment (2011-2013). The research was done together with Dr. Bart Kuipers, Dr. Michiel Kort, and Prof. Dr. Harry Geerlings (all affiliated to Erasmus University Rotterdam). The interviews and desk research were done by all four researchers. The author of this dissertation is the first author. He developed and introduced the framework and wrote for the greater part the research article, with guidance of Bart Kuipers. The article was reviewed for presentation at the conference of the *International Association of Maritime Economists 2013*, Marseille (France), and invited for presentation at a special session on Inland Waterway Transport at the conference of the *International Association of Maritime Economists 2014*, Norfolk (US). The work benefitted from comments from these conferences, and the other members of the project team. *Chapter 7* has been written by the author.

2 Identification of coordination problems and coordination arrangements[15]

2.1 Introduction

In many seaports, container transport has become the most important cargo flow. Some of the transport flows originate from or are destined for captive hinterlands in the proximity of these ports. However, most ports not only attract captive cargoes, but also compete fiercely for contestable container cargoes. These flows can easily be switched between different ports (Notteboom & Winkelmans, 2004). Since container ports have become links in a global logistics chain (Robinson, 2002), port competition has moved from competition between ports to competition between transport chains. As a result, ports are eager to enhance the quality of their hinterland transport services (Notteboom & Winkelmans, 2004). Hinterland access is now perceived as a key success factor of European ports (Bundesamt für Güterverkehr, 2005, De Langen 2004).

De Langen (2004) argues that coordination between a large group of actors in the hinterland chain is required. The quality of a port's hinterland access depends on the behaviour of many actors, including terminal operators, freight forwarders, container operators, and the port

[15] Earlier published as: Van der Horst, M.R., De Langen, P.W. (2008), Coordination in hinterland transport chains: a major challenge for the seaport community, *Journal of Maritime Economics & Logistics*, vol.10, pp. 108-129. The chapter benefited from presentations held at *Annual Conference of the International Association of Maritime Economists*, June 4-6, 2007 in Athens (Greece) and *Maritime Transport 2006*, May 16-19 May, 2006 in Barcelona (Spain). An updated version of this article is published as Van der Horst, M.R. & De Langen, P.W. (2015). Coordination in hinterland transport chains: a major challenge for the seaport community. In: Haralambides, H.E. (ed.), *Port Management*, Palgrave Readers in Economics.

authority. The assessment of coordination in inland container transport requires a theoretical approach to enhance understanding of the inter-organizational coordination.

Although coordination in maritime container transport has been studied extensively, mainly because of the ongoing debate about the effects of cooperation in conferences and alliances (e.g. Heaver et al, 2000), coordination in hinterland container transport has received little attention. Port hinterlands have been studied from a geographical perspective. This research has led to a number of important concepts and findings (see e.g. Notteboom and Rodrigue, 2005), but in general limited attention has been paid to coordination in hinterland transport chains. This has been studied from an operational and technical perspective (e.g. Konings, 1996). Such studies are valuable, but they do not provide a basis for understanding the advantages and disadvantages of different coordination mechanisms. The limited attention paid to coordination in container hinterland transport is surprising, given that hinterland-transport costs are generally higher than the maritime-transport costs, and that most bottlenecks in the door-to-door chain occur in the hinterland. Examples include congestion, inadequate rail infrastructure, and problems with the handling of barges at deep-sea terminals.

Panayides (2002) acknowledges the lack of attention paid to integration and coordination in hinterland transport systems. He presents an analytical framework firmly rooted in transaction costs economics. However, he has not used this framework for empirical analysis; neither have other scholars used the framework. De Langen and Chouly (2004) investigated coordination in hinterland transport. They introduced the concept of Hinterland Access Regimes (HARs). This was a first step towards analysing cooperation in hinterland chains, but the concept does not provide a basis for identifying where coordination is required or what mechanisms could be introduced to enhance coordination.

Although studies specifically addressing coordination in hinterland transport are scarce, the supply chain management literature recognizes that inter-organizational issues are crucial in supply chain efficiency. Notwithstanding the theoretical contributions made (e.g. Ballou et al, 2004), supply chain management literature still lacks a theoretical basis for the explanation and understanding of inter-organizational collaboration (Halldorson et. al, 2005). Supply chain management literature presents insights into the design and management of particular relationships between various actors or stages in the chain and provides a framework within which to address the issue of coordination in a wider context.

This study advances the present body of knowledge of coordination in hinterland transport in three ways. First, coordination problems in hinterland transport chains are identified on a solid empirical basis. Second, a framework within which to analyse coordination problems and evaluate mechanisms to enhance coordination is presented. This framework is based on insights from institutional economics and distinguishes four mechanisms to enhance coordination: the introduction of incentives, the creation of interfirm alliances, changing the scope of an organization, and collective action. Third, the paper analyses a huge number of coordination arrangements in inland container transport to and from the port of Rotterdam. On the basis of this analysis, the conditions that influence the effectiveness of mechanisms to enhance coordination are identified.

2.2 Coordination problems in hinterland chains

Before identifying specific coordination problems in the hinterland chain, five general arguments that explain why coordination problems arise are discussed:

- The unequal distribution of the costs and benefits of coordination. If one actor in the chain has to invest (e.g. in ICT systems) while other actors obtain the benefits, coordination may not arise spontaneously. Gain-sharing mechanisms that redistribute benefits may fail owing to high transaction costs and the risk of free-rider behaviour.
- The lack of resources or willingness to invest on the part of at least one firm in the transport chain. Even though all actors may agree that investments (including management involvement) are required to improve coordination, some firms may not be able or willing to take part. This issue is especially relevant for coordination problems involving relatively small firms.
- Strategic considerations. These can also impede coordination. Firms may be reluctant to improve coordination if competitors would also benefit. This situation is likely to arise in a market characterized by fierce competition.
- The lack of a dominant firm. A firm with supply chain power will have a major impact on the structure of a transport chain (see e.g. Groothedde, 2005). A lack of supply chain power reduces coordination.
- Risk-averse behaviour and a short-term focus of firms in hinterland chains. Firms that expect the process of establishing better coordination through cooperation to be time-consuming and feel that results are uncertain may be reluctant to put any effort into this process.

These reasons explain why the efforts and investments firms make to improve cooperation and coordination are in some cases limited. Firms often concentrate on internal issues and put less effort into resolving the coordination problems of the chain as a whole. This attitude is more marked if actors expect cooperation to be difficult to achieve. Thus, previous experience in coordination also determines a firm's attitude (Nooteboom, 2004, p. 253).

Two kinds of sources have been used to identify coordination problems in hinterland transport. First, relevant news items have been collected through scanning reports, studies, and industry magazines and journals. All relevant news items have been stored in a database. Second, expert interviews[16] were conducted with managers in the hinterland transport chain, including terminal managers, managers from transport companies, and representatives of industry organizations. The conversations with these experts led to modifications of the list of coordination problems derived from the analysis of industry magazines. The result is a set of coordination problems in hinterland chains to and from Rotterdam. Road, rail, and waterway transport have specific coordination problems while others affect all hinterland modes.

[16] A list with the interviewees can be found in appendix 1

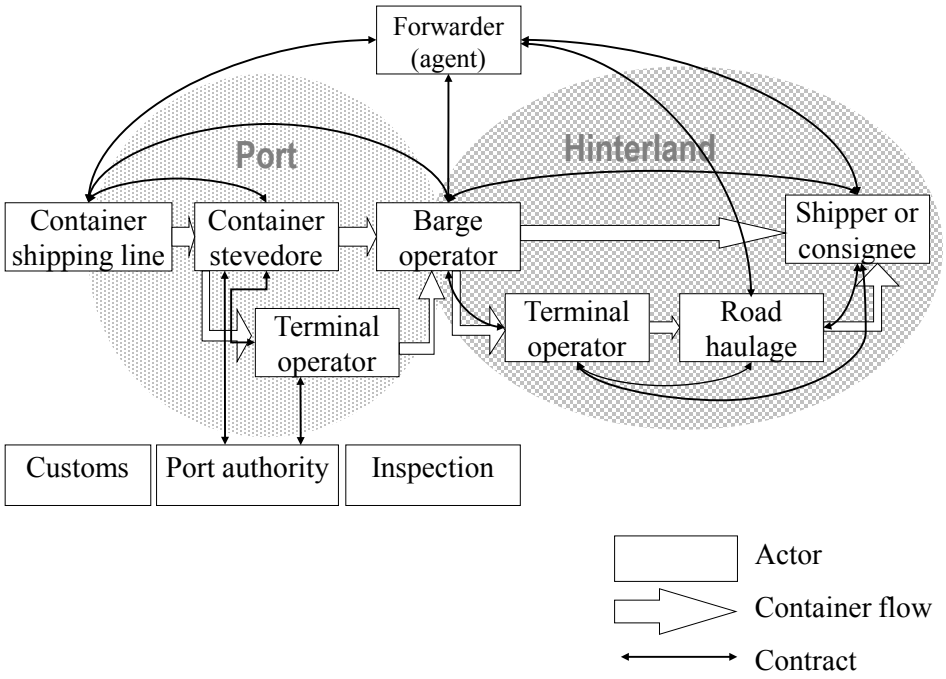

Figure 2.1 Inland shipping hinterland chain

Figure 2.1 shows the actors in the hinterland chain and their contractual relationships. Apart from the private actors who provide transport and terminal services, several public actors are involved, such as Customs, a port authority, inspection services, and infrastructure providers. Figure 2.1 shows the many different activities in the hinterland chain that lead to the involvement of a large number of different firms and public organizations.

Table 2.1 Coordination problems in container barging

Coordination problem	**Actors involved**
Long stay of barges in the port through too many calls and too small call sizes	Barge operator, container terminal operating company, terminal operator in port, forwarder
Insufficient terminal and quay planning with respect to the sailing schedules of both deep-sea vessels and barges	Barge operator, container terminal operating company, terminal operator in port,
Limited exchange of cargo	Barge operator, forwarder

Table 2.1 shows the main coordination problems in the container barging. The first two are the most important. The long duration of (un)loading cargo in the port, caused by the many calls and the small call sizes per terminal, is a first coordination problem. All barge operators call at a variety of terminals in the port and unload limited numbers of containers per terminal. Better coordination between barge operators could lead to fewer calls in the port.

Second, the terminal and quay planning for barge handling is inadequate. Roughly a decade ago, the average rotation time of a barge was approximately 22.5 hours, only 7.5 hours of which were used for loading and unloading. The remaining time was spent on sailing and waiting. The average call size was 18 TEU per terminal (Stichting RIL, 1998). Since that time there have been no signs of any significant improvements, but no hard data are available. Tight planning could reduce rotation times, but barges frequently cannot be handled as planned. The complicated nature of this planning is illustrated by the fact that only 62 percent of the barges leave the port of Rotterdam on time (Stichting RIL, 1998).
Both coordination problems can be partially explained because barge operators have no contracts with the terminal operating companies (TOCs). TOCs give priority to seagoing vessels. Barges are scheduled after seagoing vessels have been dealt with and any delays affecting seagoing vessels are passed on to the barges. Barge operators try to make an efficient rotation schedule over the various terminals (Moonen et.al, 2005), but have hardly any influence on the terminal planning.

The third coordination problem is the limited exchange of cargo between barge operators. The exchange of cargo can allow barge operators to operate larger vessels, have higher service frequencies, and fewer port calls. This exchange of cargo does not develop spontaneously, because many barge companies firmly wish to remain independent.

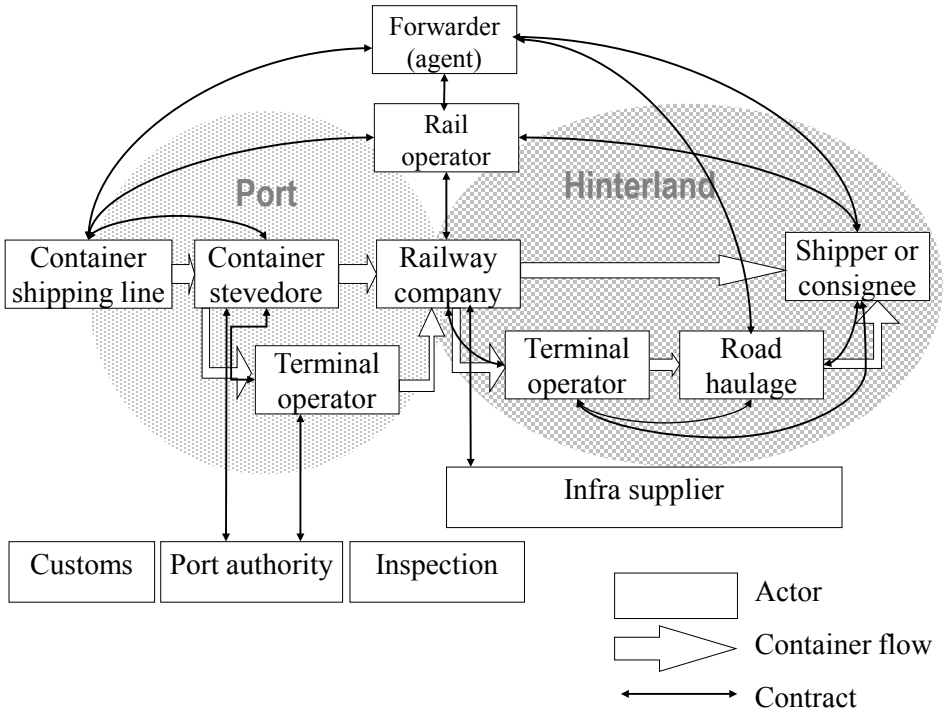

Figure 2.2 Railway hinterland chain

The railway hinterland chain (Figure 2.2) differs from inland shipping, because of the role of a rail-infrastructure supplier, who has contractual relationships with railway companies. The European rail cargo market has been liberalized, resulting in the separation of infrastructure provision from transport services provision. In the Netherlands, infrastructure is provided by

ProRail, an independent rail-infrastructure manager. ProRail allocates tracks to railway companies. The most important coordination problems in the Dutch railway market are presented in table 2.2

Table 2.2 Coordination problems in container rail transport

Coordination problem	Actors involved
Peak load on terminals; spread of terminal slots is not realized	Container terminal operating company, Rail terminal operator in port, rail terminal operator in hinterland, railway company, infrastructure manager
Unused rail tracks because of insufficient tuning	Railway company, infrastructure manager
Limited planning on rail terminal causes regularly delays	Container terminal operating company, Rail terminal operator in port and hinterland, railway company, infrastructure manager
Limited exchange of traction	Railway company
Limited exchange of rail cargo	Railway operator, forwarder

The allocation of rail tracks gives rise to coordination problems between ProRail and the railway companies. ProRail allocates train paths on a yearly basis. This method is rigid and is not aligned with the market demand for flexibility in the allocation of railway tracks. More flexible allocation could prevent mismatches and help reduce the shortage of track capacity in the port, but more and better coordination would be required. Coordination problems also arise on rail terminals in ports. Terminal operators draw up a daily terminal-handling plan with time slots for each train on the terminal. However, because of the lack of contractual relationships between the rail terminal operators and railway companies, the coordination required to achieve a terminal planning that maximizes chain efficiency falls short of requirements.

The exchange of traction (e.g. through a pool of locomotives) would increase efficiency, because the utilization of locomotives could increase substantially. Coordination is particularly required on the last kilometres of the rail track, because of the many small shunting activities that lead to idle time for locomotives. However, the strategic considerations of the railway companies can impede the exchange of traction. This hindrance is partly explained because the local offices of some railway companies do not have the autonomy to take such decisions. The fifth coordination problem is the limited exchange of cargo between railway operators and/or forwarders. This cooperation could generate economies of scale and higher equipment utilization rates, but it does not develop spontaneously.

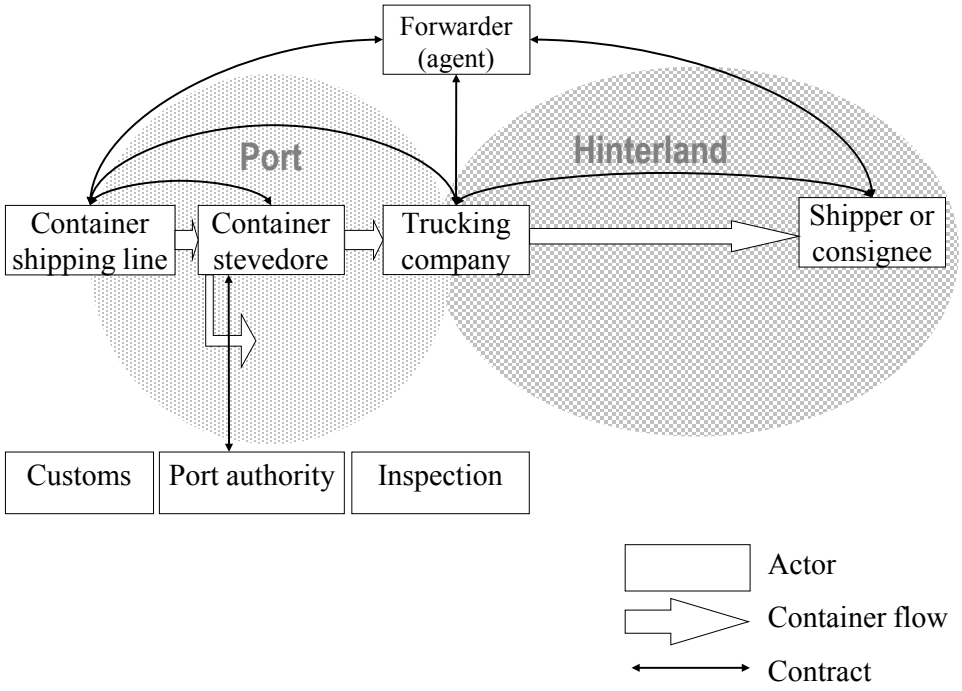

Figure 2.3 Truck hinterland chain

The truck hinterland (Figure 2.3) is the 'simplest' hinterland chain. The number of actors is large (there are more than 1000 container truck companies in the Netherlands), but the coordination in the truck chains is relatively straightforward.

Table 2.3 Coordination problems in container trucking

Coordination problem	**Actors involved**
Peak load in arrival and departure of trucks at deep-sea terminal	Container terminal operating company, truck company
Peak load in road transport causes congestion on the road infrastructure in port region area	Truck company, infrastructure supplier
Truck driver's lack of information leads to inadequate pick-up process on terminal	Container terminal operating company, truck company, forwarder
Limited exchange of cargo and truck capacity	Truck company, forwarder

Table 2.3 shows the coordination problems in container trucking. The major coordination problem is the peak in the arrivals and departures of trucks at the gate of TOCs. Peak hours

are from 6.00 to 9.00 a.m. and 5.00 to 8.00 p.m. These peaks are caused by the truck companies' planning and the warehouses' limited opening hours. The increasing numbers of mega-container vessels of different container lines can aggravate problems during the peak period (Midoro, 2005). In Rotterdam, the road capacity, especially on the main highway (A15), is limited. In the period 1995-2002, the traffic on the A15 grew by 20 percent. This congestion is mainly caused by commuters, but heavy freight flows also have an impact on it. Congestion in rush hours can also be considered a coordination problem.
A third coordination problem is the limited exchange of information between a container TOC, a truck company, and a forwarder. A lack of information exchange leads to an inefficient delivery and pick-up process at the deep-sea terminal. A fourth coordination problem is the limited exchange of cargo and truck capacity between truck companies. The utilization of trucks could increase through exchange, but this does not develop spontaneously.

Table 2.4 General coordination problems in hinterland chains

Coordination problem	**Actors involved**
Insufficient information exchange of container data causes inadequate planning	Container shipping line, container terminal operating company, forwarder, truck company, barge operator, rail operator
Investments in hinterland terminals do not come about spontaneously	Forwarder, rail terminal operator hinterland, barge terminal operator in hinterland
Introducing new hinterland services requires a basic volume; however, 'cargo controlling' parties do not commit to new services of other transport providers	Forwarder, shipper, container shipping line
Insufficient planning on transporting and storing empty containers	Container terminal operating company, rail terminal operator in hinterland, barge terminal operator in hinterland, container shipping line
Limited customs declaration physical and administrative inspection causes delay	Forwarder, Customs, truck company, barge operator, rail operator
Limited planning for physical and administrative inspection between Custom and Inspection authorities causes delay	Customs, Inspection services
Insufficient information about Customs clearance of a container	Forwarder, Customs, shipper

Table 2.4 presents the general coordination problems across these hinterland modes that are relevant on top of the coordination problems in barging, rail transport, and trucking.
The inadequate exchange of information between the container shipping line, the TOC, and the transport companies is a coordination problem. Often, there is a lack of information about the destination of the container, the consignee, and the customs status of the cargo. This lack is especially the case for export containers; almost all the cargo information for import containers is present on the ship's manifest. In contrast, transport companies often have inadequate information about export containers so the planning of the TOC and the shipping line is hampered.

A second general coordination problem is the lack of commitment of cargo-controlling firms to guarantee volumes for newly-developed hinterland services. Introducing a new hinterland service (e.g. a container rail shuttle) requires a base volume. However, shippers, forwarders, and container shipping lines are often unwilling to commit themselves to new services, either through opportunism or concern about benefits for competitors.
The planning of empty containers is a third coordination problem. Coordination between the TOC, hinterland terminals, and container shipping lines could reduce empty movements. Consultants estimate the share of empty containers in hinterland transport at 40 percent of all containers transported (Konings, 2005). These unproductive movements entail high costs.
Finally, coordination problems arise between hinterland transport companies and such organizations as Customs and inspection services, like the veterinarian or nutrition inspection. Insufficient information and poor coordination between the parties causes delay.

In conclusion, the coordination problems described above are relevant in the port of Rotterdam. Consequently, various initiatives have been taken to improve coordination. These initiatives are analysed in the next section.

2.3 A framework to analyse mechanisms of coordination in hinterland transport

This section presents a framework for the analysis of coordination problems and the evaluation of mechanisms to enhance coordination. Coordination problems arise when coordination beyond price is required on the one hand, to ensure an efficient transport chain, but is problematic on the other hand, due to opportunism and bounded rationality. Institutional economics provides a framework within which to address such questions as: Why do deep-sea container terminals take up shares in inland terminals? Why does a port authority take the initiative to start a port community (ICT) system? Why does a deep-sea container carrier own a railway company? Why do barge operators share cargo capacity in a joint pool?

In all these cases, coordination beyond price emerges. Such questions were first addressed by Coase (1937 and 1960). He argues that transaction costs with alternative forms of coordination (e.g. within a corporate hierarchy) can be more efficient than coordination through markets. Williamson (1975) expanded Coase´s work, introducing behavioural assumptions to transaction costs economics. Williamson's transaction costs concept is based on two behavioural assumptions: bounded rationality and opportunistic behaviour. While people aim to be rational, their capacity to be so is limited, owing to behavioural uncertainty

concerning the intentions and competencies of transaction partners and environmental uncertainty and the conditions that may affect the outcomes of agreements. Secondly, there is a possibility of opportunism, with a self-interest-seeking assumption that makes allowance for guile (Williamson, 1996: 56). Because of bounded rationality and opportunistic behaviour, transaction costs (e.g. the costs of finding a partner, preparing and concluding a contract, monitoring the execution of the agreement) of contracts can be substantial, especially for complex agreements. In the most efficient governance structure, total production and transaction costs are, in the long run, less than in any other governance structure.

These insights are relevant for the analysis of coordination problems (in transport); coordination problems arise when coordination beyond price is required on the one hand, to ensure an efficient transport chain, but problematic, owing to opportunism and bounded rationality on the other hand. Two devices for coordination beyond price are vertical integration and partnerships. Collective action (e.g. of all the firms in an industry) is a third mechanism to enhance coordination (beyond price). Fourth, changing the incentive structure of contracts may help enhance coordination. Thus, four broadly-defined mechanisms to enhance coordination can be identified.

Table 2.5 Four coordination mechanisms and possible coordination arrangements

Coordination mechanism	**Possible coordination arrangements**
Introduction of incentives	Bonus, penalty, tariff differentiation, warranty, auction of capacity, deposit arrangement, tariff linked with cost drivers
Creation of an interfirm alliance	Subcontracting, project-specific contract, standardized procedures, standards for quality and service, formalized procedures, offering a joint product, joint capacity pool
Changing scope	Risk-bearing commitment, vertical integration, introduction of an agent, introduction of a chain manager, introduction of an auctioneer, introduction of a new market
Creating collective action	Public governance by a government or port authority, public-private cooperation, branch association, ICT system for a sector of industry

The first mechanism is the introduction of incentives or change of the incentives structure[17]. Incentives can be used to align the interests of individual firms within an efficient overall transport chain. In general, incentives can be used to internalize the harmful or beneficial effects (externalities) of a firm's decision on other firms. Incentives can have different forms: bonus/penalty systems, differentiated pricing systems (e.g. a discount on tariffs for customers

[17] The mechanism is related to the concept of property rights. A primary function of property rights is that of guiding incentives to achieve a greater internalization of externalities (Demsetz, 1967).

that guarantee the use of a certain amount of container slots on a rail shuttle or pricing structures for peak and off-peak hours), and non-financial rewards (like a fixed window for loading/unloading).

The second mechanism for enhancing coordination is the creation of an interfirm alliance between several actors in the hinterland chain. Incentives might induce firms to act in the interests of other actors in the chain, but could yield high transaction costs. Alliances are arrangements with more commitment between the companies involved. Alliances are a better instrument than incentives, especially in cases where coordination requires investments, but benefits are unclear and uncertain. Alliances include many forms of interfirm cooperation that go beyond market transactions and include vertical alliances between buyer and supplier (subcontracting) and horizontal alliances between competitors (e.g. a joint capacity pool between hinterland transport firms). Furthermore, the term alliance covers a whole range of cooperative agreements, such as licensing and joint ventures (Nooteboom, 1999). An important characteristic of an interfirm alliance is that the actors involved remain to some extent independent.

A further step in Williamson`s framework is changing the scope of the organization. This mechanism includes hierarchical coordination of the chain and vertical integration. The fourth and last mechanism for enhancing coordination is collective action. This mechanism is especially relevant when investments have collective rather than individual benefits. Collective action can be structured through a public organization, a public/private organization or an industry association.

These four mechanisms for enhancing coordination form the starting point for the analysis of coordination arrangements in inland container transport to and from the port of Rotterdam.

2.4 Analyzing coordination in hinterland transport: an empirical application

This section gives an overview of the arrangements set up to enhance coordination in the hinterland transport chain. The analysis starts with the coordination problems identified in section 2.2 For each of these, the arrangements to enhance coordination are identified and classified as one of the four mechanisms of coordination discussed above. On the basis of a literature review, the scanning of industry magazines, and expert interviews, 76 coordination arrangements have been identified. These include some arrangements that are no longer in place as well as those that are currently implemented. The database specifies the transport mode, the actors involved, relevant coordination problem(s), the coordination mechanism (incentives, interfirm alliance, scope and collective action), and the involvement of the port authority.

The incentive structure is changed in 6 coordination arrangements; 32 can be characterized as interfirm alliances. The changing scope of an organization was found 23 times and collective action 34 times. The list of the coordination arrangements and related coordination problems is shown in appendix 2. Appendix 3 shows the links between the coordination problems and

examples of coordination arrangements for container railway transport and container trucking. In this section, the arrangements of container barging are discussed in detail. Table 2.6 illustrates the links between coordination problems and some coordination arrangements for container barging.

Table 2.6 Coordination arrangements in container barging

Coordination problem			**Examples of coordination arrangements**
Limited exchange of cargo	**INC**	-	-
	IA	8	Fahrgemeinschaften, Barge Planning Center, Bargelink.com, Teleship
	SCO	-	-
	CA	4	Lumpesammler, AMS barge
Long stay of barges in the port because of many calls and small call sizes	**INC**	2	Fixed 'time window' at a terminal as a bonus
	IA	1	Lumpesammler
	SCO	5	Extended Gate Model stevedore ECT, Barge operator Van Udens builds inland terminal in Haaften
	CA	7	Hinterlink protocol, AMS Barge (crane ship concept)
Insufficient terminal and quay planning with respect to sailing schedule of both deep-sea vessels and barges (will increase crane utilization)	**INC**	2	Pact 1999 between barge operators and container terminal operating company ECT about Quay settlement
	IA	3	Association of Inland Terminal Operators and stevedore ECT cooperate in barge planning platform
	SCO	4	Extended Gate Model stevedore ECT, investments of Maersk inland terminals
	CA	7	Internet application Barge infolink of Port infolink

Twelve coordination arrangements for exchanging cargo were developed: four through collective action and eight through interfirm alliances. These are established to exchange cargo in a joint cargo pool. This arrangement started in the 1980s on the Rhine with the Fahrgemeinschaften. This is an interfirm alliance between various barge operators with a joint sailing schedule combined with a profit pool. The main motive for cooperation is to generate economies of scale. In 2007, only two Fahrgemeinschaften were still active on the Rhine:

Fahrgemeinschaft Oberrhein (PENTA Container Line) and URCA Upper Rhine Container Alliance. As Notteboom and Konings (2003) observe, the conditions for cooperation are gradually changing owing to higher market entry barriers, the stabilization of the number of operators, and growing transport volumes. Another cooperative structure is active in the feeder traffic between the port of Rotterdam and Antwerp, namely the Barge Planning Centre. The large number of terminals in both ports creates a need to bundle container flows. There have been several bilateral agreements of barge operators on sharing equipment, but since 2001 almost all operators (CEM, Eurobarge, WCT MTA, and Interfeeder) have joined the Barge Planning Centre. There are two important conditions for establishing interfirm alliances like the Fahrgemeinschaften and Bargeplanning Center. First, the cooperating firms need to have complementary capabilities. Second, the transaction costs for establishing and maintaining the capacity pool must be low.
Because of the strong strategic differences, interfirm alliances are a more effective arrangement than complete vertical integration (changing scope). In addition to cooperation in capacity pools, some Dutch barge operators are linked to Internet membership sites where it is possible to exchange freight. Examples include Teleship, and Bargelink.

Three barge operators on the Rhine ─ CCS, Frankenbach, and Rhinecontainer ─ jointly operate a 'Lumpesammler'. This ship bundles small amounts of cargo from the three barge operators at several terminals along the Rhine. The Lumpesammler facilitates the exchange of cargo between barge operators and thereby increases a ship's efficiency. Similarly, the barge handling efficiency of TOCs is also increased, because the call sizes of barges are larger. Thus, the concept of cargo exchange in the hinterland resolves not only the (first) coordination problem of limited exchange of cargo, but also the (second) coordination problem concerning the long stay of barges in the port because of the many calls and small call sizes. The Rotterdam port authority has an interest in setting up the Lumpesammler, because a shorter stay in the port by barges increases the quality of the port product as a whole. These collective benefits justify the port authority's involvement. Fifteen coordination arrangements address the second coordination problem: barges' long stay in the port. One arrangement can be categorized as an interfirm alliance; in 5 arrangements, the scope of the organization was changed; 7 coordination arrangements create collective action; in 2 coordination arrangements incentives are introduced. A new cooperative arrangement based on the introduction of incentives has recently been launched. This includes an agreement between the barge operators and TOCs about guaranteed handle times (time window). Barge operators can 'earn' a window if they meet a set of criteria. This opportunity influences their behaviour. The agreement between barge operators and TOCs about guaranteed time windows to handle barges is part of the Hinterlink protocol, a set of rules between barge operators, container shipping lines, and TOCs. The Hinterlink protocol also includes other agreements, like the Lumpesammler project mentioned above.

Another example of collective action is the AMS-Barge project. This new transport concept consists of a container barge equipped with a crane. The concept was developed by the barge operator Mercurius and the port authority of Amsterdam. AMS Barge can provide daily pick-up and delivery container services for companies in the region or connect them to the other transport services and transportation modes.

In three coordination arrangements a container terminal operating company, a barge operator, and a container shipping line changed their scope. First, the Rotterdam container-terminal operating company ECT introduced the Extended Gate Model concept. In this, the ECT seeks to extend the gate of its deep-sea terminal to inland terminals by offering both container handling and hinterland transport services to their own hinterland terminals. This endeavour leads to terminal haulage. In the Extended Gate Model, the TOC organizes terminal services and hinterland transport. The hierarchical coordination of the hinterland chain by ECT reduces the length of stay of barges in the port. Second, the Dutch barge operator Van Uden has plans to extend its scope by setting up an inland terminal along the Rhine. Not only barge operators, but also container shipping lines like Maersk can extend their scope. Maersk plans to invest millions of euro in setting up a network of hinterland terminal companies. The Danish container carrier has plans to build more than 20 terminals (including rail terminals) in South Germany and Eastern Europe (Nieuwsblad Transport, 2007).

The third and last coordination problem in container barging is insufficient terminal and quay planning. The coordination of the sailing schedule of deep-sea vessels and barges would increase terminal efficiency. Sixteen coordination arrangements address this problem, mostly through collective action. In 4 arrangements, the scope of the organization was changed. Incentives were found twice and interfirm alliances three times. Coordination arrangements that resolved the previous coordination problem can also be used to improve the terminal and quay planning with respect to the sailing schedule of deep-sea vessels and barges. The incentive structure in the Hinterlink-protocol could also be used to improve the inadequate terminal and quay planning. In addition to agreements between the barge operators and seaport terminal operators about guaranteed time windows, Hinterlink also includes agreements about improving information exchange. An earlier protocol was agreed in 1999 by the Dutch Inland Shipping Association the Central Bureau for Rhine and Inland Shipping (CBRB). Like Hinterlink, this covenant included operational agreements regarding barge handling at ECT terminals. In addition, the organization Portinfolink developed Barge Infolink, an Internet application to verify whether parties are observing the stipulations of the covenant mentioned above. Portinfolink is a public-private partnership between the Rotterdam port authority and the Ports and Industries' association Deltalinqs.

2.5 Conclusion

This paper argues for the need to analyse the coordination in hinterland container transport: first, because costs for hinterland transport are generally higher than the maritime transport costs; second, because most bottlenecks of the door-to-door container transport chain, such as congestion, insufficient infrastructure, and problems with handling of barges, trains and trucks at deep-sea terminals, occur in the hinterland network.

This study advances the present body of knowledge of coordination in hinterland transport by identifying the coordination problems in the hinterland chains and proposing a framework within which to analyse these coordination problems. In general, coordination problems in hinterland chains arise because of an imbalance between the costs and benefits of coordination, a lack of willingness to invest, the strategic considerations of the actors involved, and risk-averse behaviour. The relevant general and specific coordination problems in road, rail, and waterway transport have been identified. Coordination problems in road, rail,

and waterway transport include the long stay of barges, trains, and trucks in the port region or at the terminal (often in combination with a peak load at the terminal), the limited exchange of cargo and transport capacity, unused and also overused rail and road infrastructure, limited quay and crane planning at the deep-sea terminal, and limited information exchange with Customs and inspection authorities.

After identifying the coordination problems, a framework based on insights from institutional economics for the analysis of coordination problems and evaluation of mechanisms to enhance coordination was presented. This framework features four key mechanisms to enhance coordination: the introduction of incentives, the creation of interfirm alliances, changing the scope, and the creation of collective action. For each coordination problem, arrangements to enhance coordination were identified and classified in one of the four mechanisms of coordination. It was demonstrated that, in the port of Rotterdam, new arrangements are continuously being developed; about 34 collective action arrangements were identified. The associations of transport companies, the port cluster association, and the port authority are active in bringing about collective action; there were 31 forms of interfirm alliance. These arrangements cover a whole range of forms of cooperation between independent firms, through transport capacity pools, freight exchange websites, train shuttles, and so forth. There were 23 scope arrangements in which container terminal operating companies, transport companies, terminal operators or container shipping lines changed their scope. Incentives were only introduced in 6 cases; penalty systems, differentiated pricing systems, and non-financial rewards (like a fixed window) are used to influence actors' behaviour.

In conclusion, an important issue in ports is hinterland access. Ports and their hinterland transport systems can only attract and manage additional container volumes if the hinterland transport network is organized efficiently and effectively. The framework for the analysis of coordination problems in a port's hinterland is not conclusive, but provides a solid basis for further research. Additional research is needed to specify more precisely under what conditions a certain coordination mechanism is chosen. The framework proposed deserves further theoretical and empirical testing. Another promising line of research would be to carry out the same analysis in other hinterlands of European ports.

3 Further examination of coordination problems and coordination arrangements[18]

3.1 Introduction

Hinterland accessibility is one of the key strategic factors in seaport competition (amongst others Notteboom & Winkelmans (2004), Wiegmans, Van der Hoest, Notteboom (2008)). Containerization has increased the geographic market coverage of seaports. As a result, the hinterlands of some seaports have expanded from captive regions to contestable regions where major container ports increasingly compete with each other (Notteboom, 1997). As a result, major container ports increasingly compete for the same inland areas, putting an emphasis on efficient hinterland chains. This is particularly the case in West European seaports (Le Havre, Antwerp, Rotterdam and Hamburg), where the distance from these ports to major cargo-generating inland areas is not the decisive variable. Efficient hinterland chains are important for three types of actors. Firstly, the ability to offer diverse and efficient hinterland transport chains is relevant to port authorities, and many port authorities have hinterland accessibility high on their priority lists for strategic actions (De Langen, 2008). Secondly, companies in the port (e.g., transport companies, terminal operators) benefit from efficient hinterland chains, as effective and efficient hinterland access contributes to their economic performance by providing them with the possibility to offer good transport solutions for their clients while maintaining their competitive cost structures. Thirdly, this issue is relevant to shippers, as improved hinterland access lowers generalized transport costs and enables more and cheaper trade (Limao & Venalbes, 2001). In Europe the subject of hinterland accessibility, together with intermodal transport, transport integration, and

[18] Earlier published as: Van der Horst, M.R., Van der Lugt (2011), Coordination mechanisms in improving hinterland accessibility: empirical analysis in the port of Rotterdam, *Maritime Policy and Management*, vol.38, pp. 419-439.

congestion, have reached top policy levels at the European Commission (which adopted the White Paper 'European Transport Policy for 2010: time to decide' (European Commission, 2001)), the OECD and its International Transport Forum (OECD, 2009), and the UN Economic Commission for Europe. Therefore, from both competitive and societal perspectives, hinterland access needs attention from all actors involved.

Earlier research has shown that coordination problems appear in the port-related transport of maritime containers (Van der Horst & De Langen, 2008). Public and private actors, including terminal operators, freight forwarders, transport companies, infrastructure managers, local and regional authorities, and the port authority, are active players in improving the efficiency of these chains. The present research proposes a theory by which to understand the emergence of coordination arrangements or coordination mechanisms in hinterland chains by making use of conceptual insights from institutional economics, specifically Transaction Cost Economics (Williamson, 1975 & 1996). This study responds to calls from scholars to clarify the inter-organisational issues in transport chains or, more broadly, in supply chains. Panayides (2002)acknowledges the lack of attention to integration and coordination in hinterland networks and presents an analytical framework firmly rooted in Transaction Costs Economics. The present research complements existing studies aiming at a better understanding of transport integration in port-related transport chains (see, e.g. Carbone & Gouvernal (2007) and Potter & Skinner (2000). These studies focus mainly on how to design and manage inter-organizational arrangement in logistics chains but do not address the economic rationale behind these designs (Halldorsson et al., 2005). In addition, Stock (1997) stresses the importance of understanding inter-organizational arrangements in logistics chains using theories from disciplines like economics, of which Transaction Cost Economics is part. Other relevant disciplines that have addressed inter-organizational arrangements are political science, sociology (e.g. the Network approach), geography (e.g. New Economic Geography), and strategic literature (e.g. the Resource Based View).

This article examines coordination arrangements in hinterland transport from a Transaction Cost Economics perspective. Understanding what types of coordination mechanisms are introduced, by whom, and under what conditions can help actors involved in port and hinterland coordination to improve hinterland accessibility. The next section describes hinterland accessibility as an organisational challenge. Section 3.3 introduces the emergence of coordination arrangements as an answer to coordination problems. Section 3.4 introduces and discusses Transaction Cost Economics with the purpose of developing an analytical framework with concrete attributes for the operationalization of our analysis. The fifth section provides the results of the empirical analysis of coordination arrangements based on a database with data on emerged coordination arrangements in the port of Rotterdam and in its main hinterland. The last section summarizes and concludes.

3.2 Hinterland accessibility as an organizational challenge

The problem of seaports' accessibility to the hinterland can be approached from infrastructural and market perspectives. From an infrastructural perspective it can be argued that a good network of roads, railways, and rivers/canals, together with efficient interconnecting systems, is a first requirement for smoothly operating multimodal hinterland accessibility. There have been many studies on optimal network design and development of

seamless interfaces between links in the chains (Koning, 2009). From a market perspective, it can be argued that there must be efficient and effective companies that deliver the various hinterland transport services to the customers. The paradigm is that these companies prosper most in a liberalised and competitive environment (European Commission, 2001). In considering how hinterland accessibility is offered to customers, we stress that we also need an organisational perspective to analyse performance and its underlying factors. Hinterland accessibility is, in most cases, the result of the joint action of a set of private companies and public actors, whereby the economic organisation of the whole activity, with a strong focus on aligning incentives, is key to success.

We can illustrate hinterland accessibility as on organisational challenge with a practical example. In a typical 'merchant haulage' import chain, the container carrier delivers the container at the deep-sea terminal. The terminal operator tranships the container to the terminal area, where it is stored or immediately transferred to the inland transport mode. The container carrier has a contract with the terminal operator and pays for the whole operation at the terminal. The inland transport operator—for example, the rail operator—has a contract with the shipper or the forwarder to pick up the container at the terminal and transport it to an inland terminal. The inland rail company ensures that there is a handling slot at the terminal at its time of arrival, and that it also has a slot for using the infrastructure–managed by the infrastructure manager. The inland rail company also ensures that the container can be released for further transport (commercial release and in terms of Customs and Inspection). Once the container arrives at the inland terminal, there is another need for a terminal handling slot. This example shows that many actors (at least 6) are involved in the operational coordination for handling one container, and sometimes coordination must take place among more than two actors at the same time. These actors have different business models and different interests in designing the transport chain or network of which they are part (see also De Langen, 2010). Table 3.1 summarizes the differences in the focus of the actors involved in a container barge chain as a result of the actors' different underlying business models.

Table 3.1 Impact of business model on design of barge services (Source: De Langen, 2010)

Actor	**Business model based focus**
Barge operators	Focus on efficient utilization of barges
Forwarders	Focus on optimizing flows managed by forwarder
Shippers	Focus on specific supply chain optimization
Deep-sea terminal operators	Focus on improving terminal efficiency
Inland terminal operators	Focus on service quality of inland terminal
Road transport companies	Focus on optimizing mix of trucks and barges
Shipping lines	Focus on container-repositioning issues
Port authorities	Focus on modal shift to alleviate road congestion

In seaports' hinterland chains the required coordination is, in many cases, lacking, and it does not always arise spontaneously (Van der Horst & De Langen, 2008 and De Langen, 2004). As a result, coordination problems arise that negatively affect the performance of the chain.

Common examples of suboptimal coordination are between the deep-sea terminal operator and trucking companies, where peak congestion emerges at the terminal gates, and between inland terminals and barges, where small call sizes and too many calls per trip lead to excessive handling costs and delays in planning. Three types of coordination problems emerge in the larger set of coordination problems that have emerged in hinterland transport networks: lack of investment, which results in an underdeveloped network with low density and, perhaps, congestion; lack of or poor operational coordination, which results in inefficiency in the chain; and lack of horizontal coordination, resulting in underutilisation of assets. These coordination problems are not always automatically resolved by the market actors involved because of differing interests, lack of information, existing incentives for strategic behaviour, and uneven distribution of power in the chain (Van der Horst & De Langen, 2008).

3.3 The emergence of coordination mechanisms

In response to coordination problems in hinterland transport chains, actors often introduce coordination mechanisms. We define these mechanisms as all modes of organizing transactions, including operational transactions, informal agreements, contracts, incentives, alliances, introduction of new actors or markets, and vertical integration. For example, a terminal operator in the port of Rotterdam, together with a set of inland terminals, introduced a formal arrangement for solving the planning problem of barges at the terminal. The terminal operator guaranteed continuous crane capacity for barge handling for the involved barge operators, and the association agreed to develop and control a smooth plan for the barge operators involved that avoided peak congestion. Another example from Rotterdam is the agreement between railway carriers, terminal operators, and infrastructure manager that they would access the port's rail line only if a terminal slot was agreed upon by the terminal operator. Within the various transport modes that serve the Port of Rotterdam are several agreements for exchange of capacity in order to improve utilization rates and avoid empty kilometers. We argue that, if these kinds of agreements emerge in practice and are sustained, there must be an economic reason. Our interest in this reason has driven our primary research question: can we get a better understanding of the emergence of coordination mechanisms between organizations involved in the hinterland transport of the port of Rotterdam, assuming that there is an economic rationale for their existence?

The starting point for our study is a set of coordination mechanisms that emerged in the hinterland chain of the Port of Rotterdam. We collected all clearly deliberate actions introduced to solve coordination problems. One could argue that existing vertically integrated companies are also forms of coordination beyond price, so they should be included in the list; however, the search is limited to mechanisms deliberately introduced with an aim to solve an existing coordination problem. The search resulted in a database of 91 coordination arrangements.

In their first analysis of coordination problems and coordination mechanisms in hinterland chains, Van der Horst and de Langen (2008) classified coordination arrangements into four types. The first category is the introduction of incentives or changes to an existing incentive structure. Incentives can be used to align the interests of individual firms within an efficient overall transport chain by internalising the harmful or beneficial effects (externalities) of a

firm's decision on other firms. The second mechanism for enhancing coordination is the creation of an interfirm alliance, through mechanisms such as subcontracts and joint transport services, among two or more actors in the hinterland chain. The next category is changes to the scope of the organisation. This mechanism includes hierarchical coordination and vertical integration of the chain. The fourth mechanism for enhancing coordination is collective action. This mechanism is especially relevant when investments have collective rather than individual benefits. Collective action can be structured through a public organisation, a public/private organisation, or an industry association. Although the choice among these four classifications does not differentiate between public and private actors, whether a public or a private organisation is involved in a coordination mechanism has an effect, as Groenewegen (2005) recognised in an analysis of organisational forms in infrastructure market segments. For our purposes, we retain the four categories distinguished by Van der Horst and De Langen (2008), but our analysis also considers whether actors are public or private.

3.4 Analyzing the emergence of coordination mechanisms

This section will specify the set of variables we use to examine coordination arrangements in hinterland chains. The research stream of Institutional Economics focuses on understanding the process and the presence of coordination arrangements in shaping economic behaviour[19]. The core of Institutional Economics, and specifically New Institutional Economics, is Transaction Costs Economics (TCE). During the mid-1970s, TCE began to attract attention when the institutional economist and 2009 Nobel Laureate Oliver Williamson published his work Market and Hierarchies (1975). This section follows Williamson's 'pragmatic methodology' (2008) in selecting the characteristics of coordination arrangements in hinterland chains. These characteristics are selected and prioritized because they make sense for 'reasonable' and 'plausible' reasons to understand complex phenomena[20].

The central focus in TCE is, of course, transactions. A transaction is said to take place when a good or service (in this case, maritime containers) passes a technological barrier. The barrier determines where one phase of activity ends and another begins and where the exchange of rights, duties, and information takes place[21]. Transactions in port-hinterland chains are not smooth because of the many coordination problems among actors in the exchange of containers, rights, duties, and information. Coordination arrangements are chosen because they minimize transaction costs either before (ex ante) or after (ex post) the transaction. Examples of ex ante transaction costs are searching for and selecting a contract partner;

[19] There are two schools in economic institutionalism. First, the New Institutional Economics (NIE), of which TCE is part, helps to answer the question about efficient governance structures to coordinate transactions. The second school, Original Institutional Economics (OEI), explains why governance structures emerge and develop. The OEI approach is more dynamic, and analysing the process of change is more important than the comparative static analysis in NIE.

[20] Williamson (2008) refers to the work of Robert Solow (2001). Solow offers three precepts: keep it simple, get it right, and make it plausible. Keeping it simple is accomplished by stripping away inessentials. It requires prioritizing and finding the central forces. Getting it right entails working out the logic. Making it plausible means preserving contact with the phenomena.

[21] Williamson defines the transaction as a transfer transaction that is between technologically separable stages. Therefore, a buffer inventory could be introduced to effect temporal separation between adjacent stages in the transaction.

drafting, negotiating, and safeguarding a contract; and organizing dispute referrals. Ex post transaction costs occur after the contract is concluded. The aim of TCE is to explain the coordination arrangements chosen based on the level of transactions costs, which are determined by the characteristics of the transaction and the actors involved. TCE assumes that actors want to minimise transaction costs, even if the actors are not completely informed and have to deal with uncertainties (Williamons, 2008). In TCE the emergence of three governance modes (market, hybrid, and hierarchy) is explained by three dimensions: asset specificity, the frequency of transactions, and the degree and type of uncertainty to which the transactions are subject (Williamson, 2009:59).

In their attempt to understand the level of hierarchical control chosen in alliances, Gulati and Singh (1998) state that, in addition to appropriation concerns, which they argue are central to the TCE approach, coordination concerns arise from the interdependence of tasks across organizational boundaries and the related complexity of ongoing activities that must be completed jointly or individually. Their main focus is on the coordination costs caused by participants' uncertainty about how activities will be decomposed and integrated and by the extent to which there is likely to be an ongoing need for mutual adaptations and adjustments. The primary factor that underlies the level of coordination costs is the type and level of the interdependency between actors. Malone and Crowston (1990) state that coordination is concerned with managing dependencies between activities and that, depending on the nature and level of interdependency, more or less strict coordination mechanisms are required.

In port-related hinterland chains, coordination problems are often related to highly interdependent operational activities instead of to real commercial transactions. Therefore, in this article we base the operationalization of our variables both on TCE and on the approach of Gulati and Singh (1998) by considering the characteristics of the transaction from both an appropriation perspective and an operational coordination perspective. We specify attributes related to the type of interdependency, to the transaction, and to the coordination arrangements chosen. We add the last category because we want to control for some context-related factors that might have an influence.

Related to the characteristics of the transaction, we include complexity as an explaining variable (see also Williamson, 1996). Complexity has to do with many factors, including the technology involved, power relationships, transparency of legal rules, and so on (Groenewegen, 2005). The term 'complexity' is often used in the context of incomplete contracts; in cases of low complexity, contracts are efficient coordination arrangements, but high complexity leads unavoidably to incomplete contracts because it is too costly to specify all of the possible contingencies in the contract. In cases of high complexity, more public involved can be efficient. In both situations—complex and not complex—the governance structure reduces transaction costs (see Figure 3.1). The main categories of coordination arrangements in hinterland chains—incentives, interfirm alliances, changing the scope, and collective action—go beyond TCE's market (contract), hybrid and hierarchy, but they exist because conditions of complexity can become such that the 'assistance' of these types of governance is needed to get the coordination done efficiently (Williamson, 1996).

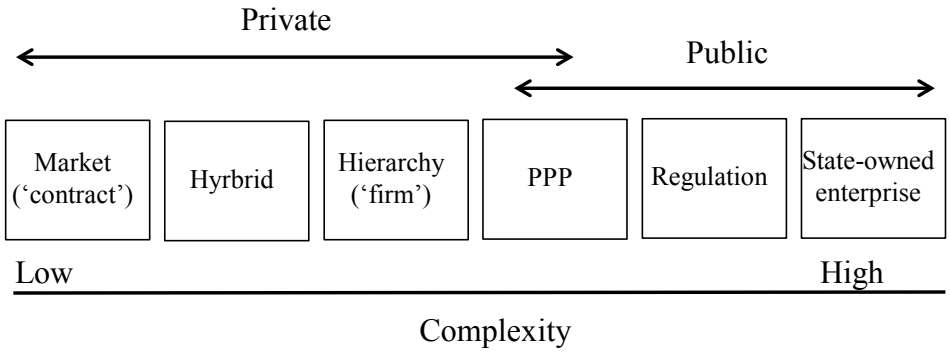

Figure 3.1 Relationship between complexity and governance structure chosen (Source: adapted from Groenewegen, 2005)

Consistent with a precept from Williamson's pragmatic methodology (2008), keep it simple, our operationalization names and explicates the key characteristics related to the complexity of the transaction and of the coordination arrangements chosen for improving hinterland accessibility. The characteristics are also chosen based on the ability to measure them in an intersubjective way. Section 3.4.1 and 3.4.2 describe the selected characteristics in detail.

3.4.1 Characteristics related to the transaction

The coordination problem to be solved
Coordination arrangements are made primarily to solve an inefficient transaction or a coordination problem (problem-based). The first question, then, is: what type of transaction or coordination problem does the coordination arrangement concern? The types of coordination problems that occur in hinterland chains can be divided into three categories: (1) lack of investment in the inland transport network (2) lack of operational coordination in the port-inland transport chains, and (3) underutilisation of assets[22]. Here we can draw a parallel with the problems related to the interdependence of tasks across organizational boundaries: lack of investment relates to resource or pooled dependence, lack of operational coordination relates to either sequential or reciprocal dependence, and underutilisation of assets relates to resource or pooled dependence (Gulati and Sing, 1998).

Number of actors involved with the transaction
The level of complexity influences the coordination arrangement chosen, and one of the key characteristics that determines complexity is group size. Coordinating a large group of actors with different behavioural characteristics and objectives is complex and requires more mechanisms than does coordinating a small, homogeneous group. Group size is rated on a scale from small to large.

[22] The emergence of a coordination arrangement can also be primarily opportunity-based. In this case, a coordination arrangement is begun to help the actors involved to remain vital and to contribute to a firm's or a group of firms' value creation.

Group character
Group character is defined as either homogeneous or heterogeneous. Coordination is assumed to be more complex if it is done among actors with different characters, different goals, and different drivers. In our analysis, if the group of actors involved is from a single sector, the group is considered homogeneous; otherwise, the group is considered heterogeneous.

3.4.2 Characteristics related to the coordination arrangement

Transport mode
For every coordination arrangement, a hinterland transport market is specified. Coordination arrangements can be introduced in container barging, container railway transport, container trucking, or all three.

Functions of the actor involved
For each coordination arrangement, the actors involved can be container shipping lines, deep-sea terminal operators, terminal operators in the port for barging and rail transport, transport companies (barge operators, railway companies, and trucking companies), the terminal operators in the hinterland for barging and rail transport, shippers, and forwarders. In addition to these private actors, the involvement of public actors like Customs authorities and regional and national governments is relevant. Next, the involvement of branch organisations and port authorities is indicated. In the case of Rotterdam, the port is organised according to the landlord model, in which a publicly owned port authority plays a central role. In 2004, the Rotterdam port authority became self-dependent and it has operated since then as an autonomous organization with a commercial focus.

Function of the initiator
There may also be patterns in the function of initiators that relate to the nature of coordination problems and the coordination arrangements. The function of initiators can reveal something about the urgency among the different actors involved in hinterland accessibility as well as about their position and ability to introduce coordination arrangements.

The power relationship of the initiator to the actors involved
Historically, advocates of TCE have been reluctant to acknowledge the possible contributions of power in understanding governance. For example, Williamson (1981: 572-3) charged that there is no precise definition of power that could explain when power does or does not influence (the rise of) modes of governance. In this paper, we follow Campbell and Lindberg (1991) in including the concept of power in our analysis on coordination arrangements. Power in the economic literature is understood as the capacity of an organization to extract for itself valued resources, including wages, profits, and information, in a system where other organizations seek to do the same thing for themselves, or otherwise to control the behavior of other organizations within the system (Perrow, 1986). In business logistics the concept of power, or dominance, is a central issue. Groothedde (2005) showed the potential of dominance to influence the actions and decisions of individuals and firms in a logistics network. We distinguish three types of power in coordination arrangements: those in which there is an equal power base, and none of the actors involved (can) take a dominant position

against the others; those in which one actor acts as a stimulator or enabler of coordination among actors in the chain, which is closely related to the concept of leader firms[23] (De Langen and Nijdam, 2003); and those that are enforced by one actor that takes a dominant position against the others.

Table 3.2 Characteristics of coordination problems and arrangements in hinterland chains

Characteristic	Criteria
Characteristics related to the transaction	
Coordination problem to be solved	Lack of investment, Underutilization of assets, Lack of operational coordination
Number of actors involved with transaction	Small (1 to 5), Moderate (5 to 20), Large (> 20)
Group character	1 sector, 2 sectors, > 2 sectors
Characteristics related to the coordination arrangement	
Transport mode	Road transport, Railway transport, Barging, All transport modes
Functions of actors involved	container shipping line, container stevedore, inland terminal operator, transport company, forwarder, port authority, national and regional government, Customs administration, and branch organisations
Function of initiator(s)	container shipping line, container stevedore, inland terminal operator, transport company, forwarder, port authority, national and regional government, Customs administration, and branch organisations
Power relationship of initiator to other actors involved	(1) equal power base, (2) stimulator/leader firm, (3) dominant actor (enforcement)
Use of information and communication technology	(1) None, (2) Limited, (3) High

[23] The concept of the leader firm in the port and maritime industry is elaborated by De Langen & Nijdam (2003), who define leader firms as 'firms in a cluster that have—because of their size, market position, knowledge and entrepreneurial skills—the *ability* and *incentive* to make investments with positive externalities for other companies in the cluster.' Externalities are, in principle, *all* investments that increase the competitive position of a network, like investments in improving the hinterland access of seaports.

Use of information and communication technology
According to observers of economic history (Chandler, 1977), innovations in technology create possibilities for new governance modes[24]. Information and communication technology facilitate the communications and decision-making patterns between actors. ICT systems can bring objectivity and rationality to decision-making since computers do not lie, and they do not behave strategically. Improving objectivity and rationality can increase trust in decision-making and lower transaction costs. Since communication and decision-making are critical activities for inter-organizational coordination (Malone and Crowston, 1990), we indicate whether each coordination arrangement uses information and communication technology. Although this research is primarily focussed on the organisational aspects of making efficient use of port-hinterland assets (orgware) and not on such things as new crane techniques or new transport means (hardware), it is relevant to investigate the role of ICT or software as being the 'in between' between hardware and orgware.

Table 3.2 summarizes the characteristics of coordination problems and coordination arrangements in port-related transport chains.

3.5 Empirical analysis

This section analyses the set of coordination arrangements with the variables described in section 3.4. After some relevant general results, section 3.5.2 links the coordination arrangements with the characteristics related to the transaction (coordination problem, number of actors involved, and group character). Section 3.5.3 provides an analysis of the characteristics related to the coordination arrangements.

3.5.1 Data collection and general results

This research builds on a database of coordination arrangements for improving the hinterland accessibility from the port of Rotterdam. The data, which was collected over the period from September 2005 to January 2010[25], consists of 91 coordination arrangements divided into the categories of introduction of incentives, creation of interfirm alliances, changes in scope, and creation of collective action. The majority of the coordination arrangements in the database (47%) belong to the category of interfirm alliance, but 15 percent are arrangements in which actors changed their scope or integrated a new business or activity. Changing the scope of an organisation is the most drastic form of arrangement because it often requires developing a completely new business model that requires new resources and capabilities. Interfirm alliances are less impacting. Incentives like penalty systems, differentiated pricing systems, and non-financial rewards were introduced in only eight cases. There are several reasons why incentives are less used: First, the lack of contracts makes the introduction of incentives between vertically related actors in the chain difficult. Second, companies tend to look at their own organisations rather than across their companies' borders to other actors in the chain. Third, there is still a substantial belief in the validity of the market mechanism, so firms may be reluctant to intervene. Fourth, introducing and maintaining incentives requires in-depth

[24] Chandler (1977) showed how revolutions in transportation and communication technology contributed to new governance modes in many mass-production industries in the United States during the nineteenth century.
[25] The database was used previously for the more conceptual research of Van der Horst and De Langen (2008) on coordination mechanism in hinterland transport chains. The database was updated and extended for the present research.

monitoring and recording of actions and results. Collective action is limited because of the fear of uneven spread of benefits and the risk of free-rider behaviour.

Additional data on coordination arrangements was collected by scanning reports, studies, and industry magazines and journals and by conducting interviews with managers in the hinterland transport chain. In the end, the database contained the following data: name of the arrangement, short description, year when the coordination arrangement has been established, transport mode, coordination problem addressed, type of actors involved, number of actors involved, initiator, power relation of initiator to other actors involved, description of the arrangement, horizontal/vertical cooperation, use of information and communication technology. The case of Rotterdam is instructive because all types of hinterland transport are present and because, given scarce capacity and growing volumes of containers, many coordination arrangements are made, especially for the road.

3.5.2 Characteristics related to the transaction and the coordination problem

The set of arrangements is about equally divided among the purposes of the arrangements: creating the investments needed in the inland transport service network, improving operational coordination in the inland transport chains, and improving the utilisation of assets (Figure 3.2) As to type of arrangement, incentives are introduced mainly to improve the lack of operational coordination, while interfirm alliances tend to focus on lack of investment and underutilisation of assets. Collective action is used primarily to solve problems related to lack of operational coordination and, to a lesser extent, underutilisation of assets. Since investments in hinterland chains by one actor often have collective rather than individual benefits, we expected more collective actions to be employed to solve the problem of lack of investment. In the case of under-utilisation of assets, creating collective action is mainly seen as optimising the use of infrastructural assets, whereas interfirm alliances are focused on exchange of (vehicle) capacity.

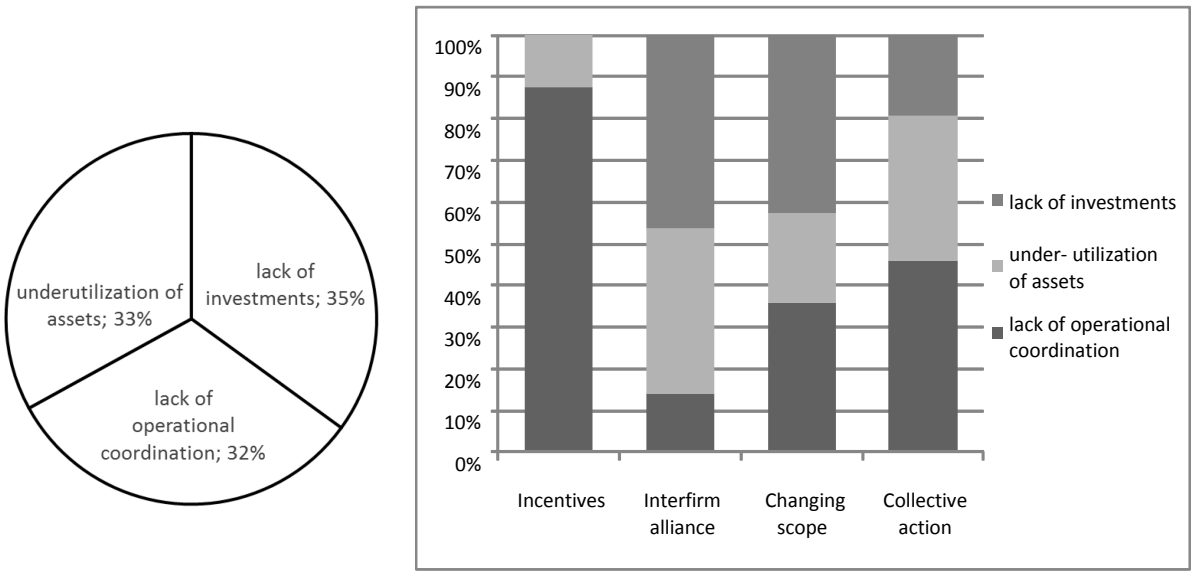

Figure 3.2 Coordination problem solved by coordination arrangements

Complexity increases with the amount of actors involved, especially if these actors are not completely homogeneous. In a large group with a lot of actors with different behavioural characteristics, coordination is likely to be complex and to require strong coordination arrangements, such as changing scope and creating collective action, in order to reduce coordination cost. If the group size is small, creating an interfirm alliance can be an efficient coordination mechanism, as Figure 3.3 shows. An individual example is the Extended Gate initiative of deep-sea terminal operator ECT, where only one actor is involved in the coordination arrangement itself. However, the coordination problem that is solved involves many actors, including a large set of transport companies and a large set of inland terminals. By integrating the inland service into its own company through investments, ECT reduced complexity by bringing the decision-making and destination of the inland transport of the container within one organisation (hierarchy).

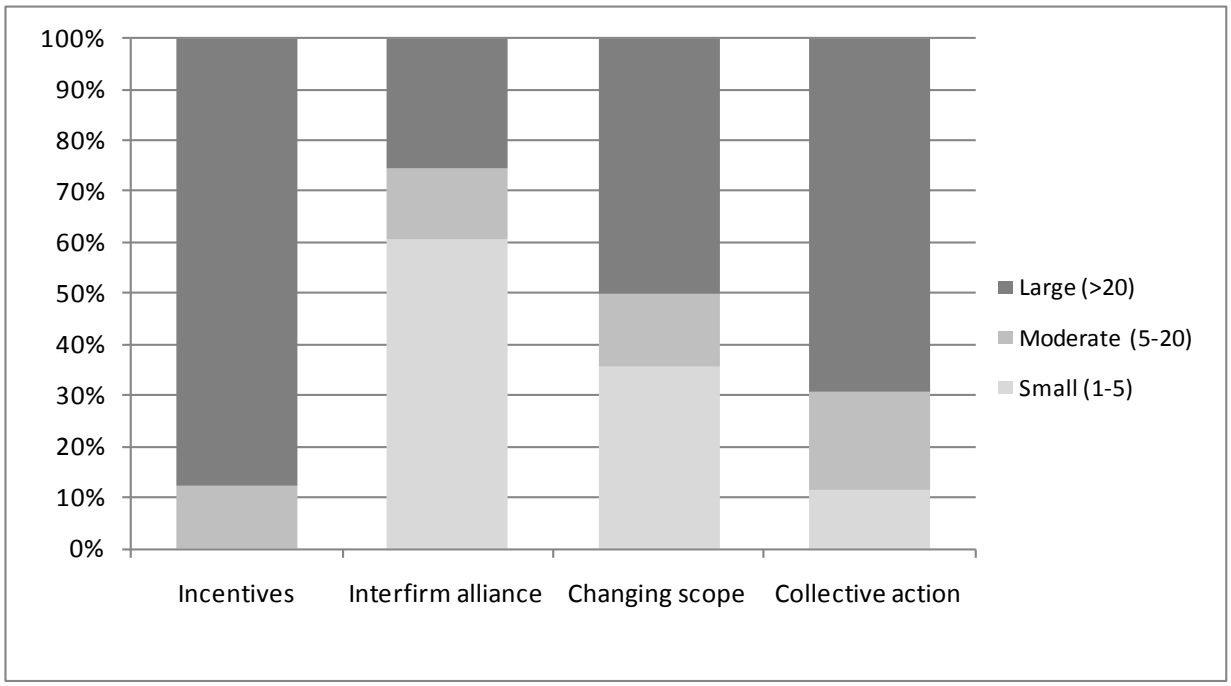

Figure 3.3 Number of actors involved

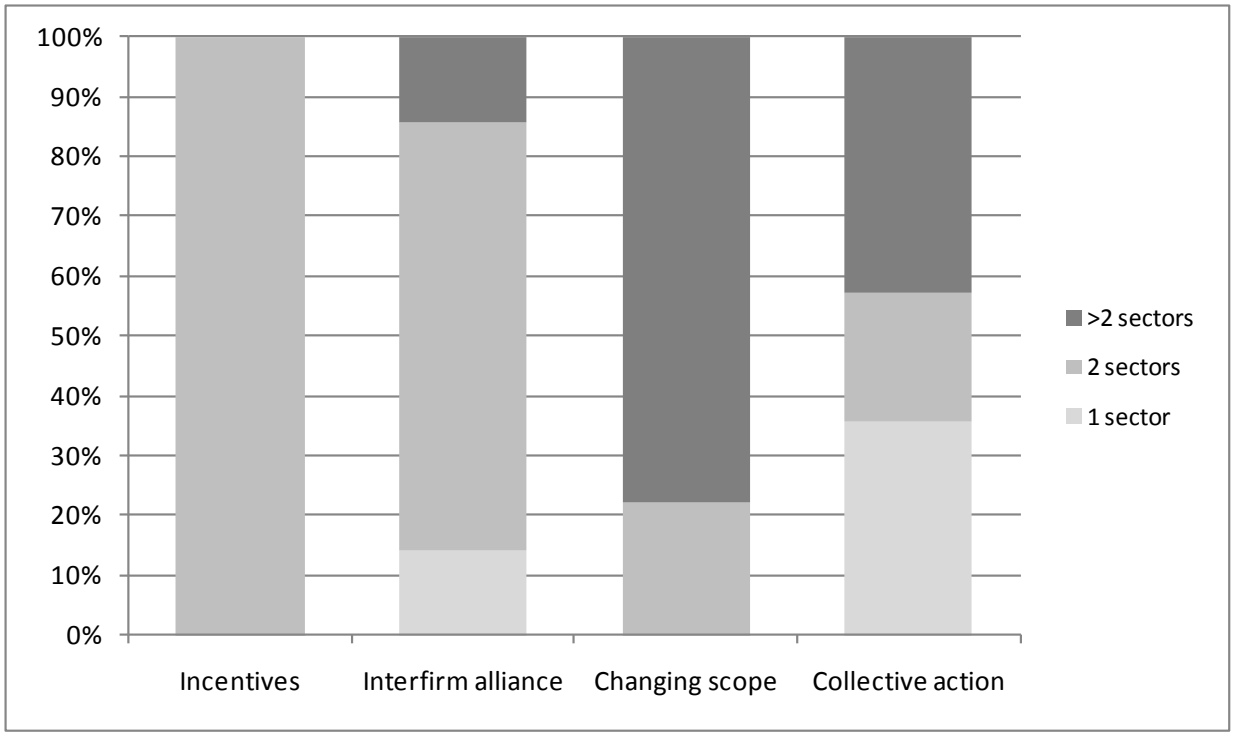

Figure 3.4 Group character

Moreover, the data shows that the majority of coordination arrangements in which incentives are introduced are chosen when many actors are involved and when actors from two sectors are involved (Figure 3.4). Changing scope does not emerge when there are many actors and more than two sectors are involved. To a certain extent, this finding matches the TCE assumption that, in situations of high complexity, because actors from different sectors are involved, strong coordination mechanisms, such as changing scope, emerge.

3.5.3 Characteristics related to the coordination arrangements

Table 3.3 divides the coordination arrangements into hinterland transport modes. In the database of coordination arrangements, the majority (47%) of arrangements are interfirm alliances, while 15 percent are scope arrangements in which actors changed their scope or integrated a new business or activity. Collective action arrangements are used in 29 percent of the cases, and 9 percent of the arrangements are incentive-based. As for transport modes, sixty arrangements emerged in the category of rail and barge (together about 66%). The dominance of rail and barge in the arrangements is indicative of their frequency in multimodal chains with more than one link (in contrast to road transport). The risk of coordination problems in these chains is much greater than in truck/road-based chains because of the rail and barge chains' higher complexity.

Table 3.3 Distribution of coordination arrangements among transport modes

	Barging		Railway		Trucking		All modes		Total	
Incentives	4	13%	1	4%	3	16%	0	0%	8	9%
Interfirm alliance	19	59%	15	54%	8	42%	1	8%	43	47%
Changing scope	4	13%	5	18%	1	5%	4	33%	14	15%
Collective action	5	16%	7	25%	7	37%	7	58%	26	29%

Rail and barge modes of transport are also more likely to need coordination arrangements because they require minimum levels of cargo to be cost efficient, so teaming up in terms of capacity is a real issue. Rail is also heavily dependent on infrastructure availability, which puts additional pressure on coordination. Collective action is evenly spread among the different types of arrangements and modalities, so it is the interfirm alliances that generate the differences between rail and barge on one hand and road on the other hand. Interfirm alliances in barge and road transport focus primarily on setting up new services in joint action, whereas interfirm alliances in road transport focus on the exchange of existing capacity. Incentives are seen least often in railway transport.

Table 3.4 Functions of actors involved with coordination arrangements

	Shipping line	Deep-sea terminal op.	Transport company	Terminal oper. inland	Forwarder	Branch organization	Port authority	Government	Customs Adm.	Total
Coordination										
Incentives	0	5	7	0	0	2	4	2	1	
Interfirm alliances	2	5	30	7	8	1	6	3	0	
Changing scope	3	5	6	6	3	0	2	1	3	
Collective action	1	8	16	3	3	13	17	10	5	
Total	6	23	59	16	14	16	29	16	9	
%	3	12	31	9	7	9	15	9	5	100

Table 3.4 provides an overview of the function of actors involved in coordination arrangements, and table 3.5 relates the actors to the coordination problem, and shows to what extent actors act as initiators. These tables make clear that, in approximately a third of all the cases, transport companies in trucking, barging, and railway transport act as initiators of coordination arrangements via interfirm alliances.

Table 3.5 Initiators of and functions of actors related to coordination problems (%)

	Shipping line	Deep-sea terminal op.	Transport company	Terminal oper. Inland	Forwarder	Branch organization	Port authority	Government	Customs Adm.	Total
Coordination problem										
Lack of investments	5	11	30	11	18	4	16	7	0	100
Underutilization of assets	2	9	37	11	4	12	19	5	2	100
Lack of operational coordination	3	16	28	5	3	9	12	12	11	100
Initiator										
Function of initiator	3	11	26	9	8	7	20	8	5	100

Many interfirm alliances between barge operators are active in container barging on the Rhine and between Rotterdam and Antwerp. These interfirm alliances are established to exchange cargo in a joint cargo pool. These alliances began on the river Rhine with the so-called Fahrgemeinschaften and in feeder traffic between the port of Rotterdam and Antwerp with the so-called Barge Planning Center. In rail transport, interfirm alliances include direct shuttle trains and are founded mainly with the involvement of carriers and railway terminals in the hinterland. Interfirm alliances in container trucking are horizontal forms of collaboration with the aim of exchanging cargo or capacity among the companies. For example, the principal objective of the cooperation of five trucking companies that created a common company under the name of Truck Load Match was a reduction in the number of empty trips. Trust also plays a role in formal cooperation between homogenous actors (in fact, between competitors). In Truck Load Match, trust is ensured by the fact that there is common understanding about the distribution of cost and benefits; the five partners each own 20 percent of the capital. The category ‘change of scope’ appears seldom among transport companies. A few trucking companies have integrated into their organisations barge transport to and from the port, including inland terminal operations. The driver for this vertical integration was congestion on the road in and around the port and on the main inland roads.

It is not surprisingly that transport companies have a great stake in improving the efficiency of port-hinterland chains and, in 26 percent of the cases, act as initiator of a coordination arrangement. Transport companies are the organisations that most directly incur the costs of bad coordination. Longer waiting times and underutilisation of their assets directly incur costs that they cannot easily pass on to their customers. This gives them a direct incentive to initiate arrangements both horizontally and vertically.

Deep-sea terminal operators and inland terminal operators together are involved in 21 percent of the cases. Table 3.4 shows that deep-sea terminal operators and inland terminal operators are active in all the categories, but particularly when incentives are introduced or incentive structures are changed. In general, the introduction of incentives is little used, but most incentives emerge between terminal operators and transport companies. Deep-sea terminals

suffer more indirectly than directly from inefficient inland transport chains, so only if they have to deal with congestion and overutilization at their terminals may they feel a need to develop better coordination, and their initiatives to introduce coordination arrangements have primarily to do with the operation of their own terminals. However, deep-sea terminal operators have begun to pay more attention to the working of the complete chain–at least in their communications—and have begun to introduce arrangements that benefit not only the working of the terminal itself but also the working of the whole chain. Deep-sea terminal operator ECT in Rotterdam has followed a strategy of taking stakes in 'key' inland terminals in Venlo (a rail terminal in the Netherlands), Duisburg (a multimodal terminal in Germany), and Willebroek (a barge terminal in Belgium). Other terminal operators in Europe are following the same strategy.

Forwarders in the port of Rotterdam have a limited stake in establishing coordination in the hinterland chain of Rotterdam. Forwarders act only sporadically as initiators of coordination arrangements. For the most part forwarders are involved in interfirm alliances in which they set up new transport services with transport companies. The low involvement of forwarders is likely because forwarders do not benefit from efficient transport chains; instead, they benefit from information asymmetry in transport chains and the lack of knowledge among shippers about transport possibilities, customs formalities, and logistics. The role of intermediaries like forwarders in the hinterlands is to act as a remedy to a lack of integration so they do not benefit from efficient transport integration (Ducruet and Van der Horst, 2009).

The Rotterdam Port Authority (PoR) is involved in approximately 15 percent of initiatives to improve hinterland accessibility, and it acts as initiator 19 percent of the time. Table 3.4 shows that the PoR plays an important role in establishing collective action. For example, in 2008 PoR was one of the founding members of the 'Verkeersonderneming' (literally translated as Traffic Cooperation), the purpose of which is to reduce traffic on the main road (A15) during rush hours. The PoR acted in close cooperation with the national branch organisations of shippers, the branch organisations of all logistical and industrial companies in the port, the Chamber of Commerce, the Province, and municipalities. Another example of collective action was the involvement of the PoR in the establishment of a port community system, PortInfolink (now called PortBase) after an agreement with the Port of Amsterdam to join forces. In 6 of the 29 coordination arrangements, the port authority was involved in an interfirm alliance, and in 2 cases the port authority changed its scope. An example in which the port authority changed its scope is the initiative to develop a container transferium in Alblasserdam, just outside the port area, where trucks can deliver their containers. The final fifty kilometres are executed by barge, thus reducing truck movements on highway A15. The PoR's high level of involvement in shaping an efficient hinterland network fits in with the general trend in which landlord port authorities have become more autonomous and operate beyond the landlord model (Van der Lugt and De Langen, 2007).

Primarily private market parties are involved with solving coordination problems in the PoR (Figure 3.5). These parties reduce or eliminate coordination problems mainly through interfirm alliances or by changing their scope of activities.

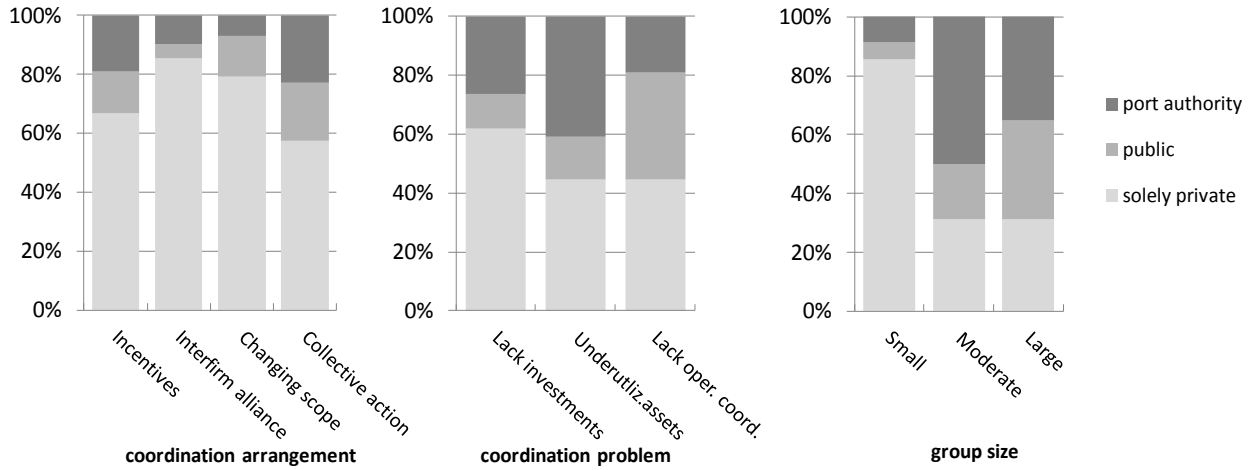

Figure 3.5 Actor involvement: private, public and port authority
Note: branch organizations are seen as public actors

Figure 3.5 shows that, as the group of actors involved with a coordination problem increases in size, the involvement of public actors or the port authority becomes more appropriate. Following TCE, efficiency increases when public actors, including a publicly owned port authority, intervene in coordination arrangements to solve coordination problems for large groups. The information in our database reveals that the intervention of a public actor or port authority is usually in form of collective action. Collective action with government involvement deals, for example, with (simplifying) procedures of the Customs Administration, but it also deals with coordination arrangements related to improving the utilisation of infrastructure.
We included the concept of power in the analysis of coordination arrangements and found that, overall, the enforcement of a coordination arrangement by one dominant actor is comparatively rare (Figure 3.6).

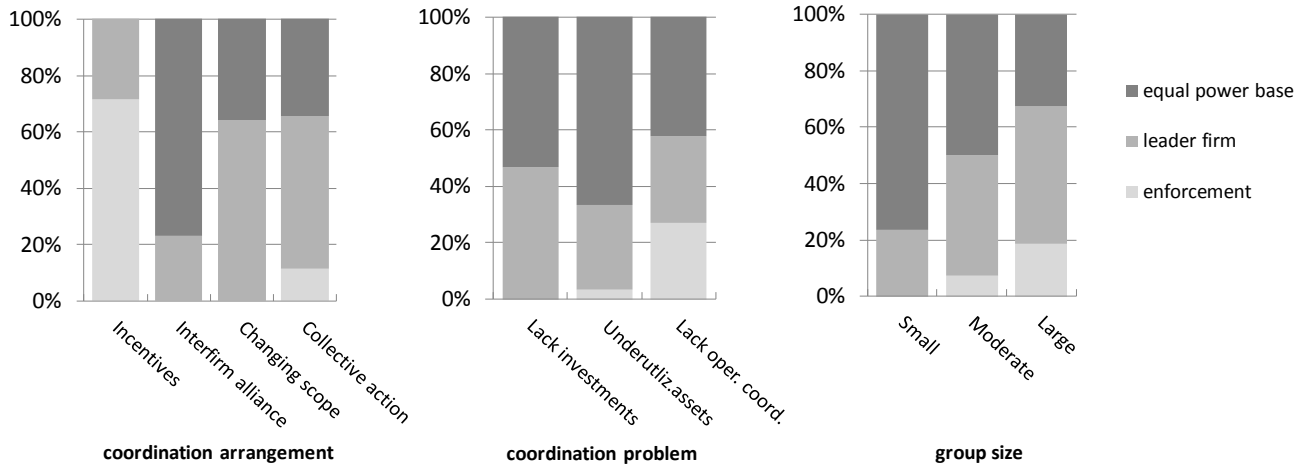

Figure 3.6 Power relation of initiator to other actors involved

In only eight cases does one actor take a dominant position against the others. Enforcement is often necessary when incentives are introduced, such as when rail infrastructure manager Keyrail introduced a new tariff system for the use of rail infrastructure in 2009. This system stimulates early bookings and contains penalties if railway companies do not cancel reserved trains tracks they do not need as soon as possible. Terminal operators also give incentives to road hauliers so they will pre-notify their arrival or use identity cards to smooth administrative procedures at the gate. The category of interfirm alliance is usually established on an equal power base. These interfirm alliances are merely the establishment of new transport services and their impact is generally not disruptive, so none of the actors involved needs to take a dominant position against the others. When actors change their scope or when they create collective action to improve coordination in the hinterland, the involvement of one actor as leader firm is important. These initiators or enablers contribute positively to better coordination because of their entrepreneurial skills.

Coordination among a large group of actors with different behavioural characteristics and objectives is complex and could require the involvement of a powerful initiator. The relationship between large group size and enforcement is limited (Figure 3.6); initiators of coordination arrangements act mainly as leader firms when group size is large. When a small number of actors in hinterland chains is involved with a coordination problem, approximately 75 percent of the coordination arrangements are done on an equal power base.

Communication and decision-making are critical activities for inter-organizational coordination. When information and communication technology is used in a coordination arrangement, it is mainly to improve the lack of operational coordination by providing information (Figure 3.7).

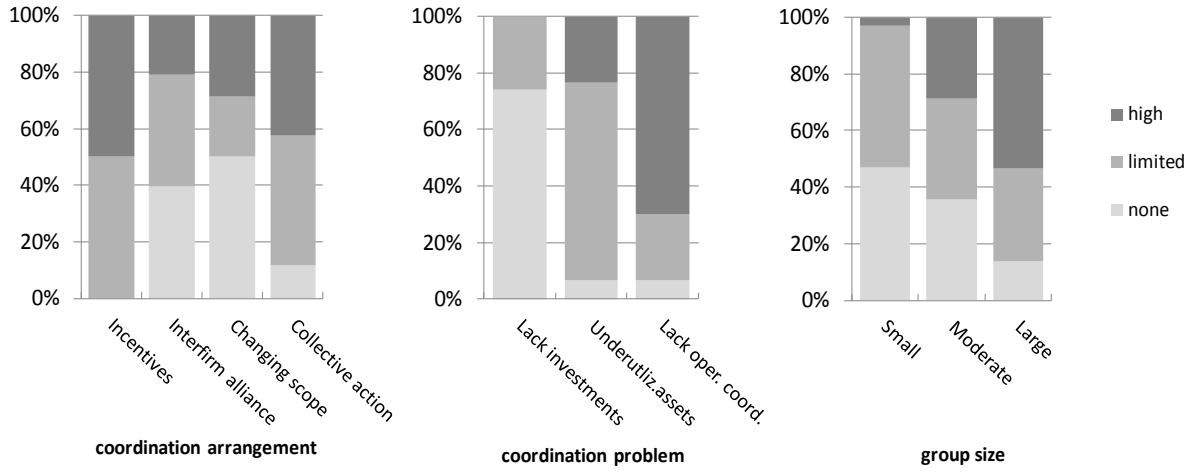

Figure 3.7 Use of Information and Communication Technology

With the inclusion of information and communication technology, what we observed most often is the provision of information for a broad set of actors involved in port operations (port community system PortBase) or inland transport services like River Information Services. River Information Services, which provides harmonised information services to support traffic and transport management in inland navigation, including interfaces to other modes of

transport, is regulated under a Directive of the European Commission. PortBase and River Information Services are both coordination mechanism in the category of collective action. Individual actors do not have the power or willingness to invest, and the large group size makes coordination complex. Initiators are the infrastructure managers (ProRail and Keyrail), the Dutch Directorate General of Public Works and Water Management (road and river infrastructure), or the port authority. In an interfirm alliance called MIS-CoBiva, five inland barge companies joined forces to develop a management information system to support inland navigation. One barge operator, Contargo B.V., is a founder member, and the project is developed together with the navigation specialists TomTomWorks and the software company BPA.

In most cases, Interfirm alliances with a high level of information technology are virtual marketplaces in which to exchange cargo that have the goal of better utilisation of assets. Incentives with a high level of information technology involved are initiated by deep-sea terminal operators with the aim of smoothing operations at the gates. Here we see a power-based action toward trucking and barge companies with the aim to smooth operations at the deep-sea terminal. Finally, ICT systems can bring objectivity and rationality to decision-making and lower transaction costs. Figure 3.7 shows a positive relationship between increasing group size and the use of information and communication technology.

3.6 Conclusion

Hinterland accessibility is one of the key strategic factors in port competition, and hinterland accessibility is, to a large extent, an inter-organisational challenge—the result of joint action of a set of actors with an operational interdependence. Transaction Cost Economics is a valuable lens through which to understand the reasons for the emergence of coordination arrangements beyond price. In applying TCE as a lens to clarify coordination in port-related transport chains, we encountered several issues. First, TCE focuses on transactions that have to do with capturing a fair share of costs and benefits. In hinterland accessibility, a strong requirement exists for inter-organisational coordination of operational tasks performed by different companies, potentially resulting in excessive coordination costs. In addition to the specific characteristics of the transaction according to TCE, the type of interdependence of the companies involved is relevant. The types of interdependence can be related to the specific coordination problems: lack of investments in the inland transport network, insufficient or suboptimal operational coordination in the hinterland transport chain, and underutilisation of assets. Second, to gain a better understanding of coordination in hinterland chains, further specification of TCE attributes is necessary. This article assumes a relationship between the coordination arrangement chosen and the complexity of the transaction. Complexity has to do with number of actors involved and the homogeneity/heterogeneity of the actors such that the more actors involved and the more heterogeneous the actors, the greater the complexity. More actors lead both to more complex appropriation concerns about excessive operational coordination costs, resulting in a requirement for more hierarchical coordination arrangements. Third, knowledge about coordination in hinterland accessibility is limited, so it is important to explore the characteristics of the coordination arrangements chosen, including the transport modes involved, the functions of the actors involved, the function of the initiator, the power relationship of the initiator to other actors involved, and the use of information and communication technology.

The analysis of the characteristics of the coordination problems and the coordination arrangements has provided some interesting insights. In Rotterdam, transport companies have a great stake in improving the efficiency of port-hinterland chains; in a quarter of the cases, transport companies act as the initiator of interfirm alliances. The Rotterdam Port Authority and terminal operators also play an important role, as the port authority acts as initiator of a fifth of the arrangements. Although terminal operating companies may be in a good position to initiate arrangements that benefit the working of the hinterland transport network, they do not play a leading role.

This research shows that, as the group of actors involved with a coordination problem increases in size, the involvement of public actors or the publicly owned port authority become more beneficial. Public actors are not much involved in interfirm alliances and do not often change their scope; however, they are active in introducing or changing incentives and creating collective action. The power relationship of the initiator to other actors involved plays a role in the type of arrangement, but the enforcement of a coordination arrangement by one dominant actor is rare. Initiators who acting as leader firms are more common when the group size is large. Information and communication technology can bring objectivity and rationality to solving coordination problems, so it is usually used to solve the lack of operational coordination and, to a smaller extent, to improve the utilisation of assets. Use of ICT is most appropriate when the group size is large.

This study reveals some relevant characteristics and causalities useful in improving the understanding of coordination issues in hinterland chains. Extending the dataset with arrangements from other ports, adding more attributes, bringing more rigour to the measurement of the attributes, and applying advanced statistical methods are worthwhile approaches for further research.

4 Change of scope by shipping lines and terminal operating companies[26]

4.1 Introduction

The market environment in which ports are operating is changing considerably. Since ports have become links in a global logistics chain (Robinson, 2002), port competition has moved from competition between ports to competition between logistics chains (Heaver, 1996). Shipping lines (SLs) and terminal operating companies (TOCs) are the main port users who have contributed to the fact that the world wide maritime transport chain is perceived as an integrated system. Over the last 15 years, the traditionally highly segmented container shipping industry (Martin and Thomas, 2001) has changed to a more integrated one. The success of a port depends on the ability to integrate the port effectively into the networks of business relationships that shape efficient supply chains, and to exploit synergies with other nodes and other players in the hinterland network (Notteboom, 2008). The efficiency of hinterland networks depends on the behavior of a large group of actors: shipping lines, terminal operating companies, freight forwarders, hinterland transport companies, inland terminal operators, port authorities, etc. Coordination between all of them is a key to form an integrated intermodal chain that passes through the port.

Van der Horst and De Langen (2008) investigated coordination in these chains from an organizational perspective. They introduced a typology with four actions that can be taken to enhance coordination. First, the introduction of incentives; incentives are used to align the interests of individual firms within one efficient overall transport chain (e.g. a bonus or

[26] Earlier published as: Franc, P., Van der Horst, M.R. (2010), Understanding hinterland service integration by shipping lines and terminal operators: a theoretical and empirical analysis, *Journal of Transport Geography,* vol.18, pp. 557-566

penalty when a transport company follows the operational rules of a terminal operator). Second the creation of an interfirm alliance. It can include many forms of interfirm cooperation. The third category is the change of scope of an organization which focuses on the vertical integration of actors in the chains and the introduction of new markets (e.g. a terminal operator starts its own transport company). The fourth and last main category is the creation of collective action in order to enhance coordination especially when investments to improve coordination have collective rather than individual benefits (e.g. development of ICT-system for the whole port industry).A framework with these four categories is based upon empirical evidence from the port and hinterland of Rotterdam. However, first, the framework lacks further specifications of the conditions under a certain coordination mechanism is chosen. Second, the framework is only applied to the port and hinterland of Rotterdam and needs to be verified in other hinterland regimes. The aim of this paper is to develop the category, 'changing of scope' further, to understand why and how shipping lines and terminal operating companies enlarge their scope in intermodal transport services and inland terminals.

Analyzing vertical integration has been an extensive subject of research both in the field of economics, and more recent in the field of strategic management. Within the field of Economics, Transaction Cost Economics (TCE) is considered to be on the prominent contemporary approached (Shelanksi and Klein, 1995). In turn, Strategic Management is dominated by the Resource-based View (RBV). On forehand, it can be concluded that a unified theory of a phenomenon like vertical integration is unlikely (Joskow, 2003). Unification of both theories is not the aim of this paper.

The next section shortly reviews the literature on TCE and RBV. In Sections 3.3 and 4.4, a number of coordination arrangements only from the North Range ports are analyzed where hinterland service integration by shipping lines and terminal operating companies takes place. The two theoretical approaches helps for a better understanding of the conditions under which shipping lines and terminal operating companies change their scope in port hinterland networks. Finally, the explanatory value of both theories will be discussed and conclusions are drawn.

4.2 Change of scope: two theoretical streams

When both shipping lines (SLs) and terminal operating companies (TOCs) enlarge their scope in hinterland services like intermodal transport and inland terminals, the different ways to be involved can be divided into three categories[27]. First, contract with risk-bearing commitment; which means long-term contract in which e.g. a shipping line signs this type of contract with a transport company or terminal to make use of their services for a fixed amount of TEUs. Second, minority investment; in other words it is when a company invests less than 50% in

[27] Parola and Musso (2007) describe four degrees of involvement of liners in terminal handling: a special agreement between the carrier and the terminal based on TEU throughput, a minority share taken by the liner in the terminal, a 50/50 joint venture between the terminal and the carrier, and a dedicated terminal owned and operated by the shipping line. In European inland terminals, all these configurations have not been observed yet. Since our analysis deals with the enlargement of scopes both in intermodal transport and in inland terminals, the following degrees of involvement of carriers inland are promoted.

another one. E.g. a TOC holds such a share in a rail-, barge- or terminal operating company. Third, own subsidiary; when one actor holds a share more than 50% and when this company has to assure the profitability and commercial exploitation.

Notwithstanding the contributions made on vertical integration within the logistics chain of shipping lines (Heaver, 2002) or concepts and findings on port hinterlands relations (see e.g. Notteboom and Rodrigue, 2005), the literature still lacks a theoretical basis about inter-organizational coordination in hinterland chains. Analyzing vertical boundaries determinants has been a subject of research both in the field of economics, particularly the field of New Institutional Economics, and more recently within the field of Strategic Management.

Within the field of Economics, Transaction Cost Economics (TCE) is considered to be one of the most prominent contemporary approaches. The reasons of its adoption probably lie in a combination of an economizing perspective, clear predictions, and considerable success related to the corroboration of such predictions (Shelanksi and Klein, 1995; David and Han, 2004)[28]. Acknowledging the lack of attention paid to coordination in hinterland transport systems, Panayides (2002) presents an analytical framework firmly rooted in TCE and claims that transaction cost theory deserves a greater attention in analyzing hinterland networks.

TCE is concerned with efficient governance structures for transactions. The transaction (which differs in its attributes) is the central unit of analysis to determine the efficiency of different modes of governance (which differ in their costs and competencies). A transaction occurs when a good or service is transferred across a technologically separable interface (Williamson, 1985, p. 1). The term ‘‘transaction cost” is frequently considered to have been coined by Coase, who used it to develop a theoretical framework for predicting when products or services would be derived from market (classical contracting) or by firms (hierarchical coordination). Indeed, for Coase (1937) the main reason to enlarge the scope of a firm – such as a SL or a TOC – is to avoid some of the transaction costs of using the price mechanism. Based on Coase’s work, Williamson (1975, 1985) introduced behavioral assumptions to Transaction Cost Economics: bounded rationality and opportunistic behavior. Because of bounded rationality and opportunistic behavior, transaction costs arise for ex ante reasons (drafting, negotiating, and safeguarding agreements between the parties to a transaction) and ex post reasons (maladaptation, haggling, establishment, operational, and bonding costs). Furthermore, TCE is characterized by three variables: asset specificity which refers to the relative lack of transferability of assets intended for use in a given transaction to other uses; uncertainty surrounding transactions; frequency of the transactions. TCE inquires about what is the cost-minimizing governance structure for given the attributes of the actors, the environmental uncertainty as well as the frequency of a transaction. Figure 4.1 summarizes the relation between these variables and the form of coordination required.

[28] Few issues of top journals such as the Academy of Management Review, Academy of Management Journal, and Strategic Management Journal are published without at least one paper mentioning transaction cost logic in one way of or another (Foss, 2005).

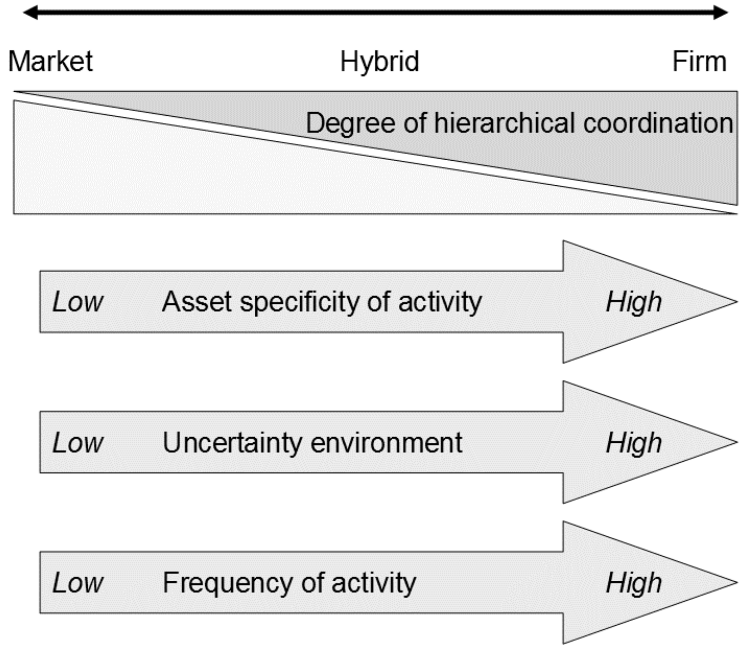

Figure 4.1 TCE framework (Source: adapted from Williamson, 1985)

According to the three different ways for SLs and TOCs to vertically integrate in the inland chain, a contract with risk-bearing commitment and a minority investment can both be considered as hybrids whereas a own subsidiary is a firm in Williamson's framework. Decision-makers must weigh up the production and transaction costs associated with performing a transaction within their firms vs. the production and transaction costs associated with executing the transaction in the market. In this respect, low asset specificity, low uncertainty and low frequency would favor a market-like contract. A transaction characterized as high asset specificity, high uncertainty and high frequency should be optimally governed within one firm (firms changing scope or coordinating hierarchically the chain). TCE helps 'explaining', for instance, why a SL starts its own dedicated terminal in the same port after 20 years of using a certain TOC in port ''via" market contracts and market prices (terminal handling charges).

Literature in Strategic Management is dominated by one theory named Resource-based View (RBV). Over hundred articles are published from this perspective each year (Rouse and Daellenbach, 2002). The fundamental principle of the RBV is that the basis for a competitive advantage of a firm lies primarily in the application of the bundle of valuable resources at the firm's disposal (Wernerfelt, 1984; Peteraf, 1993). RBV is focused on the factors that cause differences in terms of competitive advantage (Grant, 1991; Mahoney and Pandian, 1992). Through this theoretical lens 'value creating potential' of economic actors like SLs and TOCs depends largely on their unique resource configurations. In contrast to the TCE-approach where SLs and TOCs are cost minimizing actors, RBV assumes them as value creating actors who use strategic resources.

Table 4.1 VRIO framework (Source: Barney, 2001)

Valuable?	Rare	Costly to imitate	Exploited by organization	Competitive implications
No	-	-	-	Competitive disadvantage
Yes	No	-	-	Competitive parity
Yes	Yes	No	-	Temporary competitive advantage
Yes	Yes	Yes	Yes	Sustained competitive advantage

Unit of analysis in the RBV are resources in the firm, and it focuses on the relation between the resources and its performance. The firm is regarded as a ‘‘bundle of potential productive resources, bounded together in an administrative framework” (Penrose, 1959). Following the proposition made by Amit and Shoemaker (1993, p. 35), a distinction between resources and capabilities has been widely accepted throughout the Resource-based View literature (Conner and Prahalad, 1996; Makadok, 2001; Barney et al., 1991). In this respect resources are tradable and non-specific to the firm while capabilities are firm-specific and used to utilize the re- sources within the firm (Makadok, 2001). The former could be locomotives and wagons for SLs or TOCs and the latter the ability to coordinate the organization of a door-to-door transport chain. The decision concerning whether resources and capabilities are kept within the firm or transferred to external contractors should be made with regard to their strategic value for the firm. Valuable resources and capabilities should be kept within the firm, while less valuable resources should be outsourced to external providers (Prahalad and Hamel, 1990). In order to be able to distinguish these resources and capabilities, RBV offers criteria (explanations) in order to determine which ones are strategic. In this respect Barney (2001) VRIO-criteria are often used (Table 4.1).

The VRIO framework is based on two key assumptions. First, resource heterogeneity: each firm has a unique combination of resources and capabilities. Second, resource immobility: resources and capabilities in one firm cannot easily migrate to other firms. With the following questions, the VRIO-criteria will give the resources which can be best exploited. First the value: ‘‘Do its resources and capabilities enable a firm to respond to environmental threats or

opportunities?" Second the rarity: ''Is control of the resources and capabilities in the hands of a relative few number of firms?" Third the inimitability: ''Will there be significant cost disadvantage to a firm trying to obtain, develop, or duplicate the resources and capabilities?" Fourth, the organization: ''Are a firm other policies and procedures well enough organized to support the exploitation of its valuable, rare, and costly to imitate resources and capabilities?" If a firm possesses resources which are not valuable, this firm is competitive disadvantaged. At the next competitive level, a firm will be able to achieve competitive parity when it exploits and protects resources which are valuable but not commonly used. When a firm owns resources which are also rare, it can move up to another competitive level, achieving temporary competitive advantage. When a firm wants to achieve the highest competitive level, it must internalize those valuable and rare resources, which are also difficult to be imitated by competitors. In short, RBV helps 'understanding' why a SLs or a TOC organizes hinterland transport, and how this activity (or skill and knowledge) contributes to the other strategic sources of the firm.

4.3 The enlargement of scope of shipping lines

4.3.1 How shipping lines broaden their scope

At the end of the 1970s, Sealand, APL and Maersk have been the North America (Hayuth, 1982, 1987). Then, in the 1980s and 1990s, the organization of intermodal services has been developed by most carriers combining selective investments in ports inland activities with different type of coordination arrangements (Baird and Lindsay, 1996; Heaver, 1996; Evangelista and Morvillo, 2000; Notteboom and Merckx, 2006; Parola et al., 2006). This trend has been spreading to North Europe. Now, four carriers are involved in the inland leg from the Le Havre–Hamburg Range: Maersk, MSC, CMA CGM and NYK. Table 4.2 gives an overview on how these SLs changed their scope towards activities in inland transport and inland terminals.

A first type of contract with risk-bearing commitment can be concluded between a SL and a combined transport operator. Since 2004 for MSC and 2006 for Maersk, both SLs have contractual agreements with the road-barge operator LogiSeine assuming commercialization and exploitation of waterway services from/to Le Havre (Fremont et al., 2009). However a contract with risk-bearing commitment can also be signed between a SL and a rail and/or barge company. Thus, MSC concluded a long-term contract with Dillen and Lejeune Cargo (DLC), a private railway company, to provide dedicated trains between Antwerp and three inland terminals (Neuss, Germersheim and Frankfurt). NYK developed a similar agreement with the railway company Rail4Chem, in which the SL guarantees a 'fixed' cargo volume for shuttles trains between the port of Amsterdam, Rotterdam and Duisburg and Prague. Incidentally, NYK and MSC bypass combined transport operators.

Table 4.2 Examples of coordination arrangements of shipping lines to change scope in intermodal transport and inland terminals

	Mærsk	CMA /CGM	MSC	NYK
Contract with risk-bearing commitment	Barge Seine (Le Havre)		Barge Seine (Le Havre) Dedicated trains DLC (Antwerp)	Dedicated trains by Rail4chem (Amsterdam)
Minority share investment	BoXXpress (47%);	D3T Duisburg with NYK (40%)		D3T Duisburg with CMA CGM (40%)
Subsidiary	ERS Railways (100%); Inland terminal Neuss (2009)	RSC (100%); Rail Link; LTI France (100%)		

SLs own minority shares in both transport services and inland terminals. Maersk has shareholding of 47% in BoxXpress through ERS since 2000, thus providing services from the port of Bremerhaven and Hamburg. The Duisburg Trimodal Terminal (D3T) is the first directly operated by SLs. Thus, in January 2008 both CMA CGM and NYK have invested in D3T. These SLs see D3T not only as a local inland terminal for the Lower Rhine Ruhr area, but also as a future Pan-European hub.

SLs create hinterland service subsidiaries as well. Maersk owns ERS Railways as subsidiary. Created in 1994, ERS was initially a rail road transport operator. Nevertheless, since 2002 and the creation of ERS Railways, it assures tractions of trains between the ports of Rotterdam and Bremerhaven and inland terminals, mainly for Maersk (80% of the volumes), but also for other freight forwarders or carriers (20%). Maersk recently announced that it will invest 20 M€ in a 60,000 TEUs capacity dedicated terminal in the German Rhine port of Neuss. CMA CGM liner has chosen a strategy focused on the establishment of subsidiaries for inland transport: River Shuttle Container (RSC), Rail Link and LTI France, which respectively provide barge-road services on the river Seine, rail–road services from Le Havre, Zeebrugge, Antwerp, Rotterdam, and trucking transports from/to Le Havre.

4.3.2 Understanding why shipping lines broaden their scope

Firstly, Shipping lines (SLs) cope with difficulties to warrant their future revenues which directly depend on the evolution of the freight rates. Secondly, economies of scale at sea reach their limits since the size of vessels grows (Cullinane and Khanna, 2000). Therefore SLs must find new pools of productivity. Two motivations trigger the wish of SLs to enlarge their scope inland: minimizing their logistics costs (inland transport, storage and container repositioning costs) and increasing their competitiveness through differentiation. What explanations do Transaction Cost Economics (TCE) and Resource-based View (RBV) provide for the fact that MSC, Maersk, CMA CGM and NYK broaden their scopes in hinterland networks?

Minimizing costs

SLs have identified inland logistics as one of the most vital area to cut costs. Notteboom (2004b) clearly demonstrated that scale increases in vessel size shift the door-to-door cost burden from sea to land. For instance, inland costs could account for 42% of the total cost of a liner, and even 50% if the repositioning of empty boxes is included (Hastings, 1997). The deployment of mega-vessels triggers operational bottlenecks and synchronization problems along the transport chain which tends to increase the importance of coordination (Notteboom and Rodrigue, 2005). Therefore, vertical integration can lead to minimize coordination costs. In addition, with the emergence of global trade imbalances, the repositioning of empty containers has become a key challenge for liners owning or leasing containers. Forwarders do not have an incentive to return the container quickly to the SL. Therefore, SLs find a way to reduce their costs by providing transport services and by investing in inland terminals. The purpose of SLs is to rationalize their inland network by strategically settling inland depots (Slack, 1990). SLs have to find a proper balance between the inland transport price paid by shippers and the costs of container logistics that they support. This tends to limit the number of inland terminals in a few dense areas well connected by train or barge services. Empty container depots are generally inside or close to a trimodal or bimodal inland terminal in order to facilitate the repositioning of empty boxes.

The empirical analysis is not completely congruent with the core prediction of Transaction Cost Economics (TCE). In general, investments in intermodal transport are low asset specific because locomotives, barges and trucks keep value beyond their use in the context of a specific transaction; they are redeployable. Site specificity of inland terminals is quite high since terminals are hardly ‘‘redeployable”. The dependence of intermodal transport and inland terminal operators upon few SLs is increasing, due to concentration in the maritime market. According to TCE, uncertainty surrounding transactions arises because of bounded rationality and opportunism. From a qualitative point of view, it can be argued that actors in the container transport chain increasingly complain about bottlenecks such as insufficient infrastructure capacity and scarcity of terminal. For instance, in the early 2000s Maersk was not satisfied with the services of the existing railway company in the port of Rotterdam. In other words: uncertainty was high. By establishing its own railway company (ERS Railways), Maersk reduces uncertainty. Lastly, rather than the frequency of the transactions, inland volumes triggered by shipping lines increase the incentives for hybrid or hierarchy governance instead of market. Maersk, MSC and CMA CGM – the three major shipping lines in the world controlling 33.4% of the total TEU-capacity deployed on worldwide trade route at mid-March 2007 – are the main SLs involved in the hinterland. NYK is only the 8th shipping line but is part of the Grand Alliance with Hapag Lloyd, OOCL and MISC. Therefore, the total deployed TEU-capacity of the Grand Alliance puts it between MSC and CMA CGM in the shipping lines hierarchy.

Developing a competitive advantage

Being involved along the transport chain can be a source of competitive advantage. Therefore, a perspective originated from Resource-based View of the firm (RBV) is relevant as well. SLs have been led to rethink the scope of their services to improve customer satisfaction (Carbone and Gouvernal, 2005). Outsourcing some transport activities has proven to be a strategic option. As the qualitative expectations for inland services increases, SLs have to meet

shipper's and forwarder's requirements in terms of frequency, punctuality, reliability and geographical coverage (Slack et al., 1996). SLs mainly focus on providing intermodal transport services before logistics services (Fremont, 2006). Cargo owners who have strong relations with a liner may prefer the carrier involved in inland transport instead of having to deal with other parties. The provision of inland transportation services also offers shipping lines the opportunity to differentiate. Even if sea services are not so quite homogeneous (Drewry, 2006), being involved over inland offers advantages such as the capability to discriminate price and to meet market requirements.

In this context, including inland transport services and inland terminals as a pool of internal resources and capabilities strengthens the competitive advantages of SLs. How can the inland involvements of SLs be forecasted? According to the VRIO theoretical framework, implementing the organization of inland transport is an actual source of value, particularly because major shippers are increasingly expecting one-stop shops to minimize the number of third parties (Panayides, 2002). Moreover, one-stop shopping is viable and favorably received by international shippers (Semejin and Vellenga, 1995). Owning a dedicated inland terminals tends to convince shippers of the SL ability to secure container flows, and consequently to offer reliable services. But the ‘‘value" provided by enlargement of scopes both in intermodal transport and inland terminals depends on the existing offer. The value is high when the market offer is poor and the shipping line can improve the supply of such services by stepping into the business. This is what happened when ERS was set up. However, if the market offers high quality services then the value for a shipping line to step in is much lower as well. Since the liberalization of freight transportation in Europe, there are only a few rail road or barge-road operators (Gouvernal and Daydou, 2005). There are even less SLs involved in an inland terminal than in intermodal transport. In such a manner the development of these types of resources and capabilities by SLs is quite rare. Firms lacking these resources face a cost disadvantage. But they generally do not control enough volumes to enlarge their scopes. Apart from financial costs, the duplication of these types of resources and capabilities by implementing inland transport services supposes competencies beyond the core business as well as a good knowledge of the inland transport and operating terminal sectors. Eventually, the potential of SLs to support the development of new capabilities depends on SLs.

4.4 The enlargement of scope of terminal operating companies

4.4.1 How terminal operating companies broaden their scope

As shown by Notteboom (2002), the European terminal operating business is rapidly transforming. The terminal operator business is confronted with bigger, fewer and more demanding shipping lines (SLs) and cargo controlling parties in the hinterland. These changes challenge stevedoring companies to redefine their raison d'être. In reaction to the carriers' aggressive strategies and in order to exploit the investment opportunities offered by the recent ‘‘institutional turn" in ports (Juhel, 2001), the port industry has been transformed. Transnational companies have been increasingly involved in the business of terminal operation (Slack and Fremont, 2005). Terminal operating companies (TOCs) have particularly expended horizontally, through the reproduction of core services at various geographical locations all over the world.

Firms such as HPH, PSA, DP World, APM Terminals, Eurogate or even HHLA have become leading actors. Four among the major international cargo handling groups (Hutchinson, PSA, Eurogate and HHLA) control 50% of the containers handled in Northern Europe (Drewry, 2007). Like SLs, TOCs have to strive to reduce their costs and to differentiate their services. By doing so, some TOCs intend to integrate in hinterland services from the European Northern ports. Even if a terminal operator such as APM Terminals claims its independence from its parent company Maersk, it is impossible to rule out the fact that its development strategies are closely related to the strategy of the SL. Enlargements of scopes of independent carrier TOCs in the ports of the Northern range are discussed in table 4.3.

Table 4.3 Examples of TOCs coordination arrangements to change scope in intermodal transport and inland terminals

	Eurogate	HHLA	TN	HPH (ECT)	DP World
Contract with risk-bearing commitment				Daily shuttles Veolia to Venlo (Extended Gate)	
Minority investment	Contship Hanibal (33,4%) BoxXpress (38%)	Transfracht (50%); Polzug (33%)	LogiSeine (45%)		DECETE Duisburg (12%) Hintermodal services
Subsidiary		Metrans (51%); CTD (100%)		DECETE Duisburg (51%); ECT Venlo (100%); ECT Willebroek (100%)	DP World Germersheim (100%)

Some terminal operating companies (TOCs) like Eurogate, HHLA or TN are increasingly active inland without any asset in inland terminals. Eurogate could be considered as one of the most integrated TOCs in intermodal transport. First, it owns currently a 38% share in BoxXpress which organizes and runs shuttle trains from Hamburg and Bremerhaven to Southern Germany and the conurbations of South-Eastern Europe. Second, Eurogate also owns a 33.4% equity share in a train service called Hannibal. The latter organizes block trains linking Mediterranean port terminals (Gioia Tauro and La Spezia) and Southern Germany. Through the combination of Hanibal and BoxXpress, Eurogate is able to carry freight from Southern Germany and Northern Italy to its German or Italian sea terminals. The leading position of German TOCs in providing intermodal solutions is represented by HHLA. Since 65% of the throughput passing through the port of Hamburg is also handled by HHLA, this TOC strengthens Hamburg presence in Eastern Europe, through the implementation of extensive rail services via Metrans in Czech Republic and Polzug in Poland (Debrie and Gouvernal, 2006). Conversely to the major North Range ports, controlled by some of the major international cargo handling groups, containers in Le Havre have for a long time been handled strictly by local terminal operating companies. In a context of underinvestment until the end of the 1990s in Le Havre, Terminal de Normandie (TN) tooks a 45% share in the first French barge-road operator, LogiSeine.

In these different cases, enlargement of scopes among TOCs is achieved through the owning of equity share in rail operator, or by the development of subsidiaries. TOCs own shares in intermodal transport firms, but they do not commercialize and organize the transport. Only SLs in carrier haulage and freight forwarders in merchant haulage have these competences. The development of the extended gates concept shatters this traditional repartition of inland transport organization between SLs and freight forwarders. ECT and DP World Antwerp, which are developing extended gates, are dealing directly with barge or rail companies. They transport capacity by barge and train and commercialize them, bypassing the traditional barge or rail operator. The initial extended gates concept exists already for years. In a strategy of implementing extended gates, ECT, which has been taken over by HPH, is a stakeholder of ECT Venlo (100% equity), DECETE Duisburg (51%) and ECT Belgium Willebroek (100%). Deploring the lack of coordination between terminal operators and inland transport, ECT is currently implementing inland services from Rotterdam to its inland terminals and providing its clients with a terminal with a 'free customs status' to facilitate custom clearance operations at this terminal. The ability of TOCs to solve the sometimes necessary intervention of custom clearance remains one of their key issues to implement extended gates. DP World Antwerp and the multimodal logistics provider Shipit have also set up the so called Hintermodal concept. The purpose is to assist, facilitate and manage hinterland transport for DP World clients. The service proposed by Hintermodal is a package offering handling, on- and pre-carriage using barge, rail, truck, short sea or a combination, documentation, custom clearance and equipment control. Therefore, DP World aims at implementing an inland network connected to its Antwerp gateway.

4.4.2 Understanding why terminal operating companies broaden their scope

The objectives of the vertical integration in terminal operating companies include cost saving through sharing resources and competitive differentiation. Two concepts of enlargement of scopes are taken into account: the ''traditional" one, implemented by HHLA, Eurogate and TN; the ''extended gates" one, implemented by ECT and DP World. What are the explanations provided by Transaction Cost Economics (TCE) and Resource-based View (RBV) for HHLA, Eurogate and TN involvement in transport activities? And what are those furnished by ECT and DP World involvement in both transport and terminal operating activities?

Minimizing costs

The increasing container transport volumes handled in seaports have put the issues of sea terminal and hinterland transport capacities and performances on the agenda of terminal operating companies (TOCs). Over the last 20 years, container throughput of Northern Range ports has grown very rapidly (Table 4.4).

Table 4.4 Evolution of North range ports throughputs (1975–2006 in 1000TEUs) (Source: port statistics)

	1975	1985	1995	2006	Increase per year
Rotterdam	1.078	2.654	4.787	9.690	10%
Hamburg	303	1.158	2.890	8.861	16%
Antwerp	355	1.350	2.329	7.019	14%
Bremerhaven	409	986	1.526	4.450	11%
Le Havre	232	566	970	2.130	10%

In spite of huge investments in new terminals during the last 20 years, TOCs have had, due to capacity pressures, difficulties to handle these increasing volumes. TOCs like ECT introduced a policy of no long-term storage of containers at the deep-sea terminal. DP World is dealing with the same issue; a lack of terminal capacity enforces more hierarchical coordination (DP World Germersheim) to achieve an optimal use of assets. Implementing a network with (dedicated) inland terminals and developing extended gates offers an increase of space and flexibility. From a Transaction Cost Economics (TCE) perspective, assets specificity is high. Terminal investments (site and physical asset specificity) and new knowledge of the TOC's personnel to organize inland transport (human asset specificity) are high. Then uncertainty is quite high due to, firstly the lack of cooperation between inland transport providers and TOCs, and secondly because of the external uncertainty caused by congestion of ports. Finally, local problems (terminal congestion) lead to a higher frequency and synchronization of transactions between terminal operators and transport suppliers (Rodrigue and Notteboom, 2008) and thus, according to the TCE framework to more hierarchical organization.

Developing a competitive advantage

Another aim of TOCs is the diversification of the business base in order to increase its market power. For TOCs, being involved in the European hinterland is an opportunity to improve their presence on the local market, and thus to direct/redirect flows through their sea terminals. Since the competition between ports and now between terminals (Slack, 2007) is gained inland, from a RBV point of view, implementing intermodal services and investing in inland terminals give a competitive advantage to TOCs.

According to the VRIO framework, developing inland activities can trigger volumes through sea terminal, particularly if the TOC is in charge of the commercialization of the intermodal services. The reliability of services can also be improved when TOCs control the full inland chain. Thus, the value added by TOC's in the ''extended gate" approach is higher than in the ''traditional" approach. Developing ''extended gates" is less frequent than taking shares in intermodal services. Thus the degree of rarity seems ''medium" for the ''traditional" approach and ''high" for the extended gate approach. Barriers are higher for the implementation of ''extended gates" than for investments through shares. Therefore, costs to imitate could be evaluated as ''medium" for the ''traditional" concept and ''high" for the ''extended gate" concept. Finally, the capacity of a TOC to integrate these new resources among its organization depends on the firms.

4.5 Discussion and conclusion

This paper was focused on Transaction Cost Economics and Resource-based View in understanding hinterland service integration by SLs and TOCs through the different coordination arrangements: contract with risk-bearing commitment, minority investment, own subsidiary.

Table 4.5 Strengths and limits of TCE and RBV in understanding hinterland service integration

		Strengths	Limits
TCE	SL and TOC	Enlargement of scopes copes with uncertainty	Providing explanation of choices between the different forms of arrangements Understanding geographical behavior (SLs enlarge their scopes from both main and secondary ports and TOCs only from main ports) Explaining port/hinterland selection in which vertical integration takes place
	SL	Uncertainty appears when existing services are not efficient	
	TOC	Uncertainty appears in ports where congestion is high and the coordination with transport service providers is weak	
RBV	SL and TOC	The value created is both for customers and firms which implement strategies Environmental circumstances are important: ‘‘value is high when market offer is poor”	Providing a full explanation of choices between the different forms of arrangements
	SL	Hinterland differentiation can provide competitive advantage for the maritime activity	Taking into account tradition and culture of firms
	TOC	TOCs’ competitive advantage differs depending on the implementation of ‘‘extended gates concept” vs. ‘‘traditional involvement”	

According to the empirical analysis for the ‘‘Northern Range case”, both TCE and RBV provide explanations why and how SLs or TOCs integrate into hinterland services. Table 4.5 gives an overview of strength points and limitations of both TCE and RBV in understanding hinterland service integration by SLs and TOCs which came clear from the empirical analysis

in section 4.3 and 4.4. In the empirical elaboration of TCE, it can be concluded that TCE helps to understand that both SLs and TOCs aim at enlarging their scopes in order to deal with uncertainty. While SLs develop inland transport services and inland terminals especially to cope with unreliable services, TOCs try to deal with the scarcity of space in ports and terminals as well as the lack of coordination with transport service providers. However, the empirical elaboration of TCE shows some limitations in understanding the choices made by SLs and TOCs between different forms of coordination arrangements. Measuring the level of specificity of assets in the development of intermodal networks is not completely obvious and often quite subjective[29]. From the empirical analysis it became clear that SLs vertically integrate from both main and secondary ports and TOCs only from main ports. In addition, in some hinterlands SLs and TOCs are involved while in other hinterlands they are not. This ‘‘geographical behavior” of SLs and TOCs is not part of TCE. Even if RBV does not fully meet the requirements to explain the choices about efficiency, this theory can be considered as more dynamic: how should resources be (re) distributed over time to adapt a TOC or SL to changing environmental circumstances and in order to provide a competitive advantage? RBV emphasizes more than TCE on the interactions between firms and the other actors of the maritime industry. In fact, the VRIO framework highlights that creating value not only for the firm but also for customers can trigger a competitive advantage. In addition, SLs and TOCs generate less value and rarity from/to a port where the hinterland market is already strongly controlled than from/to a port that has an already less controlled hinterland network. RBV takes also into account the fact that developing a competitive advantage includes either minimization of costs or product differentiation. Indeed, in some cases, a SL can develop a competitive advantage by implementing an inland transport service that increases its inland costs but that it also attracts new clients and improves the vessel loading rate. RBV is also useful to forecast the competitive advantage developed by TOCs. For instance, in case of congested port and infrastructures, the competitive advantage gained by vertical integration looks higher for TOCs implementing ‘‘extended gates” concepts rather than ‘‘traditional” involvement inland. Nevertheless, RBV shows some limitations in understanding hinterland service integration by SLs and TOCs, in particular because this theory fails at taking into account the business culture and philosophies of firms.

[29] David and Han (2004) provided a systematic evaluation with 304 statistical tests of Williamson’s transaction cost economics framework found in 63 scientific articles. They conclude that the results were ‘mixed’.

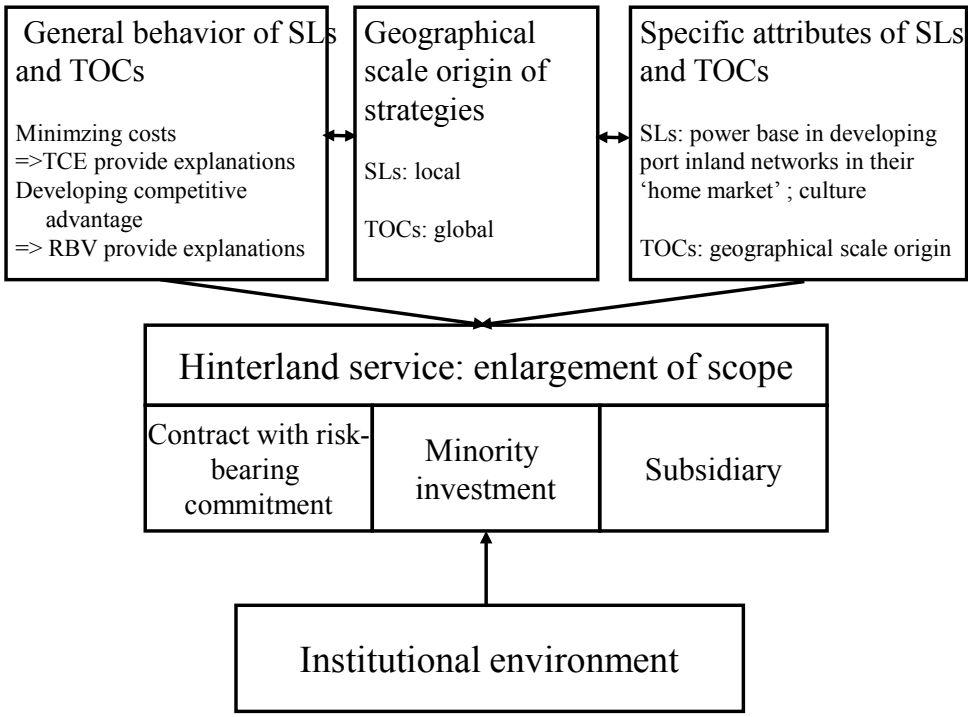

Figure 4.2 Proposition of a framework to analyze enlargement of scopes of SLs and TOCs

In this research we used only two theories which are considered as the most dominant ones concerning the topic of vertical integration. From the empirical analysis it became clear that in order to understand hinterland service integration the following aspect should be taken into account: firstly the geographical scale origin of enlargement of scopes strategies, secondly the firm attributes (power, culture and geographical origin), and thirdly the institutional environment (Figure 4.2).

4.5.1 Geographical scale origins of industry incentives

In general, it can be argued that SLs and TOCs both intent to minimize their costs, to develop a competitive advantage when they vertically integrate in the hinterland chain. TCE and RBV provide some explanations of this phenomenon. However, the scale origin of SLs and TOCs incentives produces an important difference. SLs incentives are from a ‘‘global” scale. Reducing the amount of container logistics costs has an impact on the cost effectiveness. The establishment of a seaport-land network proves their ability to offer a reliable one-stop shop service to customers. Therefore the competitive advantage developed enables them to strengthen their market position, which can positively impact the vessel fill rates, thus the cost effectiveness of the whole SL. On the contrary, the motivations of a TOC to enlarge scope inland are on a more ‘‘local” scale. TOCs cope with increasing costs triggered by rarity of terminals and local congestion (ECT in Rotterdam, DP World in Antwerp). TOCs such as HHLA in Hamburg defend local interests as well. Being involved in the hinterland network will represent a local ‘‘survive” strategy in this industry. Even the competitive differentiation of TOCs is noticeable at this particular ‘‘local” scale: containers loaded by a terminal operator in a Northern Range port would probably not be discharged by the same operator in another Port range. Thus, TOCs struggle for ‘‘local” competitive differentiation and it is mostly a

European phenomenon[30]. According to the main difference in terms of geographical scale origins of both SLs and TOCs inland strategies, it appears that SLs have to enlarge their scopes as soon as they can in order to build their network in Europe. So, SLs broaden their scopes in the hinterland of both main and secondary ports. On the contrary, TOCs are only involved from the main sea ports which are usually the most congested.

4.5.2 Specific attributes of shipping lines and terminal operating companies

The involvement of SLs in hinterland chains clearly depends on the power base of firms in each ports of the Range. In many cases, investments in deep-sea terminals were a first step in the implementation of an inland asset based network. The main SLs have substantially secured their handling activities along the North Range. The increasing gap between the objectives of ports and those of the SLs (Haralambides et al., 2002), the importance of the cost of handling operations (Stopford, 2002), the progressive lack of available deep-sea terminal spaces and the need to keep control of the intermodal chain (Heaver, 2002; Panayides, 2002; Notteboom, 2004a) are leading factors pushing SLs to control their own terminal operations. So far, the four SLs providing inland transport services – Maersk, MSC, CMA CGM and NYK – are generally involved in terminal handling from/to ports where their inland network is developed (Figure 4.3).

		1994	…	1999	2000	2001	2002	2003	2004	2005	2006	2007
Mærsk	Le Havre										*Barge operator*	TPO
	Rotterdam	*ERS*				APM Delta Terminal						
	Bremerhaven			North Sea Terminal	*BoxXpress*							
MSC	Le Havre					Terminal de l'Ocean			*Barge operator*			
	Antwerp							MSC Home Terminal/ *Dedicated trains*				
	Bremerhaven								MSC Gate			
CMA CGM	Le Havre					Terminal de l'Europe	*Rail Link*		*RSC*	*Naxco Logistics*	TDF	
	Zeebrugge										CHZ Terminal/ *Rail Link*	*D3T*
	Antwerp						*Rail Link*					
	Rotterdam									*Rail Link*		
NYK	Antwerp						Ceres Paragon Terminal				*Dedicated trains*	*D3T*

Figure 4.3 Relation between SLs involvement in port and in the hinterland network
(Source: authors, based on companies' websites and interviews).
Note: SLs dedicated terminals are written in lowercase; SLs inland transport services and inland terminals are written in italic)

Implementing an inland network, whether it is a risk-bearing commitment, a minority investment or a subsidiary, supposes a good knowledge of the ''local" market. Especially well implanted European actors propose cost effective point-to-point shuttles. European carriers involved in inland transport services, such as Maersk, MSC and CMA CGM, confirm that the presence of a home market played an important role in the enlargement of scopes process. Following many years of partnership and alliance with Sea- Land before purchasing it, Maersk has been traditionally one of the main clients of the port of Rotterdam and

[30] In the US or Asia, the ''inland game" is predominantly played by SLs.

Bremerhaven. Over the last decades, MSC and CMA CGM have developed a strong historic involvement respectively in Antwerp and Le Havre territories as well. Conversely, Asian carriers are particularly focused on Intra- Asia and transpacific trades and tend to be less represented in the European ports than Maersk, MSC and CMA CGM (Fremont, 2005). In this context, NYK strategy may come as a surprise. Only its long tradition of enlargement of scopes to inland transport and logistics can explain its strategy in Europe.

In fact, culture of firms is another incontrovertible point. For instance, MSC is more inclined to sign contracts with risk-bearing commitments with specialized firms than Maersk or CMA CGM which prefers become minority or majority shareholders of inland transport services or inland terminals. Therefore, knowing traditions of firms helps at understanding coordination arrangement chosen.

The power base of TOCs in some European ports has been fundamental as well. The first-movers inland were European TOCs: HHLA, Eurogate, ECT or TN. Moreover, these firms are involved in the hinterland of their ports of origin, respectively Hamburg, Bremerhaven and Rotterdam. Besides, the development of the extended gates concept by DP World is recent and PSA is not yet involved in this type of enlargement of scopes.

4.5.3 Institutional environment

The empirical analysis showed that SLs and TOCs choose a coordination arrangement given an institutional environment. The institutional environment contains laws and regulations, as well as public and political institutions (bureaucracies, ministries, etc.) In the institutional environment of hinterland chains recent European directives on liberalizing the European railway market influenced the way SLs and TOCs have been involved in container rail services (Gouvernal and Daydou, 2005). In ports from highly liberalized countries there was ‘room’ for SLs to develop inland transport services, e.g. from Rotterdam Maersk established a railway company ERS in 2002. On the contrary, the room for CMA CGM to establish through a partnership with Veolia Cargo railway company Rail Link came in 2007 due to slow pace of liberalization of the French railway market. While both theories make a valuable contribution in studying vertical integration of shipping lines and deep-sea terminal operating companies, this study shows the need for taking into account not only the industry incentives to broaden scopes but also geographical scale origin of these industry incentives, origin, tradition as well as power of firms and institutional environment. Further researches should precise the proposed framework. On one hand, the merits of theoretical and explanatory unification of TCE and RBV should not be denied. In unification of both theories additional theoretical research is needed into the inter-theoretical relationships and underlying philosophical premises of both theories. On the other hand, additional empirical analysis should be developed in other port ranges, particularly in Asia and in the US.

5 Effect of liberalisation on coordination in railway chains[31]

5.1 Introduction

In Europe, railway policy has concentrated on the liberalization of the market over the last two decades. It was anticipated that more competition, separating infrastructure management from rail operations, opening up the market for new operators, and the introduction of rules regarding the allocation and pricing of infrastructure use would lead to more efficiency. Efficiently organized portrelated hinterlands in terms of available infrastructure and efficient inland transport services form a key determinant in the competition among ports (De Langen, 2007; Notteboom & Rodrigue, 2008; Tongzon, 2009; Wiegmans, Van der Hoest, & Notteboom, 2008). Providing efficient hinterland chains is to a large extent a coordination challenge (Van der Horst & De Langen, 2008). The quality of efficient hinterland connections is the result of joint action by a set of actors with a great deal of operational interdependence, where interdependent activities between two or more actors should be managed (Malone & Crowston, 1994)[32]. Coordination is defined as managing interdependent activities between two or more actors to achieve good hinterland accessibility as a collective result. This paper reviews the literature and argues that despite a few studies, less attention has been paid to the economic organization of intermodal port-related transport in general, and specifically on railway transport in a liberalized environment.

[31] Earlier published as: Van der Horst, M.R. and Van der Lugt, L.M. (2014), An institutional analysis of coordination in liberalised port-related railway chains: an application to the port of Rotterdam, *Transport Review*, vol.34 (1), pp.68-85. The chapter also benefited from presentations held at the *12th Economics of Infrastructures Conference* in May 2009, in Delft (The Netherlands) and the *Annual Conference of the International Association of Maritime Economists* in June 2009 in, Copenhagen (Denmark).

[32] In this respect, interdependency and coordination are related because coordination is seen as a response to problems caused by interdependencies.

The innovation in this paper is that we propose a framework to address the issue of efficient coordination in port-related railway chains in a liberalized institutional environment. Following Ostrom (2009), this paper provides a framework that identifies a broad set of variables, their linkages and a list of attributes that are of key importance to understand coordination in port-related railway transport in a liberalized environment. Within any particular framework, alternative theories can be used; the starting point for our framework originates from institutional economics, and more specifically Williamson's (1996) work on the Transaction Cost Economics (TCE) theory.

Utilizing empirical illustrations, the paper will adapt the initial framework by introducing the theory of economic and institutional change, which is based on the work of North (2005). The framework presented in this paper lays the foundation for future work, it serves as an 'ordering system' that organizes empirical material, and improves our understanding of the effect of a regime change in the institutional environment (liberalization) on the way actors in port-related railway chains deal with coordination issues. Empirical illustrations are used from the liberalized railway market for containers in the port of Rotterdam — being the largest container port in Europe — between 2006 until 2010. It is focused on container transport because containerization has intensified port competition (Hayuth, 1981; Notteboom, 2010; Slack, 1993).

This paper is structured as follows: Section 2 will review the literature on intermodal port-related transport in general, and specifically on railway transport in a liberalized environment. In this section, we argue why and how coordination in port-related transport chains should be studied by using an institutional economics approach and we will then provide the framework. Section 3 will discuss the liberalization of the European rail market in the Netherlands. The result of an in-depth study into the economic organization of port-related railway transport in Rotterdam will be presented in Section 4. Based on these empirical observations, we will adapt the theoretical framework and come up with adjustments in Section 5. Section 6 will give some concluding remarks.

5.2 Coordination in railway hinterland chains

In their content analysis on seaport research, Pallis, Vitsounis, and De Langen (2010) note that the research on port and port-related transport and supply chains has expanded remarkably in the last decade. The growing research area mainly gained interest because of, firstly, increased container port competition and, secondly, more attention for intermodal transport, as it seen as a keystone for sustainable development of transport and ports. Port competitiveness has become an important issue in recent years. In the context of containerization, port competition has become fiercer, and the determinants in port competition have changed (Slack, 1993). Recently, Aronietis, Van de Voorde, and Vanelslander (2010) made a review of port selection criteria and evaluated the criteria among shipping lines, stevedores, shippers and logistics service providers.
The results of this research have shown that besides costs, the quality of hinterland connections is the most important determinant. The importance of having good inland infrastructure connections and hinterland transport services was shown earlier by Notteboom and Rodrigue (2008), De Langen (2007), Wiegmans et al. (2008), and Tongzon (2009). Van

Klink and van de Berg (1998) argue that ports have a good base to stimulate intermodal hinterland transport of containers via rail and barge which will extend their potential hinterland. Given its potential, intermodal hinterland transport research is emerging (Bontekoning, Macharis, & Trip, 2004) due to the high advantages for transport efficiency and sustainability. The present literature is embedded in different perspectives such as transport network design (Konings, 2007; Woxenius, 2007), transport geography (Van Klink & van de Berg, 1998) or operations research and mathematical frameworks (Lam & Gu, 2013; Macharis & Bontekoning, 2004). It should be noted that less attention is paid to the economic organization of port-related intermodal transport. The same position is taken by Panayides (2002). He states that an economic organizational approach is currently important due to the intense competition which exists in market logistics, the attempts of government to regulate in order stimulate competition and the need for economic efficiency and customer satisfaction. It was already explained that the liberalization of the rail industry in Western Europe is a relatively recent process, and the Dutch railway market relatively young. As an effect, limited research is available on the effects of the new regulatory regime on the rail freight market. Research on the economic organization of port-related transport is mainly covered by 'localized' studies in countries such as UK, France, Germany and The Netherlands (see also Pallis et al., 2010 and Bontekoning et al., 2004). Gouvernal and Daydou (2005). Debrie and Gouvernal (2006) and Woodburn (2007) focus on how the rail freight industry in Northwest Europe adapts to changed regulatory environment. The latter determined different forms of measurement in the context of the UK rail freight market. Debrie and Gouvernal (2006) analyzed the rail freight market in Western Europe. They stated that in the new regulatory environment, new roles arise and that new actors have appeared on the scene, the most important new actors come from the maritime industry. Gouvernal and Daydou (2005) took a closer look at the economic organization of rail services in ports in a liberalized institutional environment. They specifically investigated the role of shipping lines, deep-sea terminal operators and port authorities in the rail services network.

Port economic literature stresses the importance of the design of appropriate hinterland strategies and hinterland access regimes (De Langen & Chouly, 2003; Notteboom, 2010). Providing hinterland accessibility is, to a large extent, a coordination challenge (Van der Horst & De Langen, 2008) and is the result of joint action by a set of actors with a high-level operational interdependence. Following Malone and Crowston (1994), we define managing the interdependent activities, both vertical and horizontal, as coordination. Figure 5.1 shows the interdependencies that exist between actors. Several interdependencies give rise to coordination problems (see Van der Horst & De Langen, 2008 for a detailed analysis). The interdependency between the infrastructure manager and the railway company is a case where insufficient coordination could lead to suboptimal use of assets. If a railway company wants to use a rail track or a rail yard in the port area, then he must put in a request to the infrastructure manager. The infrastructure manager's allocation of rail tracks and rail yards has led to coordination problems since they allocate train paths on a fixed point in time (mainly on a yearly basis). Also at the interface between deep-sea rail terminals and railway companies, coordination problems exist. Because of the lack of contractual relations between the deep-sea rail terminal operators and railway companies (Figure 5.1), there is often a mismatch between the operations of both. Also, horizontal coordination can improve. The exchange of traction between railway companies would increase the utilization of

locomotives. This mutual exchange of traction is particularly required on the last kilometers of the rail track in seaports, because of the many small shunting activities that lead to idle time for locomotives.

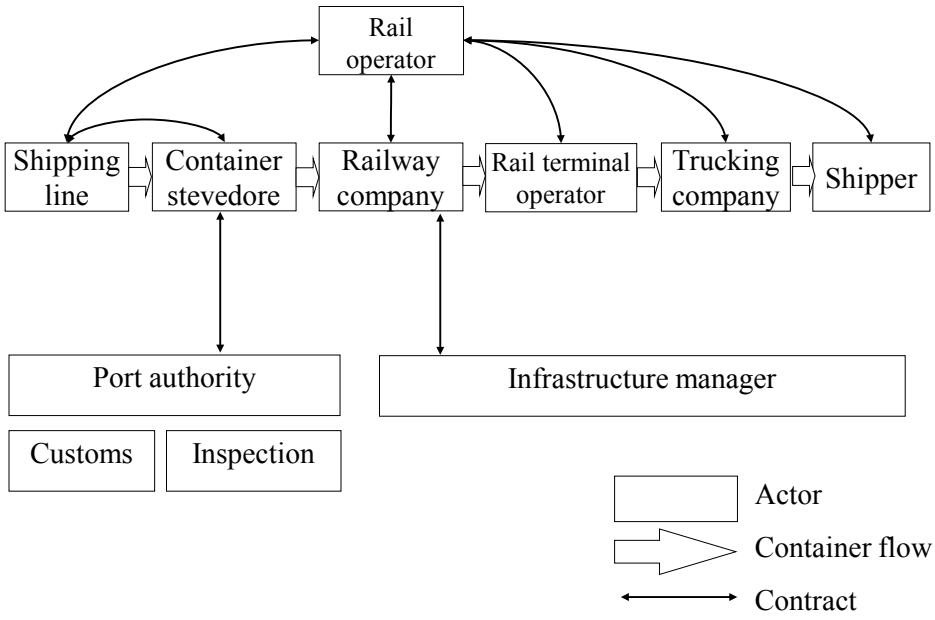

Figure 5.1 Intermodal railway chain

In this paper, we argue that there is a need to understand coordination in liberalized port-related railway chains from an institutional economic perspective. A framework for understanding the coordination arrangements of railway hinterland chains in a general way is the three-layer scheme[33] shown in Figure 5.2. This framework, inspired by the work of Nobel laureate Williamson (1996), is rooted in New Institutional Economics (NIE), and more specifically in TCE. The layered scheme allows for a better understanding of coordination in the portrelated transport chain because it acknowledges that coordination does not take place in vacuum, but is influenced by the institutional environment. Institutional economics, more specifically TCE, has barely been applied in port and intermodal transport literature (see Woo, Pettit, Kwak, & Beresford, 2011 for a review of theories, frameworks and concepts used). The earlier mentioned study of Gouvernal and Daydou (2005) classified the port and railway-related actors into a classification (contracts, joint venture, subsidiary and vertical integration) inspired by TCE. Panayides (2002) also applied the TCE to assess the most optimal governance structure in intermodal transportation. He concluded that a qualitative approach is beneficial for research on intermodal transport. In port research, the TCE approach was applied in De Langen and Chouly (2003) for making an institutional economic analysis of the port of Rotterdam. Franc and Van der Horst (2008) applied insight from TCE

[33] Williamson (1996, p. 223) introduces it as a 'scheme'; for clarity and for the goal of this paper, we will use the word framework following the work of Ostrom (2009). This allows us to use alternative theories. In this paper, the TCE from Williamson (1996) and the Theory on Economic and Institutional Change of North (2005).

to get a better understanding of vertical integration by shipping lines and deep-sea terminal operators in the Hamburg–Le Havre range. Besides, port- and transport research transaction cost theories were used in studying liberalized network industries such as, e.g. the electricity market (Joskow, 2002; Künneke, 2008) and water supply (Ménard & Saussier, 2000).

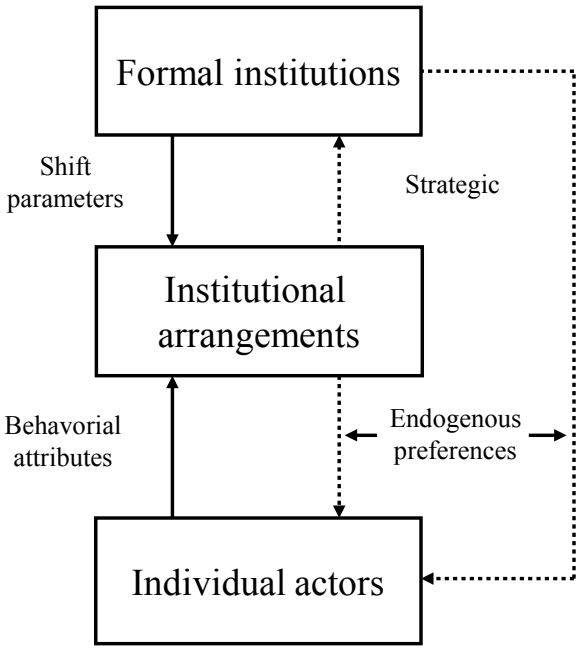

Figure 5.2 Three layer framework: static view (Source: adapted from Williamson,1996)

In Figure 5.2 the institutional environment is placed at the upper-most layer. It deals with informal institutions (values, norms, traditions and customs) and formal institutions (national and international laws, regulations and procedures). The European directives on liberalization, that unbundled infrastructure ownership and opened international railways to private companies, are relevant examples. On the second layer, we find the play of the game, or the coordination arrangements that govern the actor's interdependencies resulting from transactions.

As stated above, a number of transactions among the actors involved in port hinterland chains require coordination. Transactions do not involve just the physical exchange of commodities, such as maritime containers (the focus of this research), but also include an exchange of rights and duties. Coordination is not free. There are all kinds of transaction costs, such as the cost of searching for the right partner, the cost of searching for information, the cost of negotiating a contract, as well as monitoring costs and the costs of settling disputes. In TCE, characteristics of the transaction (asset specificity, frequency and uncertainty (including complexity, which is effectually similar)) determine the efficient governance structure. The individual actors, both private and public, are positioned at the third level. Individual actors are modeled as cost-minimizing and are bounded in their rationality and show opportunistic behavior. The most efficient coordination arrangement is chosen, given the institutional

environment and given behavioral attributes. TCE is about matching the characteristics of the transaction and governance structures. When the choice is made, none of the actors has an incentive to conform to his position, or in other words, equilibrium occurs. However, if an exogenous variable changes, then TCE predicts that the new efficient coordination arrangement will be the cost-minimizing coordination arrangement, given the new value of the exogenous variable. Note that also the so-called secondary effects are included in this framework (dotted arrows in Figure 5.2). These secondary effects are called endogenous preferences and strategic or instrumental effects. A strategic effect is the influence of the governance structure on the institutional environment. Endogenous preferences are found in the influence of the institutional environment and governance structure on the individual economic actor. Although, Williamson included these secondary effects and argued that TCE can often relate to them; other modes of the analysis (the solid arrows) are more 'pertinent' or can provide 'refinement' in the analysis (1996, p. 225). By neglecting the interdependencies, the framework shows a static economic perspective. When and how the process of selecting a coordination arrangement takes place and whether it will really result in an efficient equilibrium is not a part of this analysis.

In the next sections, the framework (Figure 5.2) will help to organise material from an in-depth empirical study of the economic organization of the liberalized container railway market at the Port of Rotterdam. The next section will discuss the liberalization of the railway transport market in Europe and the Netherlands (development at Layer 1 of the model). Section 5.4 will discuss the effect of the regime change as to how actors in port-related railway chains (Layer 3) can improve coordination (Layer 2) in container railway transport in terms of efficiency. It will also discuss coordination arrangements that are adopted to improve coordination between 2005 and 2010[34].

5.3 Liberalization of railway transport market in Europe and the Netherlands

Over the last two decades, the railway sector, like other network industries such as electricity and telecommunication, has been liberalized in Western Europe. The European Commission began this initiative based on the conviction that the market should play a central role in the context of congestion, pollution and promoting the use of (intermodal) railway transport. (Debrie & Gouvernal, 2006; European Commission, 2001; Giorgi & Schmidt, 2002). The first step in the European rail freight liberalization was Directive 91/440 in 1991, which focused on vertical unbundling, i.e. the separation of infrastructure and operations. The First Railway Package was adopted in 2001. It granted railway companies the opportunity to offer services

[34] The database was used previously for the research of Van der Horst and De Langen (2008) on coordination mechanisms in hinterland transport chains. The database was updated and extended for the present research. The data were collected from September 2005 to January 2010. It consists of 91 coordination arrangements divided into the categories: (1) introduction of incentives, (2) creation of interfirm alliances, (3) changes in scope and (4) creation of collective action. Data on coordination arrangements were collected by scanning reports, studies and industry magazines and journals and by conducting interviews with managers in the hinterland transport chain. In the end, the database contained the following data: name of the arrangement, short description, year when the coordination arrangement was established, transport mode, coordination problem addressed, type of actors involved, number of actors involved, initiator, power relation of initiator to other actors involved, description of the arrangement, horizontal/vertical cooperation, and the use of information and communication technology.

in all EU countries under equal and non-discriminatory conditions. A Second Railway Package was adopted in 2004 based on the belief that by removing legal entry barriers and by opening access, it would enhance competition with the aim of creating a legally and technically integrated European railway system. The Third Railway Package was adopted in 2007. It focused on opening the railway market for international rail passenger services, rail passenger rights and obligations, as well as the certification of train drivers.

The liberalization of the Dutch railway market started in 1995 with the legal separation of rail infrastructure management and operations into two different organizations. Before liberalization, all railway activities were concentrated in one single organization, the Nederlandse Spoorwegen (NS, literary translated, 'Dutch Railways'). In 1996, the infrastructure management of Dutch railways was separated into three organizations, two owned by the incumbent NS. In 2003, Prorail was granted a 10-year concession as the infrastructure manager for the Dutch Combined Railway Network for passenger and cargo transport. It was later decided that a separate organization Keyrail would be created that would be responsible for the infrastructure management of the Betuweroute, the Dutch Railway Network for freight traveling from the Kijfhoek freight yard to the German border, including 45 km covering the Rotterdam port area. Keyrail is under joint ownership. It is partly owned by the port authority of Rotterdam (35%) and Amsterdam (15%) and Prorail holds the other 50% of the shares. Since 1995, there has been open access for railway companies in the Netherlands. The former freight subsidiary of the NS (NS Cargo) and that of the German railway company Deutsche Bahn merged into a new firm called Railion (since 2009 called DB Schenker Rail). Several other private firms entered the container railway market, including Rail4Chem, ACTS and ERS Railways.

Table 5.1 Number of market players in container rail transport in port of Rotterdam in 1995 (before liberalization) and 2010 (after liberalization) (Source: Railcargo, 2010, revised by authors)

	1995	**2010**
Railway companies	1	14
National rail operators	3	6
International rail operators	3	15
Infrastructure manager	1	1
Rail terminals in port of Rotterdam	3	8

Note: The figure represent national figures for inland container transport. Given the fact that the port of Rotterdam dominates the Dutch rail freight market, the number of operators is virtually the same at the national and port level.

In 2010, 14 railway companies were active in the port-related container transport by rail (Table 5.1). The number of national and international rail operators increased between 1995 and 2010.The rail operator is responsible for commercially organizing container shuttle trains and sells wagon capacity from the railway companies to the shippers and forwarders. In 2010, 21 rail operators were active in Rotterdam. In some cases, one company may undertake the role of the railway company and rail operators (e.g. ERS Railways). In many cases, rail

operators have no traction capacity, they only organize container shuttle trains (e.g. Hupac). An important functional distinction between railway companies and rail operators is that railway companies have a license from the infrastructure manager to drive trains; they have to request the use of a train path from the infrastructure manager. Railway companies sell traction capacity to rail operators. In Europe, the introduction of the new rail market regime varies quite considerably from country to country (European Commission, 2012; Friebel, Ivaldi, & Vibes, 2010; Gouvernal & Daydou, 2005; IBM, 2011). The Dutch legal framework and regulatory aspects, as well as its relatively low practical barriers for market access, are the reasons why the Dutch rail market is referred to as being 'advanced' liberalized (European Commission, 2012; IBM, 2011), and the outlook seems positive (Van de Velde, 2011).

Eisenkopf et al. (2006) has shown that the new railway companies are relatively small when compared to the incumbent railway company. This was also the case in Rotterdam. In 2007, the market share of the incumbent railway company Railion (DB Schenker Rail) in container transport was 44%. The second largest railway company ERS Railway had a market share of 29%. The five other newer entrants possessed a market share between 1% and 11% (Railcargo, 2008). In 2011, the DB Schenker Rail still had a market share of about 70% (Railcargo, 2012).

Liberalization not only changed the situation for the incumbent railway company, but it also changed the Dutch government's role with regard to rail infrastructure. The national government's role as owner, manager, planner and financer of the infrastructure has given way to market-based principles. The period between the start of the liberalization process in the early 1990s until today can be characterized as a period in which the rail sector in the Netherlands, and more specifically the Port of Rotterdam, changed from a single and homogenous actor constellation into a multiple and heterogeneous actor constellation (WRR, 2008). In a relatively 'young' transport market, different actors have to manage the efficiency of different parts of the chain of transactions. Multiple and relatively small newcomers have entered the rail market, despite the dominance of the incumbent operator, and cargo-controlling parties such as forwarders and shippers can no longer rely on a state-owned and controlled public monopoly provider for rail transport services. All different actors in the liberalized railway hinterland chain have to adjust to the new market situation.

5.4 Liberalization in railway container transport at the Port of Rotterdam

In terms of the framework rooted in TCE, on Layer 1, the liberalization of the railway transport had a definite impact concerning 'the play of the game' in the railway container transport in the port of Rotterdam. This impact is referred to as a 'shift parameter'. If we acknowledge the liberalization on Layer 1 as given, the question is what were the effects of liberalization on the organization of the market's 'the play of the game' at Layer 2? From the previous section, it appeared that it is the European Commission's general belief that the market should play a central role in the context of the use of (intermodal) railway transport (European Commission, 2001). In a liberalized market, the assumption is that the institutional changes introduce 'high-powered market incentives' that will lead to more efficiency

(Groenewegen & De Jong, 2008, p. 51, 52). More market competition is the main driving force; coordination among actors should take place in such a way that the resources are used in a way that meets the need of consumers (allocative efficiency), that new services, processes and products are innovated (dynamic efficiency) and that the input or resources to produce a product of service are used effectively (technical productive efficiency). The rail market at the Port of Rotterdam has improved in terms of meeting consumer's preferences (prices) and developing new processes, products and services. In the first ten years of liberalization, the market showed a fall in rates from 15% to 25% between 1997 and 2007 (KIM, 2007). Another positive effect of the liberalization can be illustrated by the development of shuttle train services. A shuttle train is a train service between two destinations on regular dates with set times of departures and arrivals. The development of shuttle services has increased substantially. From 1997 until 2010, the number of shuttle trains per week doubled to more than 250. Moreover, the number of origins and destinations increased from 29 in 2001 to 55 in 2010 (Railcargo, 2010). In addition to rail operators, many deep-sea and inland terminal operators are also active in changing the scope of their activities to include establishing and commercially operating rail shuttles. In terms of the three-layer scheme, opening up the market for new operators at Layer 1, allowed more opportunities for the actors at the port to start new activities. For example, in 2006, a large inland terminal operator in the hinterland of the Port of Rotterdam, namely Rail Terminal Tilburg, agreed to a long-term contract with the railway company ACTS to take the commercial risk for frequent rail services between the terminals of Tilburg and Eindhoven and Rotterdam. Vertical integration can also be illustrated by a trucking company that changed its scope of activities toward rail transport. The liberalization gave room to the GTO trucking company to initiate a 'port shuttle' in 2008 from the ECT Delta terminal (the western part of the port area) to the Pernis Combi Terminal (the eastern part of the Rotterdam port area). Moreover, an example can be found where deep-sea container carriers started railway activities. In the early 2000, Mærsk established ERS Railways. These types of hierarchical coordination are positive since the rail cargo of the container carrier is 'bundled' within the firm and at the same time reduces transaction costs[35].

In terms of technical productive efficiency, Dutch Ministry of Economic Affairs (2008, p. 184) found that the productivity of the rail infrastructure for cargo transport greatly increased during the last decade, mainly due to an increased utility rate of trains.[36] However, we argue that, if you look closely at the ports, then liberalization has not brought an optimal allocation of resources. We argue that managing interdependent activities between railway actors (coordination) became more problematic. First, managing the interdependent activities between railway companies and infrastructure managers regarding the allocation of train paths became more difficult. With the market entrance of more railway companies, the planning and allocation of train paths lead to an increase in transaction costs. The capacity of railway tracks and yards had to be negotiated with, and to be allocated to, 14 different railway companies in 2010. Till recently, Keyrail had to allocate railway capacity to a high number of railway companies, namely 17 companies in 2013 (Keyrail, 2013b). In such a situation, with the

[35] Masten (1996) shows that measuring transaction costs is problematic. Also in our case, we are not able to measure transaction costs and benefits directly.

[36] It can be questioned whether the increase in productivity is an effect of liberalization and whether that has lead to an increase in transport demand. The causality could also be the other way around, namely that an increased demand has led to economies of scale and caused an increase in productivity.

uncertainty of the arrival and the departure of trains, efficient allocation is only possible when complete integrated real-time information on train positions is available. Where the infrastructure manager has problems with the allocation of railway infrastructure, railway companies lack incentives to use it efficiently. An analysis of the timetables[37] of the three major railway companies, with a joint market share of 80% in 2008, shows that 66% of container trains are direct trains and 34% of the container trains make two or more stops in the port. The turnaround time of these multi-stop trains is between 8 and 30 hours, while the average turnaround time of direct trains is 12 hours. This behavior can be explained by the fact that with the old pricing regime, railway companies did not pay for inefficient use of infrastructure. The second coordination problem we identify is the interdependency between deep-sea rail terminals and railway companies. Since liberalization, coordination between both worsened. In 2007 and 2008, the average punctuality at terminals was 65% and 72% for departing container trains (Keyrail, 2013a). To better discuss some of the coordination problems that emerged after liberalization, we will now look at five illustrative coordination arrangements that were adopted in recent years by various actors in the Rotterdam railway sector in order to improve coordination in railway operation in the port (Table 5.2).

Table 5.2 Illustrative examples of arrangements to improve coordination

Coordination arrangement	Coordination problem	Actors involved (interdependency)
1. Tariff system Keyrail with bonus (early booking) and penalties (last-minute cancellation)	Unused rail tracks because of insufficient tuning	Railway companies and infrastructure manager
2. Agreement among railway companies to use each other's locomotives in case of obstruction	Unused rail tracks because of insufficient tuning & Limited exchange of traction	Railway companies and infrastructure manager
3. Extended gate; stevedore ECT changes its scope in railway operations	Limited planning on rail terminal causes regularly delays	Container stevedore, rail terminal operator and railway company
4. Rail planning, application in port community system Portinfolink (Portbase)	Limited planning on rail terminal causes regularly delays	Container stevedore, rail terminal operator and railway company
5. Project 'Chain Management Port Rail Track'	Limited planning on rail terminal causes regularly delays & Unused rail tracks because of insufficient tuning	Container stevedore, rail terminal operator, railway company, and infra-structure manager

The first new coordination arrangement was adopted by the infrastructure manager Keyrail at the Port of Rotterdam in 2009. That year Keyrail introduced a new tariff system for the use of rail infrastructure, including rail tracks and rail yards. The new system seeks to encourage

[37] For the analysis, the timetables have been derived from the public websites of railway companies Railion, ERS Railways and ACTS for one week in November 2008. The total market share of the three railway companies have been calculated with the Timetable of Shuttle Services of departing trains via Railcargo (2008). In November 2007, 233 shuttle trains departed from the port of Rotterdam every week. The three railway companies provided traction some 186 times (Railion: 102; ERS Railways: 57 and ACTS: 27).

early bookings of rail tracks and yards and also contains penalties for both Keyrail and railway companies. As part of their obligation, Keyrail is required to provide good connections with national and international rail networks. In the case of cancelation, Keyrail may recover certain costs. If the booking is canceled 30 days before departure, then 25% of the fare must be paid, but if the booking is canceled within 4 hours of departure, then the company recovers a penalty of 90% of the fare (Keyrail, 2013b). Prior to 2009, most railway companies did not have the right incentives to efficiently use the rail infrastructure at the port. In some cases, railway companies requested for train tracks that they did not use, they parked their locomotives and wagons for longer periods at rail yards and they used the tracks at times that were convenient for them, but which often created A peak hour rush. New conditions gave the infrastructure manager the right to introduce a tariff system that enabled better management and allocation of the rail tracks and the rail yards in the ports.

A second additional coordination arrangement was established by several railway companies in 2007. Railway companies Railion Nederland, ERS Railways, ACTS, Rail4chem Benelux and Veolia Cargo agreed on the exchange and the use of each other's locomotives for the removal of wagons of other railway companies in case of obstruction. The agreement was made in order to ensure that the rail tracks and rail yards are used more efficiently. In the newly liberalized market, railway companies sometimes influence the operation of other companies by obstructing the rail tracks and rail yards.

The third coordination arrangement is the Extended Gate concept by the deep-sea terminal operator ECT in 2007. In this concept, ECT commercially operates train shuttles to their own inland rail terminal in Venlo in the east of the Netherlands. ECT operates in this extended concept 20 shuttle trains a week nowadays (ECT, 2013). The arrangement helps to address the increased complexity of terminal planning due to the substantial increase in the number of market players and train shuttle services. The increased port traffic has led to diseconomies of the port's rail network. By integrating vertically, the deep-sea terminal operator, ECT is enabled to deal with local constraints by externalizing them to a 'stocking point' in the hinterland (Veenstra, Zuidwijk, & Van Asperen, 2012).

The fourth coordination arrangement can be found in the port community system Portinfolink (in 2009 renamed as PortBase) that developed the application Rail Planning, a computer application that exchanges information between the rail operator, the railway company and the terminal operators. The system makes it possible for rail operators to give a pre-notification for containers at the rail terminal; the system also provides real-time information about the status of containers (charged/discharged). It can not only improve the planning at the rail terminals, but also stimulate the spread of terminal slots and avoid regular delays. Portinfolink is a public–private partnership between the Rotterdam Port authority and the Port Industry Association Deltalinqs. Such a public–private partnership is an efficient governance mode, given the high asset specificity of a port community system, the many and relatively small parties that participate and the distribution of the relatively large collective costs and benefits. TCE assumes that actors have the tendency to act opportunistically and stresses the need to take measures with rising asset specificity. This partnership with the involvement of the association Deltalinqs generates trust. Trust lowers transaction cost and sustains cooperation.

The fifth coordination arrangement is the pilot project 'Chain Management Port Rail Track' that started in 2007 and remains active. The purpose of this project is to improve the punctuality of trains by introducing new 'rules of the game' concerning the exchange of information such as the estimated time of arrivals, number of containers and real-time reservation of the train tracks. Moreover, reducing the number of multi-stop trains is also an important goal of this pilot project. Besides the two largest terminal operators (ECT and the Rail Service Centre Rotterdam), three railway companies (ERS Railways, Railion and Veolia Cargo) and three rail operators (ERS, Hupac and Intercontainer) participated in the start-up phase. Infrastructure manager Keyrail is the coordinator of the project, and the Rotterdam Port Authority facilitates the project. It is noteworthy that these new operational rules were not made and enforced by the infrastructure manager. The rules were adopted after an informal process of mutual consultation between the parties involved. In one year, the parties learned more about each behavior and business processes. The result of this project is that the average punctuality of container trains leaving the rail terminals improved from 65% in 2007 to 88% in 2010 and 91% in 2011 (Keyrail, 2013b). The operational rules became part of the yearly contracts between railway companies and the infrastructure manager from 2009 onwards.

5.5 Towards a dynamic framework for understanding coordination in railway hinterland chains

The three-layer framework introduced in section 5.2 represents a static approach toward the working of the railway hinterland system of containers. The framework focuses on how the hinterland chain organizes itself, given a number of environmental factors and a set of attributes of actors. The optimizing behavior of actors may or may not lead to a situation of allocative, dynamic and technical productive efficiency. With this static approach, the focus is upon optimization, despite various constraints. Not unexpectedly, a change in constraints will lead to changes in production and a change in governance structures. In the context of railway hinterland chains, liberalization is the exogenous variable in the institutional environment on Layer 1 which has affected the economic organization of the railway market in ports on Layer 2 of the framework.

Figure 5.3 suggests a dynamic framework for understanding coordination in hinterland chains. The dynamic framework is rooted in the work of Douglass North's theoretical framework to study economic and institutional change (2005) and is considered by him as an extension of the New Institutional Economics (Mantzavinos, North, & Shariq, 2004). In this section, static framework is adjusted and enriched by means of empirical observations. We will discuss why such an approach could be relevant to a 'young' transport market that changed from a single and homogenous actor constellation into a multiple and heterogeneous actor constellation.

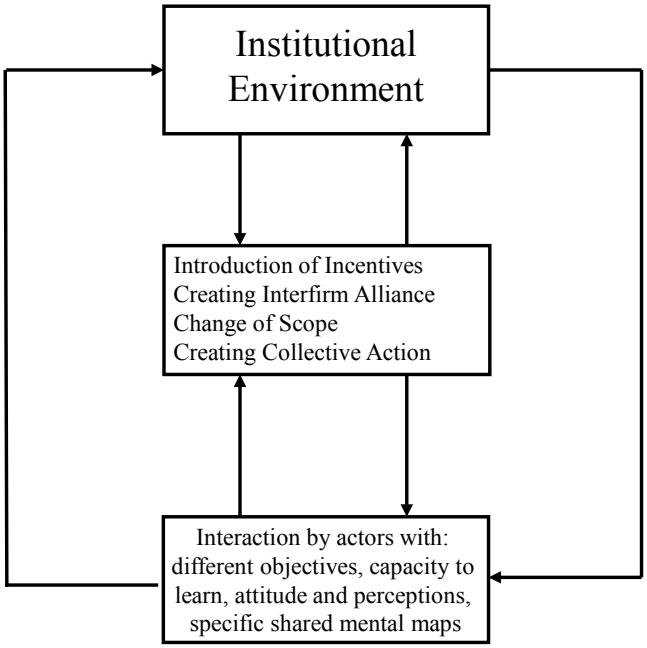

Figure 5.3 Three layer framework: dynamic view (Source: adapted from Williamson, 1996; North, 2005; Groenewegen, 2005)

First, we observed that institutional change at Layer 1 directly affects the allocative behavior of individual actors at Layer 3. Coordination among actors became more difficult due to regime change. With the market entrance of more railway companies, planning the port's railway system has now become more difficult. Railway track and rail yard capacity must now be allocated to 14 different railway companies. Moreover, the eight deep-sea terminal operators at the port have to make good agreements with the railway companies that visit their terminal. Coordination became complex because more actors are involved, which means actors with their own different characters, goals and business drivers. The increasing number of actors can be seen as an important 'problem multiplier' that has increased complexity and uncertainty, as one of the dimensions in the transaction cost framework.

Second, the role of the institutional environment in the framework needs discussion. In a specific institutional environment, for this paper, a liberalized environment for the rail sector in a port, laws and regulations has an impact on the choice of arrangements for better coordination and is seen as a 'shift parameter'. This shift parameter is the difference between coordination in a liberalized and coordination in a non-liberalized situation. On the one hand, the institutional environment can be seen as a type of 'constraint', since it constrains the behavior of market actors in the rail sector. On the other hand, the institutional environment can be seen as an 'instrument' because it also creates possibilities for coordinating behavior. An illustration of this is Keyrail's introduction of the tariff system in 2009 discussed earlier. This system actually encourages the efficient use of rail tracks and rail yards. Another example is the truck company which took the initiative to start a port train shuttle in 2009 to connect two rail terminals at the port. In the three-layer framework, it is recognized that, for instance, firms try to influence the laws that regulate their operations, but these strategic

actions are not considered a crucial issue. The empirical analysis has made it clear that feedback exists from Layer 2 (coordination arrangement) to Layer 1 (institutional environment). According to North (2005), the continuous interaction between institutions and institutional arrangements in the economic setting of scarcity and hence competition is the key to institutional change. This is the third adaption that can be applied to the framework.

The interaction between coordination arrangements and the institutional environment can be seen in the project 'Chain Management Port Rail Track'. In this arrangement, private companies discussed, based on their specific knowledge, among themselves on a voluntary basis about new norms and rules to improve the efficient use of the rail infrastructure. Mutually dependent market parties established a collective culture, in which new rules were created. At a certain moment in time (2009), 'the rules of the game' became part of the yearly contracts between railway companies and the infrastructure manager, and so an exogenous constraint. By making the rules, part of the contract infrastructure manager Keyrail complies with the interest of the market parties, because of the Keyrail dependence on the market parties (regulatory capture). This observation shows that rules of the game are not only exogenously determined, but can also be spontaneously and/or endogenously shaped[38]. On the one hand (a group of), actors can be constrained by the existing institutional environment; while on the other hand, they are capable of changing that structure according to their own preferences. This is an interesting observation for the relatively new rail market, that with relatively small newcomers and dominance of the incumbent railway company, and the (formerly state-owned) infrastructure manager. The project is in line with North's ideas about institutions as rules of the game. He states that 'institutions are not necessarily or even usually created to be social efficient; they are created to serve the interests of those with the bargaining power to create new rules' (North, 1994, p. 360). For a deeper understanding on how these rules were established, it is relevant to take into account the behavioral attributes of the actors.

This is the fourth and last adaption of the framework on understanding coordination in port-related transport chains. An adaption can be made with respect to the behavioral attributes of the actors in hinterland chains that go beyond Layer 3. According to the original framework rooted in TCE, bounded rational actors with opportunistic behavior choose their coordination arrangements in order to reduce transaction costs. The observations made above that (1) a liberalized institutional environment works as an instrument to create possibilities for coordination and (2) that interaction is possible between the coordination arrangements and the institutional environment is 'in a setting of scarcity and hence competition the key to institutional change'. It also illustrates the importance of 'adaptive efficiency' (as distinct from 'allocative efficiency'). Adaptive efficiency indicates the willingness to invest in skills and learning by doing. This is an essential proposition from North. He states that in an environment of (increased) competition 'learning on the job or the acquisition of formal

[38] See e.g. Aoki (2007) on endogenously generated institutions. In his view, an institution is a selfsustaining,salient pattern of social interactions, as represented by meaningful rules that every agent knows and is incorporated as agents' shared beliefs about how the game is played and to be played (Aoki, 2007, p. 6). So, during an interaction process, the players of the game create shared beliefs about the structure of the game. In this 'institutions-as-an-equilibrium-approach', institutions are defined as the outcome of interactions of individual actors who maximize their pay-offs.

knowledge' is the key to survive for actors and their organizations. Given the fact that 'institutional change is a deliberate process shaped by the perceptions of the actors about consequences of their actions', a better understanding is needed about how actors perceive the world around them (North, 2005, p. 22). This includes a better understanding of the values, norms, habits, historical specificity (path dependency) and mental maps which influence all actors in the system[39].

5.6 Conclusion

The goal of this paper was to elaborate a framework to understand the issue of coordination in port-related railway chains in a liberalized institutional environment. From the literature, it appeared that research on port-related transport is growing. This can be explained by the fact that containerization increased port competition, and the quality of hinterland infrastructure and transport services by rail is an important determinant. We may conclude that, despite a few studies, less attention has been paid to the economic organization of intermodal port-related transport in general, and on railway transport in a liberalized environment specifically. From a theoretical point, a framework rooted in TCE was used as an ordering framework to organize empirical material to understand better the effects of liberalization on coordination in port-related railway chains of containers. The TCE framework was adjusted and enriched with empirical observations from the liberalized railway market for hinterland transport of containers in the port of Rotterdam. An important empirical observation is that liberalization leads to positive developments. In the case of the Port of Rotterdam, new entrants have stepped into the market, new train services have been established and freight rates have decreased. On the other hand, coordination problems intensified after liberalization substantially changed the port railway sector. The intended or expected consequences of liberalization did not fully emerge in the railway sector at the Port of Rotterdam. Conditions of uncertainty became so complex that additional governance or 'assistance' of coordination arrangements was needed to get the coordination done more efficiently. The liberalization of the railway market also offered room for other actors in the hinterland chain to change the scope of their activities. This paper also discussed an initiative where actors themselves established new 'rules of the game' to prevent the inefficient use of the rail infrastructure and terminal capacity. In other words, coordination arrangements were not only chosen, given the institutional environment, actors also wanted to influence the institutional environment in which the 'rules of the game' are formed This initiative coincides with the general observation that the actors in liberalized port-related railway chains are currently realigning and redefining their roles in a changed institutional environment, which is characterized by a high degree of uncertainty and distrust. Based on the empirical findings, the initial TCE framework has been adapted toward a dynamic framework. This framework was influenced by the work of Douglas North's theory on economic and institutional change and can be seen as an extension of the TCE framework. A dynamic framework explains how the institutional environment of hinterland transport markets and coordination arrangements influence each other and develop as path-dependent phenomena. In this framework, the institutional

[39] In his later work, Williamson acknowledged that a better understanding on the mechanisms of the human mind should be part of the analysis. This institutional analysis of embeddedness is an important but underdeveloped part of the story (2000, p. 610).

environment can not only be seen as a constraint but also as an instrument, because it creates possibilities for coordinating behavior. Also the interaction between coordination arrangements among port related actors influencing the (new) institutional environment gets a place in the dynamic framework. Moreover, the actor's attributes show behavior towards 'adaptive efficiency' which indicates the willingness to learn shaped by the perception of actors. Therefore, a better understanding is needed about the values, norms, habits, historical specificity and mental maps which influence all actors in the system.

6 A multidisciplinary analysis behind coordination problems in container barging in the port of Rotterdam[40]

6.1 Introduction

This paper focuses on port-related container transport by barging in the port of Rotterdam, the largest container port in northwest Europe. It is expected that the container throughput will increase due to the construction of Maasvlakte 2, the port extension project in Rotterdam. It implies a growth of the numbers of containers handled, in the range of 26 million TEU in 2020 towards 33 million TEU in 2035 (Port of Rotterdam, 2011). Because of the favourable environmental performance and the almost unlimited capacity of infrastructure of Inland waterway transport, the policy of the Dutch government and the Rotterdam Port Authority is to realise a modal split in favour of container transport by barge (Ministry of Transport, 2007; Port of Rotterdam, 2011). The share of container barging from and to Maasvlakte should increase from 42,9% in 2013 to 45% in 2035 (8,1 million TEU; Port of Rotterdam, 2013). Despite this policy goal, the share of container barging hardly grows. At the same time, it is observed that the performance of container barging in Rotterdam is quite inefficient compared to competing modalities, due to long turnaround times of barges and inefficient terminal planning. In reality, it seems difficult to improve these coordination problems. The goal of this research is to provide a multidisciplinary case study of context factors (causes) that may hinder or stimulate a better performance of Inland Waterway Transport of containers in the

[40] Based on Van der Horst M.R. & Kuipers, B. (2013). Multidisciplinary analysis behind coordination problems in container barging in the port of Rotterdam. *Proceedings International Association of Maritime Economists, 3-5 July 2013, Marseille, France*. Invited for presentation at a special session on Inland Waterway Transport: Van der Horst, M.R. & Kuipers, B. (2014). Improving coordination in container barging: a case study in the port of Rotterdam. *Proceedings International Association of Maritime Economists, 15-18 July 2015, Norfolk, USA*.

future. The next section will briefly describe the research methodology guided by a framework that offers a starting point to come to a set of context variables related to the informal and formal institutional environment, market organisation and institutional arrangements. Section 3 will provide the results of the study. The last section will synthesise the results of the case study.

6.2 Research methodology and framework

6.2.1 Research methodology: case study

In this research, a single case study approach was chosen to better understand why it is difficult to solve coordination problems and why the performance of container barging in Rotterdam is lacking behind, although there is a strong policy willingness to increase the share of this sector in the total modal split. Furthermore, a single case study is relevant because the issue studied in this paper is unique and local (Rotterdam-based), and theory on improving coordination is limited and good learning experiences are hard to find (Van Binsbergen et al., 2009). The lack of attention for inland shipping can be explained by the small number of ports worldwide where container barging has an important market share. In Europe, for instance, container barging is only well developed in the ports of Antwerp and Rotterdam. An overview of literature on improving the handling of container barging in these two ports can be found in, e.g. Konings (2007) and Caris et al. (2011). In Shanghai and Hong Kong the role of barging in hinterland transport is also manifest, but hardly any lessons can be drawn from ports in North and South America where container barging plays a very limited role. This research is based on a large research project in the container barge sector in Rotterdam in 2012 and 2013. It was part of a research programme commissioned by 'Rijkswaterstaat' – Centre for Transport and Navigation, being an executive arm of the Dutch Ministry of Infrastructure and the Environment. The case study contains four research steps. Firstly, 15 semi-structured interviews were held with actors active in the container barge hinterland chains, like barge operator, deep-sea terminal operator, and inland terminal operators. In addition, representatives of the sector associations of container barging companies and inland terminal operators, a financial executive, experts and professors in the field of business history, (inland) transport law, and port management contributed to discussions. During the interviews the following working hypothesis was discussed: 'The container barging sector in the port of Rotterdam is unable to pick-up the expected future role, namely providing efficient hinterland transport of 45% of the maritime containers in Maasvlakte 2 in 2030.' In general, in case studies the boundaries between phenomena and context are not clearly evident and multiple data sources are needed (Yin, 2003). The interviews were helpful to make a set of subjects related to reasons behind coordination problems in container barging as a second research step. Besides setting the boundaries of the research, the interviews also guided the selection of the, mainly secondary, data sources. Thirdly, a desk research was executed, according to the structure of the theoretical framework presented in the next section. The research takes an abductive approach by investigating the link from phenomenon to cause (Peirce, 1931). Abductive reasoning allows borrowing suitable theoretical lenses from other disciplines, which is rather common in logistics research (Stock, 1997). It is a process where the theoretical framework and the empirical work evolve simultaneously in the form of systematic combining (Dubois and Gadde, 2002). Systematic

combining allows for (1) interaction or iteration between theory and empirical observation, (2) creativity (Andreewsky and Bourcier, 2000), and (3) intuition (Kovacs and Spens, 2005) to find a matching framework. Fourthly, the results of the desk research were discussed with the interviewees. After incorporating feedback, the results were reviewed by an external committee, including representatives from the Ministry of Infrastructure and the Environment, Rotterdam Port Authority and from the National Institute for Advanced Logistics. From the results, we draw some general conclusions. In this qualitative 'process of inquiry' the combination of triangulation is important (Patton, 1987). The four most common forms of triangulation according to Yin (2008) can be justified. We used multiple methods (methodological triangulation) such as interviews, workshops with experts, and desk research to achieve a greater accuracy and a more coherent interpretation. Next, we used a review group (evaluator triangulation). By using the different data sources from different research fields, we justify theory and data triangulation.

6.2.2 Framework

The framework developed (Figure 6.1) is inspired by Institutional Economics (Williamson, 1998) Williamson distinguishes between different types of institutions based on different theoretical approaches which are relevant in the structure or context of a market. By investigating these context factors, we could better judge if and how the container barge sector could fulfill its expected future role. A comparable institutional approach was earlier applied in port research (De Langen and Chouly, 2004) and by studying liberalised infrastructure markets, like the electricity market (Künneke and Fens, 2007). The work of Williamson has its origin in Transaction Cost Economics (TCE), which deals with matching categories of transactions with categories of efficient governance structures until 1993. Later, Williamson (1993: 112, 113) states: 'Governance does not operate in isolation', but categorical context factors play a role. This is considered a first important value of the framework for our research because it allows a multidisciplinary analysis, combining different theoretical lenses. A second reason is that the framework gives coherence to our type of empirical inquiry. Figure 6.1 shows that institutions are not randomly developing, but are interrelated with certain logic with a hypothetical time period for change.

In the framework, at level 1 we find informal institutions which are based on broad beliefs, values and norms that influence the behaviour of economic actors. These informal institutions are assumed to be deeply rooted in society and only change over a very long period of time (according to Williamson, between 100 and 1000 years). They emerge spontaneously within the social context, are typically non-calculative by nature, and stay in the domain of economics historians and economic sociologists[41]. Where level 1 focuses on the level of 'embeddedness', referring to economic and social behaviour of actors, level 2 refers to formal or the legal embeddedness. Here, 'the laws regarding property rights – their definition and enforcement – are prominently featured' (Williamson, 1998: 27). Moreover, it includes the area of formal governmental policy. Periods of change at this level are between 10 and 100 years. The third element concerns the market organisation, firms and other institutional arrangements. The relevant theoretical lens here is TCE. Periods of change are quite short, namely between 1 and 10 years. Resource allocation, behaviour and performance by the

[41] We could also speak about 'economic sociology', the interdisciplinary knowledge field of where the interaction between economic activity and economic environment is studies with 'historical sense' is studied (Van de Braak, 1988).

market actors are described at the fourth level. It focuses on third-order optimizing: 'Adjustments in price and output are made in a (more or less) continuous way in response to changing market conditions' (Williamson, 1998: 29). The arrows connecting higher levels with lower levels mean that the higher level imposes a constraint for the level immediately below. The reverse arrows signal feedback. Although Williamson recognizes that the system is fully interconnected, he mainly neglects the feedback. The focus is on efficient governance structures (Level 3).

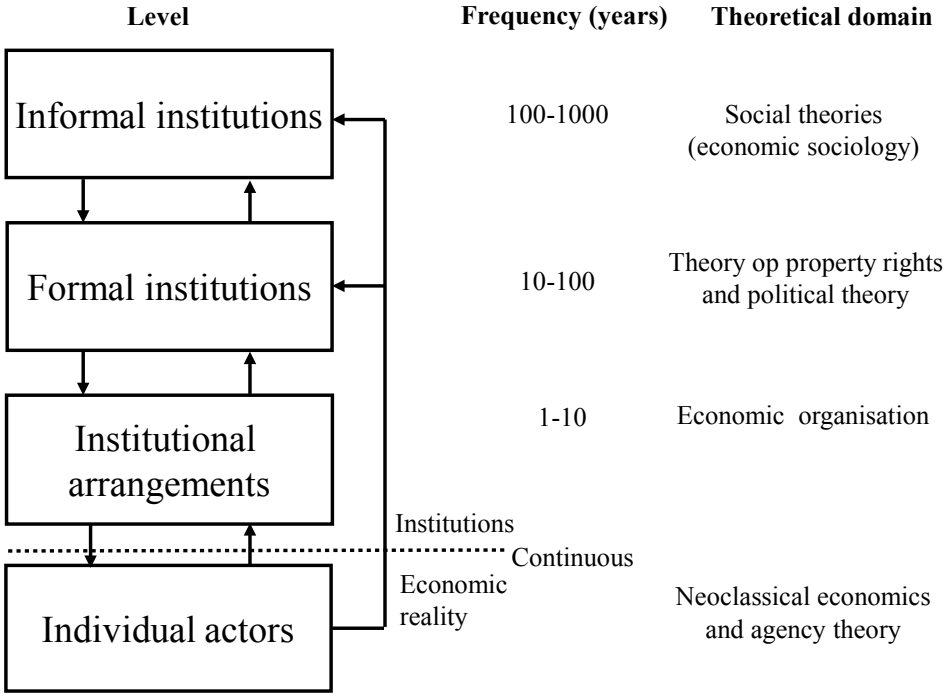

Figure 6.1 Analytical framework (Source: adapted from Williamson (1998))

The aim of this research is to identify reasons or causes behind the stagnation of container barging and coordination problems in the port of Rotterdam in the light of the ambition to increase the future share of container barging. The purpose is to identify causes for this 'market reality', therefore we also consider the feedback arrows in the framework from level 4 to 1. By doing so, the framework fits in the school of Original Institutional Economics. A central aspect herein is the interaction between the actors and the dynamics of institutions. Following the influential definition of Douglas North (1990), institutions are 'humanly devised *constraints* that structure political, economic and social interactions'. He states that institutions are the underlying *rules of the game* and can be divided in formal and informal institutions. In terms of the four layer model North makes a crucial distinction between institutions (layer 1 and 2) and market organization, firms and other institutional arrangements (layer 3). In our research, we include market organisations, firms and other institutional arrangements as a form of institution[42]. We analyse possible causes that lie in the institutions (layer 1, 2, and 3) for a phenomenon or an economic reality (layer 4), namely the

[42] Note that the 'early' Douglas North included also institutional arrangement as a form of institution besides informal institutions and formal institutions (Davis & North, 1971). In this respect Hodgson (2006) emphasizes that distinction of the 'late' Douglas North (North, 1990) has led to misinterpretations suggesting that organizations are not institutions. According to Hodgson (2006), organisations are special institutions that involve membership and sovereignty. Hodgson notes that North was making an abstraction rather than defining organisation.

stagnating growth of container barging due to coordination problems. In this respect, we see institutions as *constraints* as well as instruments to provide a structure for human interaction that regulates the behavior of actors.

6.3 Results of case study: application of the framework

In this section, the framework will be applied to container barging in the port of Rotterdam. The following section will introduce the market actors and their interaction. It will present some key data that illustrate the performance of container barging in the port of Rotterdam. Next, we will discuss the most relevant elements in the context of the container barge sector, namely the informal institutions, the formal institutions, and the institutional arrangements.

6.3.1 Market actors in the container barge transport chain

Figure 6.2 shows the main market actors involved in container barge transport. On the demand side of the transport chain we have the shipper, freight forwarder or the carrier. Primarily, a shipper is the owner of the goods and demands for transport. Commissioned by the shipper, freight forwarders could arrange hinterland transport; they do not own vessels or terminals, but purchase transport and terminal services from third parties. Although deep-sea carriers are traditionally responsible for the seaborne transport, they could also be involved in organising hinterland transport of the container by barge (carrier haulage).

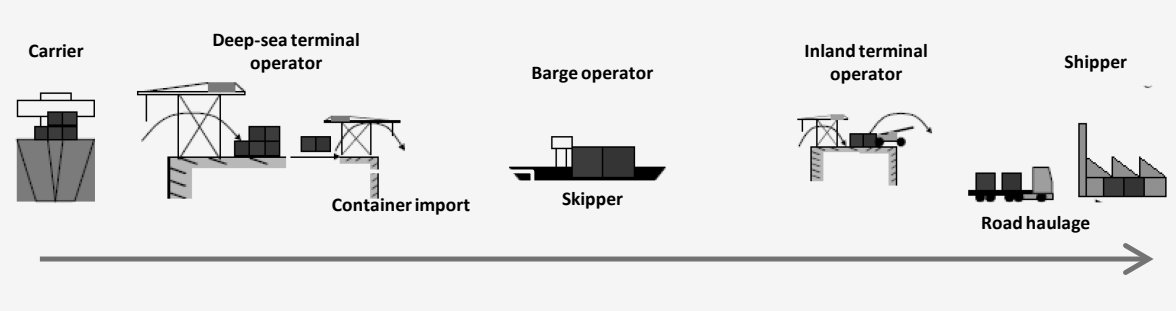

Figure 6.2 Hinterland transport chain of container barging (Source: A&S Management, DLD, & Stichting Projecten Binnenvaart, 2003, adapted by authors)

On the supply side, three actors play a role in the provision of container barging, namely: barge operator, inland terminal operator, and the private barge company or skipper. The core business of the barge operator is organising container barge transport by providing frequent shuttle services between the deep-sea and inland terminals. In Rotterdam, 65% of container barge transport is organised by barge operators (Bureau Voorlichting Binnenvaart, 2011). Inland terminal operators handle the container flows arriving by barge and transfer the containers to the truck for final transport to the shipper.

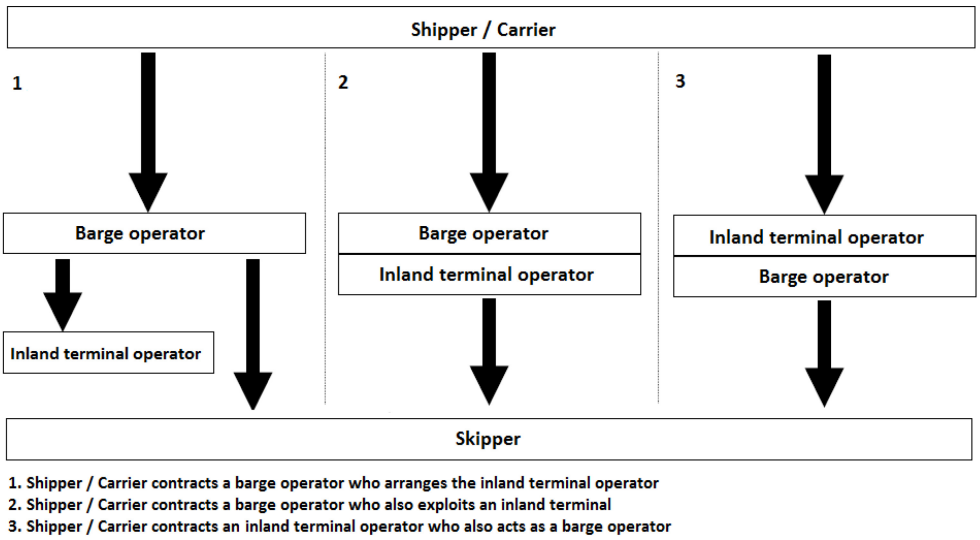

Figure 6.3 Interaction between actors in container barge market (Source: Rabobank, 2000, adapted by authors)

An inland terminal can also function as a depot for the storage of empty containers, and act as a barge operator and contracts skippers (Figure 6.3, option 3). Many inland terminals are owned by companies active in regional intermodal transport. Both the barge operator and the inland terminal hire ship capacity from skippers with short- or long-term contracts. The skippers offer barge capacity (including crew) for a fixed period; the barge and inland terminal operator offer the logistics management.

6.3.2 Performance of container barging in port of Rotterdam

In the period from 1985 to 1995, barge traffic in the hinterland of Rotterdam grew from 200,000 TEU to about 1 million TEU (Konings, 2007). In 2006, 2.2 million TEU corresponded with a share of 30% in the modal split. In 2011, the share in container barging in hinterland transport is 33% (table 6.1). The long-term goal of the Rotterdam Port Authority is to realise a modal split in favour of container transport by barge and train of 65% for the total Maasvlakte port area in 2035. The ambition for container barging is to realise a modal split of 45% (Port of Rotterdam, 2011).

Table 6.1 Development modal split in port of Rotterdam (whole port) (million TEU) (Source: Port of Rotterdam, 2013)

	2002		2004		2006		2008		2010		2011	
	TEU	**%**	**TEU**	**%**	**TEU**	**%**	**TEU**	**%**	**TEU**	**%**	**TEU**	**%**
Barge	1,8	32	2,0	31	2,3	30	2,3	30	2,4	33	2,4	33
Rail	0,5	9	0,6	10	0,8	11	1,0	13	0,8	10	0,8	11
Truck	3,3	59	3,8	59	4,3	59	4,5	57	4,1	57	4,1	56
Total	**5,6**	**100**	**6,49**	**100**	**7,4**	**100**	**7,8**	**100**	**7,2**	**100**	**7,3**	

Although Rotterdam has good natural conditions, such as the location of the port at the estuary of the river Rhine (the most important inland waterway for freight transport in Europe), and container volumes handled in the port are increasing, the development of container barging is stagnating. The tables above show that the share of barging in the modal split has been stable for many years. For the port as a whole, the share of container barging in the total modal split increased slightly from 30% in 2008 to 33% in 2011. For the Maasvlakte the share of Inland Waterway Transport increased from 37% in 2008 to 40% in 2010. A main feature in the performance of container barging in the port of Rotterdam is the fact that there is a lacking sense of urgency or an inability to find solutions for a further increase of its market share. In some aspects the performance of container barging even decreased, e.g. with respect to its environmental performance. At the same time, the road transport industry was able to improve its environmental performance innovated at a relative faster rate, e.g. by introducing Euro 5/6 trucks and the 3-TEU trucks.

The core problem of this performance, however, concerns the coordination problems of container barging related to the port operations. It became clear from the previous section that the market organisation of container barging is complex because many actors are involved in the demand and supply side of the market. Many interdependencies exist between the actors, and lead to coordination problems. Two coordination problems are particularly relevant. The long duration of (un)loading cargo in the port, caused by the many calls and the small call sizes per terminal, is the first coordination problem. All barge operators call at a variety of terminals in the port and unload limited numbers of containers per terminal.

Table 6.2 Average call size (containers) and share of call size < 10 containers in Rotterdam (Source: Nextlogic, 2012)

	Maasvlakte								**Waal/Eemhaven**					**Port**
Terminal	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Av.**	**8**	**9**	**10**	**11**	**Av.**	**Av.**
Av.call size	39	44	46	47	38	51	24	41,3	20	24	18	15	19,5	33,3
% call size	20,5	8,0	10,0	9,8	13,7	8,5	30,1	12,9	35,7	52,6	50,1	54,3	45,7	25,8

Table 6.2 shows that the average call size of a container barge fluctuates between 15 and 52 containers. The average call size of the 11 container terminals is 33,3 containers. There is an important difference in the call size between terminals active in the Maasvlakte area (western part of the port, located near the sea with good nautical accessibility) and the terminals active in the Waal/Eemhaven area (40 km from the sea). In general, the average call size is higher in the Maasvlakte port area, namely 41,3 containers, although there are large differences between the lowest call size (24 containers) and the highest call size (51 containers). The average call size in Waal/Eemhaven is 19,4 containers. In addition, the share of ships with a call size smaller than 10 containers is much lower in Maasvlakte (average 12,9%). Almost half of the container barges calling at the terminals in Waal/Eemhaven have a call size smaller

than 10 containers (average 45,7%). These findings correspond to the fact that the average rotation time of a barge varies from 21 hours (smaller vessels < 85 metres) to 36 hours (larger vessel > 111 metres) (Nextlogic, 2012).

The second coordination problem is related to the relationship between the barge operator and the deep-sea terminal operator and deals with inadequate terminal and quay planning for barge handling. Tight planning could reduce rotation times, but barges frequently cannot be handled as planned. In the port of Rotterdam, 41% of the calls by barging, the actual handling at the deep-sea terminal deviated by less than 2 hours from the planned start time; 59% of the barges are therefore handled outside -2/+2 hours of the start time (Nextlogic, 2012).

6.3.3 Informal institutions

During the interviews, it was emphasised that generally the Inland Waterway Transport sector can be characterised with an individualistic culture where cooperation and coordination are not manifest. De Langen (2004) concludes that improving hinterland accessibility is a ‘collective action problem’. In literature on collective action (Olson, 1971), associations or interest groups are mentioned as a way to enable groups of actors. Looking at interest groups in inland shipping, we distinguish two groups: socioeconomic and technical-nautical interest groups. It is remarkable that there is only one nautical-technical interest group (Royal Schuttevaer) that was already established in 1849. Where nautical-technical interests have been represented by one organisation for more than 160 years, the socioeconomic representation was fragmentised throughout the years. The wide range of socioeconomic interest groups in Inland Waterway Transport goes back to the 1920s. From this early period, the mentality of about 10.000 private skippers was characterised as highly individualistic and limping between two opinions: a skipper felt that they were neither a ‘worker’ nor a 'patron' (Van Zuuren, 1992). After World War I, socioeconomic interest groups were formed based on ideology or religion (Socialists, Protestants and Roman Catholics). The crisis in 1929 led to the Act of Proportional Freight Distribution in 1933. The aim of this Act was to spread the cargo amongst skippers on a rotation list. The ship registered for the longest was assigned the first suitable trip. Despite industry growth and modernisation of the fleet, this Act led to further division of socioeconomic interest groups. In the early 1970s, the European Commission wanted to abolish the Act on Proportional Freight Distribution. This divided the skippers in the Federation of Skippers Unions (who intended a more commercial market approach) and the Independent Dutch Skippers Union. The 1980s were characterised by many shifts in membership among the two Unions: socioeconomic interest groups that stepped in and out. In the early 1990s there were two socioeconomic organisations: the so-called ‘Kantoor Binnenvaart’ (literally translated as Office Inland Shipping) and the Dutch Central Bureau for Rhine and Inland Navigation, the entrepreneurs' and employers' association representing owners and operators of inland vessels. In 1995, attempts were made to form one umbrella organisation assembling Schuttevaer, Kantoor Binnenvaart and the Dutch Central Bureau for Rhine and Inland Navigation. This initiative collapsed when the subsidy from the national government stopped in 1999. The result was that there were 10 socioeconomic interest groups in the beginning of the 20th century. It can be concluded that collaboration on

socioeconomic themes between individual skippers in the Netherlands is fragmented and shows a history of 'trial and error'[43].

Although cooperation and coordination are not obvious, a second characteristic of the sector is its embededness in a long tradition of horizontal and vertical cooperation and coordination. This varies considerably in (geographic) market segments, motives, and different time periods. The anthropologist Verrips (1991) indicates that cooperation was a survival strategy of skippers in difficult economic times. The question of whether a skipper chooses the vertical or horizontal way depended on several factors and varied greatly per period. Verrips (1991) concludes that the behaviour shows a chameleonic ability of the sector. In general, the 'horizontal strategy' took place when prices were too low and the bargaining power of shippers and charterers was too high. By working together, skippers formed a united front against shippers and charterers. The horizontal strategy required patience and discipline, which is why the 'vertical' solution is attractive. In this strategy, skippers tried to be on good terms with charterers and shippers. Skippers with smaller vessels and little debt followed often the horizontal survival strategy than skippers with larger ships and heavy mortgages. Also in economically difficult times, skippers were more likely to cooperate horizontally; after economic recovery they wanted to build a good relationship with shippers and charterers. Most of the interviewees agreed that the container barge sector became a mature transport sector because of horizontal cooperation. This is also stressed by Van Driel (2000). He notes that the initial phase of container shipping in the 1970s is strongly characterised by horizontal cooperation as a response to (1) high investments in new vessels and (2) the establishment of scheduled services in a new market being risky. Many of the first barge operators in Rotterdam participated in the so-called Fahrgemeinschaften in the mid-1980s and early 1990s. A Fahrgemeinschaft is a form of horizontal cooperation between barge operators with a joint sailing schedule combined with a profit pool. The history of Inland Waterway Transport shows a tradition in vertical and horizontal alliances. The sector see to be able to adapt well to changes in the environment (chameleonic ability). Container barging is a market segment that became mature because of horizontal cooperation among operators.

The third element is the conservative entrepreneurial behaviour of the sector, combined with flexibility and focus on the future. Inland Waterway Transport has a long tradition of family businesses. The crew of 75% of the ships of skippers consists of family members (Hubens, 2004). In this case the ship serves not only as an 'asset' but also as a home. The presence of family business results in a strong flexibility in their daily operations with respect to working hours and the ability to switch between different (geographical) cargo markets. However, family businesses are financially vulnerable, which is mainly caused by the fact that the families own one ship with high fixed costs and less variable costs. Generally speaking, only the fuel costs can be treated as variable costs (between 10–25%). In combination with financial vulnerability, a main value or norm of family businesses in Inland Waterway Transport is a conservative entrepreneurial spirit. Positive aspects of this denomination are hard work; negative aspects are frugality and conservatism. Nevertheless, the study of Hubens (2004) shows that family businesses follow numerous trends such as information and

[43] This observation fits into a more general view that interest groups often play a 'paradoxical' role. Individual firms tend to use interest groups when it suits them, but are avoided when the benefits ('profits of joint actions') are less than the costs of collective action (Olson (1971).

communications technology. It was stressed during the interviews that entrepreneurs in the container barge sector have a strong future focus on renewing or extending their fleet. Operating container barges in the context of family business offers a lot of 'flexibility'. Precise flexibility is very characteristic in modern logistics practice (Naim et al., 2006).

6.3.4 Formal institutions

In the case study, two important conditions related to the formal institutional environment were named by the participants and further analysed, namely the policy by the EU and Dutch governments and the present division of property of decision rights.

The European Commission[44] sees inland shipping as an energy-efficient mode of transport. Therefore, inland shipping should receive a larger share in the distribution of transport modes. According to the White Paper (European Commission, 2011), 30% of all goods transported by road over more than 300 kilometres must be transported by rail or inland shipping by 2030. In 2050 it is expected that the share increases to 50%. In addition, the White Paper included the following statement on inland shipping: 'Inland waterways, where unused potential exists, have to play an increasing role in particular in moving goods to the hinterland and in linking European seas' (European Commission, 2011, section 2.2 point 27). This underlines the importance of the inland shipping transport system. Compared to earlier European policies, recent policymaking pays more attention to the potential of Inland Waterway Transport. Europe also wants to create an integrated transport network by using the instrument of regulation. On 19 October 2011, two new proposals for regulations were introduced: the Trans-European Transport Networks (TEN-T) Guidelines and the Connecting Europe Facility (CEF). The use of the regulation instrument ensures that the realisation of the network in all Member States is uniform and a mandatory character. The TEN-T network includes two sub-networks: a core network (realised towards 2030) and an extensive supplying network (realised towards 2050). Based on the proposals from the Member States, there have been 30 Priority Projects identified, which are included in the guidelines for the development of the TEN-T as project of European interest. The Priority Projects were chosen according to both their 'European added value' and their contribution to the sustainable development of transport. Their completion — planned for 2020 — will improve the economic efficiency of the European transport system and provide direct benefits for European citizens. The 30 key projects consist of 18 railway projects, 3 mixed rail-road projects, 2 Inland Waterway Transport projects, and one short sea shipping project. This choice reflects a high priority towards more environmentally friendly transport modes, contributing to the fight against climate change. The national policy[45] on inland shipping covers several areas: spatial organisation, traffic and transport, economy, environment, innovation and safety. The Dutch national government wants growth of the share of inland

[44] The European Commission plays different roles with respect to inland shipping. Next to a role of stimulator, the role of legislator is especially of importance. This role enables the European Union to set environmental standards on emissions from ships. Since 2004 the emission standards are published in Directive 2004/26/EC. The European Commission has announced a tightening of these standards in 2012.

[45] Dutch national government plays different roles including legislator, infrastructure manager, and financier, provider of subsidies, licensing authority, waterway authority, regulator, innovation manager and enforcer. In these roles, new priorities emerged in recent years. Instead of providing funds for investment (financier), the national government has given priority to an agenda-setting role regarding safety and the environment and facilitating innovations in inland shipping—especially innovations strengthening the environmental performance of the industry.

shipping because of the importance of a well-functioning transport system for the Dutch economy. Within the limits of sustainability, safety and environment, it is the ambition in national policymaking to facilitate the growth of freight volumes as much as possible. Policy objectives focus on the elimination of maintenance backlogs and bottlenecks in inland waterway infrastructure, better use of existing infrastructure, sustainable transport, safety, reliable travel times, and reducing the administrative burden by ensuring better-quality information. In addition, innovation has a prominent position on the policy agenda. New waterways are not needed in the coming years (Ministry of Transport, 2004). Priority is given to Inland Waterway Transport on the main infrastructural axes and serving the port of Rotterdam. In 2020, the main waterways meet the stated targets of width, depth, vertical clearance and waiting times at locks (Ministry of Transport, 2004). The policy 'Sailing for a vital economy: a safe and sustainable inland' (Ministry of Transport, 2007) is a further development of the policy of freight by water and the innovation of the inland waterways. For this purpose, five spearheads were elaborated in an implementation agenda of policy actions: (1) strengthening the competitiveness of inland shipping; (2) the realisation of a future-proof network of waterways and ports based on a network and chain approach; (3) inland shipping being the cleanest modality (CO_2 reduction); (4) the continuous improvement of safety in inland navigation; and (5) stimulating innovation in inland navigation.

Figure 6.4 shows all possible contractual relations that actors in the container barge chain could possibly have with each other. Line a (Figure 6.4) shows that the container stevedore has a contract with the container shipping line. In this contract, the terminal handling charges are agreed. The container shipping line pays the stevedore for three services: (1) the transfer from deep-sea vessel to the container stack, (2) the temporary storage of containers at a stack on the terminal, and (3) the transfer to the hinterland mode (barge, rail or truck). There is no contractual relationship between the barge operator on the one hand and the deep-sea terminal operator on the other. Such a contract would give an incentive to both parties to better match the quay planning of the container stevedore and the sailing plan of the barge operator. Most of the interviewees and workshop participants mentioned that these missing contractual relations and the fact that stevedores give priories container shipping lines hinder improvement of handling container barges. Some interviewees added that the absence of contractual relations is even worse because container barges are mostly handled along the same quays as deep-sea vessels in the present situation. In addition, between 70% and 80% of container hinterland transport in Rotterdam is organised by 'merchant haulage' (Port of Rotterdam, 2011). In this case (lines b1 and b2 in Figure 6.4), transport is organised by a forwarder or shipper. These parties have in the current contract structure a very limited impact on the performance of the container stevedore and barge operator in the port. In the case of carrier haulage (line c), container shipping could encourage stevedore companies or the barge operator to perform better.

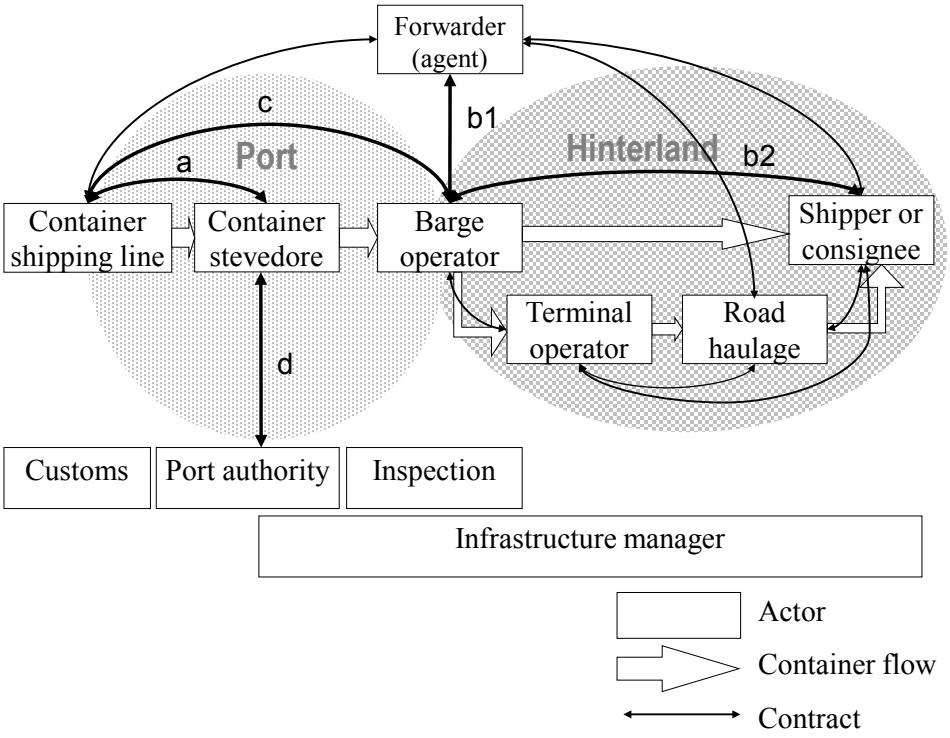

Figure 6.4 Contractual relations in container barging (Source: Van der Horst & De Langen, 2008, adapted by authors)

The same figure shows that there is no contract between the barge operator and the infrastructure manager. The main reason for the missing contractual relation can be found in the Manheim Convention on Navigation on the Rhine from 1868. The guiding principles of the Rhine Regime are freedom of navigation for the ships of all estuary nations (Belgium, France, Germany, the Netherlands and Switzerland), equality of treatment of domestic and foreign vessels, uniform administration, and the elimination of all tolls or other fiscal exactions levied solely on the right to navigate (CCR, 1868). Due to the principles of the Mannheim Convention there is no formal relationship between the barge operator or skipper and the owner and infrastructure manager for the use of the waterway at a particular place and a particular time. This limits the guidance of behaviour to achieve a more efficient use of the port's infrastructure. In comparison, in rail transport there is a formalised connection between the rail operator and the rail infrastructure manager. In the so-called access agreement, the contract between an operator and the port's infrastructure manager, there are numerous operational rules, bonuses and penalties that stimulate the efficient use of infrastructure[46].

The present division of property and decision rights in container barging in the port of Rotterdam is not an optimal to improve efficiency of container barging in the future. This can be regarded as one of the most fundamental reasons behind the existing coordination problems and is hard to change in the near future. However, the Rotterdam port authority has a possibility to control the behaviour of the container stevedore. In the concession contracts

[46] Although there is no contract for the use of infrastructure in road transport, there are possibilities to guide behaviour. In the Netherlands there is a recent project that focuses on rewards for avoiding peak hour driving in the Rotterdam port region as an alternative to road pricing. The project, called 'Spitsmijden', is focussed on passenger transport.

(line d in Figure 6.4) with the new container terminal operators at Maasvlakte 2, it is agreed that they must meet the criterion that at least 65% of their hinterland transport is carried out intermodally (barge (45%) and rail (20%)). This led to some initiatives of deep-sea operators integrating vertically in the hinterland chain (see section 6.4.2). This part of the concession contract is typically an example of how the formal institutional environment can act as an instrument to enable new forms of coordination.

6.3.5 Coordination arrangements

A preliminary conclusion from the previous sections is that, on the one hand, there are favourable geographical conditions, stimulating policies by European and Dutch governments and port authority, positive cultural characteristics such as a long tradition in horizontal and vertical cooperation, and entrepreneurs in container barging having a future-oriented and flexible focus. On the other hand, many actors are active in providing container barge transport, and its share in the modal split of inland container transport remains stable for years. The present division of property and decision rights in the container barge chain does not support improvement of coordination in the port of Rotterdam. In addition, the sector is embedded in a conservative culture where collective action is not manifest. Based on these positive and negative conditions, we discuss the three most relevant organisational observations about the coordination institutional arrangements.

Firstly, Rotterdam has a long tradition of trial and error in collective action. A relevant reason that measures for the ability (or impossibility) to improve coordination problems is the present membership rate of interest groups or branch associations. 57% of the skippers were members of a socioeconomic interest group in 2011 (Hubens, 2011). Looking at barge and inland terminal operators, it is relevant to look their membership of the Member Group Container Operators of the Dutch Central Bureau for Rhine and Inland Navigation (CBRB) and the Association of Inland Terminal Operators (VITO). According to the first-named association, members of the Group Container Operators Members organise 70% of container transport volumes on the Rhine, between Rotterdam and Antwerp and in the BeNeLux (CBRB, 2007). About half of the container shuttles from/to the port of Rotterdam are organised by a member of the Group Members Container Operators. The degree of organisation of inland terminal operators is lower than that of the inland operators, namely 23%. This low percentage can be explained by the fact that VITO is a Dutch association; inland terminal operators from Belgium, France or Germany cannot become a member. Almost all Dutch terminal operators are members of VITO. In total, 71% of the container shuttles in Rotterdam are organised by members of the two mentioned interest groups (Bureau Voorlichting Binnenvaart (2011) via Port of Rotterdam (2012)).

Secondly, the Rotterdam port community has a good track record with regard to the development of initiatives or coordination arrangements to increase efficiency of container barging in the port. Nevertheless, a lot of the initiatives have failed[47]. Three remarks on these coordination arrangements can be made. Firstly, there is a high involvement of barge operators and the branch organisations. A lot of ‘non-barging parties' such as deep-sea

[47] Initiatives are collected analysed from the studies of Van der Horst and De Langen, (2008) and Van Binsbergen, Van der Horst, Konings en Veenstra (2009)

terminal operators, the port authority, and public authorities are involved in improving coordination. Secondly, we observe that there is a strong focus on hardware solutions. Some new concepts require an efficient use of an appropriate organisational structure ('orgware') and a supporting information system ('software'). Mainly hardware solutions fail. The underlying reasons are the necessary investments in terminal equipment or vessels or the additional storage and handling time, resulting in higher operating costs. The failing factor is that these costs are not fairly allocated to the parties in the transport chain. Thirdly, it can be observed that many initiatives failed because there was a temporary necessity to improve coordination. Mainly initiatives are mainly taken in time periods with an above-average growth in container throughput and scarcity of handling capacity at the deep-sea terminal. When container growth declines or handling capacity increases the necessity disappears and initiatives are stopped.

A third characteristic about the coordination arrangements is that the deep-sea terminal operator, as the 'unusual party', takes the lead in organizing container barge transport. In 2010, the Rotterdam container stevedore ECT introduced a new concept called the "Extended Gate Model". In this concept, ECT tries to extend the gate of its deep-sea terminal to inland terminals by offering both container handling and hinterland transport services to their own hinterland terminals. From 2011, APM Terminals has organised a daily barge service to the Delta Marine Terminal (DMT) in Moerdijk. In these two examples, one might speak of 'terminal haulage'. Compared to container railway transport, vertical integration by deep-sea terminals and container shipping lines is poorly developed. Vertical integration by the deep-sea terminal operator is regarded as positive by the market. In this case container cargo for one destination is bundled within the firm (the deep-sea terminal operator), which helps to decrease the call size. Although there is vertical integration by the deep-sea terminal operators, none of the shipping lines is vertically integrated in container barging in Rotterdam. In the Hamburg-Le Havre range, only a few examples exist where shipping lines are active in container barging (Franc & Van der Horst, 2010). For example, in Le Havre, three of the six barge operators are affiliated with the shipping companies Maersk, MSC and CMA-CGM. Such developments are not observed in Rotterdam yet. Whereas we noticed vertical integration by deep-sea terminal operators, we also see a prominent role for inland terminal operators in organising container transport.

Table 6.3 Horizontal integration ITOs: terminal groups in the Netherlands

Terminal group	Region	Volume (TEU) 2011	% of total capacity Netherlands
Brabant Intermodal (BIM)	South West Netherlands	335.000	18%
BCTN	Middle East Netherlands	300.000	16%
CTU (Theo Pouw Group)	Middle Netherlands	132.550	7%
HCL & IMS [1]	North Netherlands	84.000	5%
MCS	North Netherlands	76.000	4%
	Total volume:	**927.550**	**50%**

1: Volume is including ROC Kampen. HCL & IMS offer a joint line service to Rotterdam in cooperation with ROC Kampen

About 40% of the container shuttles from and to Rotterdam are organised by inland terminal operators (Bureau Voorlichting Binnenvaart (2011) via Port of Rotterdam (2012)). This number increased during the last years. The increased involvement of inland terminal operators is positive because they are well embedded in the region and are able to bundle cargo in that region which benefits the call size in the port. Next to their increasing role in organising container barge transport, they create large interfirm alliances, which includes vertical and horizontal alliances. In the inland terminal network of Rotterdam some large groups of terminal operators exist. Those groups own more than one inland terminal. Table 6.3 shows the most important terminal groups in the Netherlands. Together they hold 50% of the handling capacity in the Netherlands (927.550 TEU on a yearly basis). Brabant Intermodal is the largest terminal operating group in the Netherlands (18%), followed by BCTN (16%). Interestingly, all terminal operating groups have their own geographical scope. For example, BCTN focuses on the Middle and Eastern part of the Netherlands with terminals in Nijmegen, Den Bosch and Wanssum, while HCL, IMS and MCS focuses on the Northern part of the country.

6.4 Synthesis

The aim of this research was to better understand the stagnation of container barging and related coordination problems in the port of Rotterdam. This seems in contrast to the ambition to increase the future share of container transport by barging. Because container barging in Rotterdam is a unique and local phenomenon, and experiences from other ports are hard to find, a case study was adopted to get better insights into the actual situation. In a multidisciplinary research approach, we used a framework rooted in New Institutional Economics, and a constructed truth that identified different categories of institutions. The value of this research is that the performance of the container barge sector in the port of Rotterdam, and the possibility to improve it, has not been studied as an isolated issue, but is related to the context of the sector.

In recent years, the container barging's performance has been lagging too much to be able to play the foreseen dominant role in the hinterland transport. The market share of barging in the supply and transport of containers to the Maasvlakte is, at best, remaining stable for years. The performance of container barging in Rotterdam is inefficient due to long turnaround times of barges and inefficient terminal planning. Given the long period of time in which the share of container barging remains stable, it seems hard to improve coordination. We observe a paradox: on the one hand, many interdependent actors are undertaking a range of institutional arrangements to improve coordination in container barging, but at the same time, by a non-existing 'sense of urgency' among the main stakeholders and the unwillingness to cooperate, the sector's market share is weakening.

The sector's performance and the interaction between actors take place continuously; the informal and formal institutions and institutional arrangements are changing with different time periods. Informal institutions are deeply rooted in the container barging sector and they only change over a very long period. The actors in the Rotterdam container barging sector are embedded in a history with many vertical and horizontal alliances. Although the sector can be characterised as conservative and individualistic, operating container barges in the context of

family business acts with an entrepreneurial and future-focused spirit. Moreover, the container barging sector in the port of Rotterdam operates in a tradition of adapting to changes in the market environment. We observe that this 'chameleonic behaviour' influences, to a large extent, the market organisation nowadays. Inland Waterway Transport in Rotterdam has a long tradition of trial and error in collective action. Nevertheless, there is a high degree of organisation among barge operators and inland terminal operators nowadays. This reflects a high level of ability to work on improve coordination in the future. The present market organisation is characterised by a large track record of initiatives to solve existing coordination problems in container barging. Unfortunately, these initiatives often have a strong focus on hardware solutions and a temporary necessity.

There is a lot of discussion on what is needed to give an impetus to container barging in Rotterdam. It seems that the current policy is lacking or formulated by means of the traditional government approach. Not all stakeholders are aware that new roles and new approaches are needed to benefit from opportunities for inland shipping. The need for an efficient, sustainable and functioning inland shipping sector is acknowledged on different levels such as local, regional, national and even European level, but manifests most directly in the performance of the port(s). This case study concludes that the present division of property and decision rights in container barging in seaports is a bad condition for future improvement. Firstly, there is no contractual relationship between the barge operator and the deep-sea terminal operator. Secondly, due to the principles of the Mannheim Convention there is no formal relationship between the barge operator or skipper and infrastructure manager. The division of property and decision rights is hard to change in the short term. This research showed that not only barge operators have an important stake in organising efficient container barge transport, but also deep-sea terminal operators and inland terminal operator increase their influence by different forms of vertical and horizontal integration.
The challenge is to develop an ex-ante methodology that addresses the new challenges in a coherent transition strategy. This implies that all stakeholders (forwarders, shippers, barge operators, etc.) have to reconsider their role. It is necessary to work on awareness raising and to recognise the need for cooperation and interaction between the governments and private firms to improve the performance of container barging in the port of Rotterdam, and to fulfil the changing needs of society on logistics.

7 Conclusions and recommendations

This chapter summarizes the main findings of the articles in section 7.1. Section 7.2 will discuss the contribution of the conducted research to the research field, gives a reflection on the theoretical framework, and provides suggestions for future research.

7.1 Summary of findings

This thesis started from the point that containerization of goods has not only led to an increase of international trade of manufactured goods, but also increased the competition between ports and put pressure on the use of scarce hinterland infrastructure. Having good coordination between all actors involved in port-related transport, including infrastructural access to the hinterland and the availability of transport services, is required to be successful in container port competition. However, this coordination does not always develop spontaneously and needs to be arranged through private and public ordering. The thesis aimed at advancing the understanding of how public and private actors in port-related transport chains improve coordination. The core of the thesis consists of five articles. They form a 'pattern of discovery' of different issues related to coordination in hinterland chains applying different theoretical lenses of inter-organisational theories in which Institutional Economics plays a central role. In the remainder of this section the five articles are summarized.

Chapter 2: Identification of coordination problems and arrangements
The goal of the first article in chapter 2 was to enhance the body of empirical knowledge on coordination issues in port-related transport chains and to propose a typology to analyse coordination arrangements. This article stated the need to analyse coordination in hinterland container transport. First, because costs for hinterland transport are generally higher than the maritime transport costs. Second, because most bottlenecks of the door-to-door container

transport chain occur in the hinterland part. Based on literature review, desk research, and interviews, the chapter concluded that coordination problems in hinterland chains occur, in general, due to an imbalance between the costs and benefits of coordination, a lack of willingness to invest, the strategic considerations of the actors involved, and risk-averse behaviour. Coordination problems in road, rail, and waterway transport include the long stay of barges, trains, and trucks in the port region or at the terminal, the limited exchange of cargo and transport capacity, unused and overused rail and road infrastructure, limited quay and crane planning at the deep-sea terminal, and limited information exchange with customs and inspection authorities.

The article provided four mechanisms to enhance coordination which are helpful for the analysis of coordination arrangements. These include: the introduction of incentives, the creation of inter-firm alliances, changing the scope, and the creation of collective action. Incentives are used to internalize harmful or beneficial effects of a firm's decision on other firms, such as financial or non-financial bonuses, penalties or differentiated pricing systems. Incentives could yield high transaction costs. In the article we concluded that alliances are arrangements with more commitment between the companies involved. Alliances are better instruments to improve coordination than financial and non-financial incentives, especially in cases where coordination requires investments, but benefits are unclear and uncertain. In inter-firm alliances the actors involved remain to some extent independent. The degree of independence changes when an organisation changes its scope. The article stated that the organisation of collective action is more relevant when investments have collective rather than individual benefits; it can be achieved via a public organisation, a public/private organisation or an industry association.

In the empirical part, coordination arrangements were identified in the inland waterway transport of containers and were linked with the relevant coordination problem. The chapter showed that new arrangements are continuously developed in an attempt to organise collective action by the different actors involved including the sector association, the port cluster association, and the Rotterdam Port Authority. About one-third of the forms of coordination were inter-firm alliances covering forms of cooperation between independent firms like transport capacity pools, freight exchange websites and train shuttles. In about 25% of the arrangements, actors changed their scope of activities. In only a few cases incentives were introduced to positively influence the behaviour of actors. It was concluded that additional research is needed to better understand when, how and by whom a certain coordination arrangement is chosen by further elaborating the typology theoretically and empirically.

Chapter 3: Further examination of coordination problems and arrangements

The last conclusion of chapter two formed the main motivation for the study in this chapter, in which we further explored coordination arrangements in the port of Rotterdam taking the research database and typology from the first article as a starting point. Key characteristics related to the complexity of the transaction (number of actors involved, group character, and coordination problems to be solved) and of the coordination arrangements (type of coordination arrangement, function of actors involved, function of the initiator, power base of the initiator, transport mode and use of ICT) were defined. The article showed that

Transaction Cost Economics (TCE) is a valuable lens to understand the reasons for the emergence of coordination arrangements. In the operationalisation of TCE in transport chains, we found out that hinterland accessibility requires inter-organisational coordination of operational tasks performed by different companies, potentially resulting in excessive coordination costs. In addition to the specific characteristics of the transaction according to TCE, the type of interdependence of the companies involved is relevant. The type of interdependence can be related to the following specific coordination problems: lack of investments in the inland transport network, insufficient or suboptimal operational coordination in the hinterland transport chain, or underutilisation of assets.

The analysis showed that transport companies are the most important initiator of coordination arrangements. The Rotterdam Port Authority and terminal operators also play an important role. This article assumed a relationship between the chosen coordination arrangement and the complexity of the transaction. Complexity has to do with the number of actors involved and the degree of heterogeneity of the actors: the more actors involved and the more heterogeneous the actors, the higher the complexity. More actors in an alliance lead to more appropriation concerns resulting in more hierarchical coordination. The involvement of public actors or the publicly owned port authority reduces transaction costs. Furthermore we extended the TCE approach and explored the role of power. Since we expected that coordination among a large group with different behavioural characteristics and objectives is not only complex but would require the involvement of a powerful initiator. However, the analysis showed that the relationship between the group size and enforcement based on power was limited. When a group size is large, initiators of coordination arrangements do not enforce it, but act mainly as a stimulator or an enabler (leader firms). Moreover, the article looked into the role of information and communication technology to solve coordination problems and lower transaction costs. The analysis showed that ICT is usually applied to solve the lack of operational coordination and, to a smaller extent, to improve the utilisation of assets. The use of ICT is most appropriate when the group size is large.

Chapter 4: Change of scope by shipping lines and terminal operating companies

Changing scope was one of the four mechanism to improve coordination as introduced in the first article. The aim of the third article was to improve the understanding of why and how shipping lines and terminal operators vertically integrate (change of scope) in intermodal transport services and inland terminals. Based on desk research, interviews and the use of both Transaction Cost Economics (TCE) and the Resource Based View (RBV), different cases from ports in the Hamburg–Le Havre range have been investigated. The research showed that shipping lines have identified inland logistics as a vital area to reduce costs. Through vertical integration they strive to minimise coordination costs. By integrating into inland transport services and inland terminals, shipping lines try to deal with uncertainty and unreliability of hinterland services. Further, via integration terminal operators cope with the scarcity of port and terminal space and the lack of coordination with hinterland transport companies. Vertical integration offered shipping lines a competitive advantage. Moreover, the theoretical investigation showed that the provision of inland transportation services also offers shipping lines the opportunity to differentiate. Terminal operators are confronted with fewer, larger and more demanding shipping lines and cargo controlling parties. Terminal operators are challenged to redefine their business, minimize cost and to differentiate their ownership

shares in intermodal transport firms. The creation of a network with (dedicated) inland terminals and extended gates was identified as a way to differentiate and increase space at the deep-sea terminal and flexibility.

In the empirical analysis we observed that it is hard to measure the level of asset specificity being a limitation of Transaction Cost Economics; some outcomes of the empirical analysis were not completely congruent with the core predictions of TCE. From the analysis it became clear that both shipping lines and terminal operating companies mainly aim at enlarging their scopes in order to deal with uncertainty. The article showed that RBV is focussing on the dynamics and emphasizes the interaction between firms. A change of scope in business activities creates a competitive advantage for firms based on both cost minimisation and product differentiation. Based on empirical observations, the study suggested to include three other elements in the analysis. Firstly, the geographical scale of vertical integration strategies should be taken into account. The motivation of a terminal operator to enlarge its scope is more locally oriented; incentives of the shipping line are more globally. Secondly, the elements of power and culture of the firms should be included. Thirdly, the analysis should be extended with the formal institutional environment. In the institutional environment of hinterland chains recent European directives on liberalising the European railway market influenced the way shipping lines and terminal operators have been involved in container rail services.

Chapter 5: Effect of liberalization on coordination in railway chains
In the fourth article the focus was on including the role of the institutional environment and dynamics in the analysis of coordination in hinterland chains. The goal of this article was twofold. Firstly, to discuss both the positive and the negative effects of the liberalization of the European railway market on coordination in hinterland chains. Liberalisation is seen as an important change in the institutional environment. Secondly, to review and apply our conceptual framework originating from Williamson's (1996) three-layer model of Transaction Cost Economics.

More market competition is the main driving force in liberalised transport markets. Coordination among actors should take place such that the resources are used in a way that (1) meets the need of consumers, (2) services, processes and products are innovated and that (3) the input or resources to produce a product or service are used efficiently. With regard to the first two objectives, the study concluded that liberalisation of the railway market led to positive developments in the port of Rotterdam. New entrants stepped into the market and freight rates decreased. The number of container train services has increased substantially in the years after liberalisation. The number of shuttle trains and number of origins and destinations doubled.

The study concluded that liberalization has not brought an optimal allocation of resources to the port. We argued that managing interdependent activities between railway actors became more problematic. In this respect, the number of actors could be an important 'problem multiplier', resulting in the need for additional governance.

Based on the empirical findings from the railway sector in the port of Rotterdam, the original framework has been extended towards a dynamic framework. The dynamic framework is inspired by the work of Douglass North on economic and institutional change (North, 2005). We stated that such a framework is relevant to study port-related railway chains that changed from a single and homogenous actor constellation to a multiple and heterogeneous actor constellation. In the adapted framework, the institutional environment is not only a constraint, but as an instrument creating possibilities for improving coordinating behaviour, it also allows interaction between the coordination arrangements and the institutional environment. The article revealed the importance of 'adaptive efficiency', being the willingness to invest in skills and learning by doing. The study plead for including the values, norms, habits, historical specificity (path dependency) and mental maps, which influence actor behaviour in hinterland chains.

Chapter 6: A multidisciplinary analysis behind coordination problems in container barging

The last article explored the causes of coordination problems focussing on container barging in the port of Rotterdam. We performed a multidisciplinary analysis by adopting a single case study approach. The case study was guided by a framework inspired by the four layer model of Williamson (1998) thereby distinguishing the interaction between actors, institutional arrangements, as well as formal and informal institutions. The article discerned that performance of container barging in Rotterdam is inefficient due to long turnaround times of barges and inefficient terminal planning. The study analysed the possible institutional reasons that caused coordination problems for actors in container barging.

The organisation or the market is characterised by a large track record of coordination arrangements. These initiatives often have a strong focus on hardware solutions. A paradox can be observed: many interdependent actors create a range of arrangements to improve coordination, but at the same time there is not a sense of urgency among them. With respect to the informal institutions, the article concluded that the container barging sector in Rotterdam is embedded in a history with many vertical and horizontal alliances. Although the Inland Waterway Transport sector can be characterised as conservative and individualistic, container barge operators act with an entrepreneurial, adaptive and future-oriented spirit. The studies showed that the degree of organisation among barge operators and inland terminal operators active in organising barge transport is relatively high. This reflects an ability to improve coordination in the future. The formal institutions are more problematic. More specifically, the present division of property and decision rights form a bad condition for future improvement. This includes the fact that there is no contract between the barge operator and the deep-sea terminal operator and, due to the principles of the Mannheim Convention, there is no formal relationship between the barge operator or skipper and the owner and manager of the waterway infrastructure. The division of property and decision rights is hard to change in the short term.

7.2 Concluding remarks and issues for further research

Contribution to the research field

This thesis offers a rather new approach in the young and small research domain of Port Economics Management and Policy by applying insights from inter-organisational theories to hinterland chains. Since the publication of the first article from this thesis (Van der Horst & De Langen, 2008) the attention for coordination in hinterland chains increased. First, the issue of improving the understanding of specific actors in port-related transport chains has been addressed. Especially the role of the port authority received much attention multiple times. Van den Berg & De Langen (2012) and Van der Lugt et al. (2014) provided insights in the role of the port authority in the development of a hinterland strategy. Second, the theoretical lenses used in this thesis, like the Transaction Cost Economics approach, have been adopted in the study of Lendjel & Fischman (2014) on governance structures of container barge transport in France, for example. Furthermore, coordination in hinterland chains as a means of differentiation studied from the Transaction Cost Economics and Resource-Based View perspectives has been further studied and discussed with respect to the value proposition around inland terminals (Van den Berg & De Langen, 2014). Finally, the conceptualisation of the development of inland terminal networks and dry ports from a governance perspective received more attention in recent years (e.g. Monios (2015), Roso and Lumsden (2010)).

Considerations on the framework

This thesis clarified that hinterland chains, or port-related transport chains, are very complex, for several reasons:

- There are multiple, different actors involved acting in different industries: Inland Waterway Transport, railway transport, trucking, terminal operating business, infrastructure management, etc.
- There are multiple interdependencies and interactions between actors that need coordination.
- There are both public and private parties involved with their own specific interests.
- Many actors perform beyond their traditional scope of activities of their company or organisation
- The actors are influenced by different forms of formal institutions at different geographical levels (local by Port Authority up to the European Commission).

In this thesis we propose a framework to analyse coordination in hinterland chains. Such a framework, being a broad set of variables, their linkages and a list of attributes (Ostrom, 2009) was not yet available. The framework is a means to cope with the complexity of hinterland chains. It helps with the exploration and better understanding of the real-life observations of phenomena in port-related transport.

In chapter one we introduced a framework distinguishing the actors in port-related transport chains and different institutions at different layers of analysis: informal institutions, formal institutions, coordination arrangements, and the actors in hinterland chains. The framework offered room for different, alternative theories. The starting point for the framework was New Institutional Economics with Williamson's work on Transaction Cost Economics (TCE) in its core. TCE is relevant because it deals with the understanding of efficient coordination arrangements, given an institutional environment and given assumptions about the actors.

TCE is helpful in explaining why we need market, hierarchies (vertical integration) and various forms of hybrids like alliances. In chapters two and three it became clear that many coordination arrangements go beyond TCE. The analysis of coordination arrangements was extended with the theory on Collective Action and Property Rights. In order to come closer to the complexity of the 'reality' of coordination in hinterland chains, it can concluded that TCE makes often too strong assumptions about the rationality, opportunism and cost minimising behaviour of the actors. In chapter three we stated that the complexity primarily stems from the number of actors involved and the heterogeneity of these actors. Although the 'authentic' TCE-approach does not include the concept of power, we included it in the analysis. In chapter 4 we extended the framework about understanding vertical integration with the Resource-based View. The Resource-based View assumes that actors are creating value using strategic resources. The study showed that the behaviour of shipping lines and terminal operators is influenced by power, culture and geographical origin, and supported of taking the institutional environment into account. In chapter five extended this foundation towards a more dynamic framework, thereby focussing on the interrelations between the different layers. In the last study this dynamic framework was used as an 'ordering system' to organise empirical material as explanatory (exogenous) variables for existing coordination problems in container barging.

The underlying studies have been written during a longer period based on different research projects. The framework was constructed using multiple stages of data collection. It shows, to some extent, the learning curve of the author. The framework and the included theories in its final stage may only be partly relevant. It helps to isolate different issues and to create constructions or representations. The relevance (of parts) of the framework and theories depends largely on the issue you want to address, the behaviour of the actor, and the data available to the researcher. For example, if you want to address a research questions about the 'common' issue of vertical integration in transport chains, and all data on asset specificity is available and the actors can be regarded as bounded rational, opportunistic and cost minimizing, then TCE is relevant. If the research question is about the effect of the liberalisation of the European transport market and coordination arrangements, it is more relevant to take more explanatory variables into account, and to study the dynamics. In conclusion, when the conditions and assumptions about the reality changes, your theoretical approach may also change.

Future research directions

Based on experiences during the different studies, the scientific contributions and limitations of the study some suggestions can be made for further research.

- Coordination in hinterland chains was mainly studied in the port of Rotterdam. A first valuable research direction is extending the study to other ports and their hinterlands globally and to learn from possible differences and similarities.
- The database with coordination arrangements, as used in chapters two and three, could be extended by adding more attributes and bringing more rigour by applying statistical methods to the measurement of the attributes.
- The willingness and ability to invest in better coordination should not be studied as an isolated issue, but should be related to the context of the sector, thereby analysing more closely the values and norms embedded in the culture of a transport sector, and

acknowledging that these are changing slowly and will not always lead to efficiency. Research on unravelling the informal institutions can, for example, be done by a survey among transport companies[48].

- Often coordination arrangements have a short lifetime. Initiatives stop because of many reasons, like funding problems, problems with the distribution of the joint costs and benefits, or difficulties to find the minimum efficient scale for an initiative. This research did not include an in-depth analysis of these success and fail factors[49], which would be a relevant suggestion for further research.
- Inland terminal operators gain a more prominent role in organising container barge transport. The number of inland terminal operators in the Rhine-Meuse-Scheldt delta increased during the last years. A relevant research direction would be to find out if new inland terminals create additional container flows, and how their involvement will affect the efficiency of the hinterland chain.
- Another promising research line would be to focus on the issue of self-regulation and/or spontaneous order. This is inspired by two examples discussed earlier in the thesis, namely the 'Verkeersonderneming' and the project 'Chain Management Port Rail Track'. It is interesting to have a closer look on how formal institutions are not only exogenously determined, but can also be shaped spontaneously, and are later recognized by public actors[50], in a situation with no enforcement by these public actors.
- More additional research is needed to measure the cost of inefficiencies in hinterland chains. Once the costs of inefficiencies are evident and recognisable, steps can be made into the development of gain sharing mechanisms. Clear underlying gain sharing mechanisms for future coordination arrangements can be considered as a condition for success.
- More knowledge is needed about the changing requirements of the shipper and the role of the freight forwarder. Extending the analysis to the shipper is relevant because they are the end-user of port-related transport. Their logistics requirements are not static but have developed in the last decades (Melnyk et al., 2010).
- The future role of the freight forwarder as an intermediary in port-related transport chains could change. The forwarder plays a minimum role in coordination arrangements (see chapter three). At the same time, many actors in port-related transport chains act more beyond their traditional scope. For example, deep-sea operators become active in the exploitation of inland terminals and are directly dealing with barge and railway operators

[48] In this respect, the studies of Hubens (2004, 2001), as used in chapter 6, are good examples. In these studies entrepreneurs in Inland Waterway Transport (IWT) received a questionnaire with issues related to organisation of the sector and future ambitions, thereby also identifying the socio-economic background of the entrepreneurs (age, education, knowledge level, etc.). Such a study can be updated and/or executed among entrepreneurs in container trucking.

[49] We touched shortly upon the success and fail factors in chapter 6. A recent study can be found in e.g. Van Binsbergen et al., 2014

[50] See for example Hodgson (2002). He pointed out that while some institutions can emerge and develop spontaneously, it is often the case that an institution reaches an important stage of development when it becomes consciously recognised and legitimated by the state.

for the organisation of transport to and from the inland terminal. Moreover, the concept of synchromodality is gaining popularity[51]. In synchromodal transport the customer (shipper or forwarder) is offered an integrated solution for its hinterland transport. If the shipper or forwarder is offered an already integrated transport solution, then it is relevant to further investigate how this will influence their future role.

[51] Synchromodal transport is the flexible and sustainable deployment of different transport modalities in a network managed by a logistics service provider in an optimal way, in such a way that the customer (shipper or forwarder) is offered an integrated solution for its hinterland transport (Stuurgroep Synchromodaliteit, 2012) Please note that the concept of synchromodal transport is not uniformly defined in academic literature, and could develop in different directions.

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Appendix

Appendix 1 List of interviewees

Name	Function	Company	Chapter
Frans van den Boom	Managing director	C. Groenenboom Transport Ridderkerk	2
Henry Nugteren	Project member	Customs Administration Rotterdam	2
Ton van der Avert	Chairman Group	CBRB (sector association IWT)	2
Ton Roos	Managing director	CBRB (sector association IWT)	2
Rink Jan Slotema	Policy advisor	EVO Dutch Shippers' Council	2
Albert Thissen	Managing director	Hapag-Lloyd	2
Pieter Jongens	CEO	Informore	2
R.J. Zimmerman	Managing director	Mercurius Scheepvaart Group	2
Bart Roozekrans	Managing director	Portinfolink (Portbase since 2009)	2
Iwan van der Wolf	Manager Strategy	Portinfolink (Portbase since 2009)	2
Tom Dekker	Managing director	Port of Rotterdam Authority	2
Marc Stubenitsky	Business developer	Port of Rotterdam Authority	2
Martien Windhorst	Business developer	Port of Rotterdam Authority	2
Cor Hoenders	Managing director	Rail Service Center Rotterdam	2
Carel Robbeson	Managing director	Railion Nederland	2
Jos Helmer	Managing director	Rhinecontainer	2
Paul Swaak	COO	Samskip	2
Don van Driel	Managing director	Trimodal Europe	2
Paul Zoeter	Analyst	ECT	4
Cees Van Altena	General Manager	Maersk	4
Robert-Jan Brussaard	Intermodal Manager	NYK Rotterdam	4
Jan Nater	Business Developer	ECT	4, 6
Ton de Jong	Head Unit Inland	ABN-AMRO	6
Erik Nooijen	Chairman	Ass. of Dutch Inland Terminal Operators	6
Nick van Haag	Project Leader	Bureau Telematica	6
Marco Zwaap	General Manager	Danser Container Line	6
Maira van Helvoirt	Secretary	CBRB (sector association IWT)	6
Frank Smeele	Prof. Commerc. Law	Erasmus University Rotterdam (Law)	6
Hugo van Driel	Assistant professor	Erasmus University Rotterdam (RSM)	6
Khalid Tachi	Managing director	Expertise and Innovation Center IWT	6
Henk Molenaar	Former CEO	Former CEO Port of Rotterdam and	6
Jan Buiter	Chairman	Logistics Intermodal Network (LINC)	6
Henk Blaauw	Managing director	Maritime Research Institute Netherlands	6
Herman Taal	Policy Advisor	Ministry of Infrastructure & the Environ.	6
Arie Verberk	Ambassador IWT		6

Appendix 2 List with coordination arrangements (Chapter 2)

Abbreviations mechanisms:
INC: introduction of incentives
IA: creation of an interfirm alliance
SCO: changing scope
CA: creating collective action

Coordination arrangement	**Hinterland chain**	**Coordination mechanism**
AMS-barge container service	barge	CA
Barge Planning Center	barge	IA
Hessennoordnatie (Antwerp) inland barge terminal in Rotterdam	barge	SCO
River Information Services	barge	CA
Germersheim Inland terminal	barge	SCO
Sikzneb	barge	IA
Pact 1999 Central Bureau for Rhine and Inland shipping Association	barge	INC
Fixed time window as a bonus at terminal of stevedore ECT	barge	INC
Combined Container Services establishment	barge	IA
Rhinecontainer establishment	barge	IA
Hinterlink protocol	barge	CA
Waterslag project	barge	CA
Fahrgemeinschaft Oberrhein, (PENTA Container Line)	barge	IA
Fahrgemeinschaft Niederrhein	barge	IA
Lumpesammler (joint barge to collect and exchange cargo)	barge	CA & IA
Teleship (freight exchange)	barge	IA
www.bargelink.com	barge	IA
www.bargeplanning.nl	barge	CA
B-W@ve	barge	CA
Fixed window bonus (part Hinterlink-protocol)	barge	INC & CA
Freight exchange barging via www.overmeer.com	barge	IA
URCA Upper Rhine Container Alliance	barge	IA
Barge operator Van Uden inland terminal Haaften	barge	SCO
Cooperation 4 Dutch inland terminals	barge	CA
Association of Inland Terminal Operators and stevedore ECT cooperate	barge	IA
AIT and Penta in joint Rhine service Amsterdam-Basel	barge	IA
Quality Rail Rotterdam	rail	CA
Rail Cargo Information Netherlands	rail	CA
Keyrail	rail	IA
Cooperation between rail terminals Eindhoven and Tilburg	rail	IA
BoxXpress	rail	IA & SCO
Platform rail capacity extension	rail	CA
Cooperation of several branch organizations in Rail Freight Transport	rail	CA
Rail4Chem Benelux BV	rail	SCO
Trailers-on-trains project	rail	CA
Kombiverkehr established Intercontainer Austria shuttle	rail	IA

Coordination arrangement	Hinterland chain	Coordination mechanism
AMS-barge container service	barge	CA
Barge Planning Center	barge	IA
Hessennoordnatie (Antwerp) inland barge terminal in Rotterdam	barge	SCO
River Information Services	barge	CA
Germersheim Inland terminal	barge	SCO
Sikzneb	barge	IA
Pact 1999 Central Bureau for Rhine and Inland shipping Association	barge	INC
Fixed time window as a bonus at terminal of stevedore ECT	barge	INC
Combined Container Services establishment	barge	IA
Rhinecontainer establishment	barge	IA
Hinterlink protocol	barge	CA
Waterslag project	barge	CA
Fahrgemeinschaft Oberrhein, (PENTA Container Line)	barge	IA
Fahrgemeinschaft Niederrhein	barge	IA
Lumpesammler (joint barge to collect and exchange cargo)	barge	CA & IA
Teleship (freight exchange)	barge	IA
www.bargelink.com	barge	IA
www.bargeplanning.nl	barge	CA
B-W@ve	barge	CA
Kombiverkehr - Optimodal Rotterdam	rail	IA
Rail4Chem drives NYK trains	rail	IA
ROLYS: shuttle to Lyon by Non Rail Operating Common Carrier	rail	IA
Rail Shutte Wenen Linz-Rotterdam	rail	CA & IA
Geest North Sea Line opens rail shuttle Rotterdam-Hamburg	rail	SCO
Raillink	rail	SCO
Raillink Europe	rail	IA
Cooperation railway company ACTP and rail and barge terminal Tilburg	rail	IA
Swiss logistics service project Bertschi opens rail terminal in Rotterdam	rail	SCO
European Railway Shuttle	rail	SCO
Agreement on exchange locomotives and train drivers between	rail	IA
User's platform Rail Freight Transport	rail	CA
Public transshipment point outside port regions (de-coupling point)	truck	CA
Cargo Card	truck	INC
W@ve Road planning	truck	CA
www.vrachtuitwisseling.com (freight exchange webiste)	truck	CA & IA
Quality Road Rotterdam	truck	CA
Van Uden Nedcargo and RFM container transport alliance	truck	IA
Pact 1997 stevedore ECT en Ass. Dutch Sea Container Truckers	truck	INC
One Way Truck: project empty container trips	truck	IA
Ceres-Rijn service established by 2 terminal operators	truck	IA
Road Planning and exclusive 'pre-arrival desk' at terminal	truck	INC
Compensation ECT to truck company in case of waiting times	truck	INC
Extended Gate Model ECT ('terminal haulage')	barge/rail	SCO
Investment of Maersk in terminals	barge/rail	SCO
Port Infolink (Port Community System)	truck/barge/rail	CA
Rotterdam Representatives in hinterland	truck/barge/rail	CA
Inland terminals of stevedore ECT in Venlo, Duisburg and Willebroek	truck/barge/rail	SCO

Coordination arrangement	Hinterland chain	Coordination mechanism
AMS-barge container service	barge	CA
Barge Planning Center	barge	IA
Hessennoordnatie (Antwerp) inland barge terminal in Rotterdam	barge	SCO
River Information Services	barge	CA
Germersheim Inland terminal	barge	SCO
Sikzneb	barge	IA
Pact 1999 Central Bureau for Rhine and Inland shipping Association	barge	INC
Fixed time window as a bonus at terminal of stevedore ECT	barge	INC
Combined Container Services establishment	barge	IA
Rhinecontainer establishment	barge	IA
Hinterlink protocol	barge	CA
Waterslag project	barge	CA
Fahrgemeinschaft Oberrhein, (PENTA Container Line)	barge	IA
Fahrgemeinschaft Niederrhein	barge	IA
Lumpesammler (joint barge to collect and exchange cargo)	barge	CA & IA
Teleship (freight exchange)	barge	IA
www.bargelink.com	barge	IA
www.bargeplanning.nl	barge	CA
B-W@ve	barge	CA
Inland Container Terminals Netherlands BV	truck/barge/rail	IA
Land bridge Rotterdam-Rostock	truck/barge/rail	IA
Platform Modal Split - PCR RIL	truck/barge/rail	CA
Combi terminal Pernis	truck/barge/rail	SCO
FENEX (forwarders) regular conference with Customs/Inspection	truck/barge/rail	CA
Mobile Custom Scan	truck/barge/rail	CA
Central direction 'verifying containers'	truck/barge/rail	SCO
Custom check at inland terminals (export containers)	truck/barge/rail	CA
Central Electronic Gate ('secure lanes')	truck/barge/rail	CA
Pre-arrival check in warehouses of forwaders	truck/barge/rail	SCO
Lading gate (1 office for scanning en nuclear control)	truck/barge/rail	CA
Authorized Economic Operator = Custom	truck/barge/rail	SCO

Appendix 3 Coordination arrangements rail transport and trucking (Chapter 2)

Coordination arrangements in container rail transport

Coordination problem			Examples of coordination arrangements
Peak load on terminals; spread of terminal slots is not realized	**INC**	-	-
	IA	3	Cooperation rail terminals Eindhoven & Tilburg
	SCO	5	Maersk - inland terminals
	CA	3	Quality Rail Rotterdam
Unused rail tracks because of insufficient tuning	**INC**	-	-
	IA	1	Keyrail
	SCO	-	-
	CA	3	Platform rail capacity extension
Limited planning on rail terminal causes regularly delays	**INC**	-	-
	IA	2	Cooperation rail terminals Eindhoven & Tilburg
	SCO	5	Maersk - inland terminals
	CA	3	Pressure Group Rail Freight, Quality Rail Rotterdam, Ass. of Inland Terminal Operators
Limited exchange of traction	**INC**	-	-
	IA	7	Agreement on exchanging locomotives and train drivers between 5 Dutch railway companies
	SCO	3	Rail4Chem Benelux
	CA	4	Quality Rail Rotterdam
Limited exchange of rail cargo	**INC**	-	-
	IA	8	ROLYS: shuttle to Lyon established by Non Rail Operating Common Carrier Trimodal
	SCO	3	European Railway Shuttles, Raillink (CMA-CGM)
	CA	5	Cooperation of several branch organizations in Rail Freight Transport

Coordination arrangements in container trucking

Coordination problem			Examples of coordination arrangements
Peak load in arrival and departure of trucks at deep-sea terminal	**INC**	3	Pact 1997 stevedore ECT en Ass. Dutch Sea Container Truckers, Road Planning and exclusive 'pre-arrival desk' at terminal
	IA	-	-
	SCO	1	Public transhipment point outside port regions (de-coupling point)
	CA	4	W@ve Roadplanning,
Peak load in road transport causes congestion on the road infrastructure in port region area	**INC**	3	Road Planning and exclusive 'pre-arrival desk' at terminal
	IA	-	-
	SCO	1	Public transhipment point outside port regions (de-coupling point)
	CA	4	Quality Road
Truck driver's lack of information leads to insufficient pick up process on terminal	**INC**	3	Cargo card
	IA	-	-
	SCO	-	-
	CA	2	Road planning, Port Infolink
Limited exchange of cargo and truck capacity (would increase efficiency, but does not develop spontaneously)	**INC**	-	-
	IA	2	One Way Truck
	SCO	-	-
	CA	4	Dutch Sea Container Transporters Alliance involvement in freight exchange website www.vrachtuitwisseling.com

Summary

Containerisation has led to increased competition between ports and put pressure on the use of scarce hinterland infrastructure. Having good coordination between all actors involved in port-related transport, including infrastructural access to the hinterland, is required to be successful in container port competition. In hinterland chains, different coordination problems exist for different reasons. As a response, different public and private actors undertake coordination arrangements to solve coordination problems. The goal of this thesis is to advance the understanding of how actors in port-related transport chains improve this coordination. The core of the thesis consists of five article. They form a 'pattern of discovery' of different issues related to coordination in hinterland chains applying different theoretical lenses from inter-organisational theories in which Institutional Economics plays a central role. This thesis introduces a framework to analyse coordination in hinterland chains. The framework helps to cope with the complexity of coordination in port-related transport chains and it is a tool to explore coordination issues systematically.

The first study shows that different coordination problems exist in transport by road, rail, and waterway. These coordination problems occur due to the imbalance between the costs and benefits of coordination, a lack of willingness to invest, the strategic considerations of the actors involved, and risk-averse behaviour. Based on literature review, desk research, interviews, and cases of coordination arrangements from the port of Rotterdam, we introduce a typology of four main categories of coordination arrangements. The categories are inspired by Transaction Cost Economics, theory on Property Rights, and Collective Action theory, and include: introduction of incentives, creation of interfirm alliances, changing scope of the organisation, and creating collective action. In the empirical part, coordination arrangements from container bargingin the port of Rotterdam are discussed and linked with the relevant coordination problem.

The second study further explores coordination arrangements in the port of Rotterdam taking the typology from the first article as a starting point. Key characteristics related to the complexity of the transaction (number of actors involved, group character, and coordination problems to be solved) and of the coordination arrangements (type of coordination arrangement, function of actors involved, function of the initiator, power base of the initiator, transport mode and use of ICT) are defined. The analysis shows that transport companies are the most important initiator of coordination arrangements. The Rotterdam Port Authority and terminal operators also play an important role. This article assumes a relationship between the chosen coordination arrangement and the complexity of the transaction. More actors involved leads to more complexity, resulting in more hierarchical coordination arrangements; the involvement of public actors or the port authority reduces transaction costs. When the group size is large, initiators of coordination arrangements do not enforce coordination, but act mainly as a stimulator or enabler (leader firms). The analysis shows that ICT is usually applied to solve the lack of operational coordination, and when the group size is large.

The third article further explores one main category of coordination arrangements, namely ‘changing scope’, thereby focussing on two actors, namely shipping lines and terminal operating companies. By making use of insights from Transaction Cost Economics and the Resource-based View, the paper helps to understand why and how shipping lines and terminal operating companies vertically integrate into intermodal transport and in inland terminals. The paper discusses a number of cases from the Hamburg–Le Havre range, where shipping lines and terminal operating companies have changed their scope. After the theoretical and empirical analysis, the papers draws conclusions on the explanatory power of the theories. From a theoretical point of view, and based on empirical observations, the study shows that three other aspects are relevant to take into account: the geographical scale of vertical integration strategies, the elements of power and culture of the firms, and the role of the formal institutional environment.

In the fourth study, the focus is on including the role of the institutional environment and dynamics in the analysis of coordination in hinterland chains. Based on an in-depth study into coordination in liberalised railway market in the Port of Rotterdam, empirical illustrations are used to adjust the Transaction Cost Economics approach towards a dynamic model influenced by Douglas North's theory on economic and institutional change. The study states that such a framework is relevant to study port-related railway chains that changed from a single and homogenous actor constellation to a multiple and heterogeneous actor constellation. In the adapted framework, the institutional environment is not only a constraint but also an instrument creating possibilities for improving coordinating behaviour, and allowing interaction between the coordination arrangements and the institutional environment.

The last article deepened the insights on causes of coordination problems focussing on container barging in the port of Rotterdam. A multidisciplinary analysis is performed, analysing possible institutional reasons that cause coordination problems. The study shows that container barging has a large track record of coordination arrangements. The sector is embedded in a history with many vertical and horizontal alliances. Although the Inland Waterway Transport sector can be characterised as conservative and individualistic, container barge operators act with an entrepreneurial, adaptive and future-oriented spirit. The degree of

organisation among barge operators and inland terminal operators, active in organising barge transport, is relatively high, reflecting an ability to work improve coordination in the future. The present division of property and decision rights forms a bad condition for future improvement. This includes the missing contract between the barge operator and the deep-sea terminal operator, and between the barge operator or skipper and the infrastructure manager. This is difficult to change in the short term.

Samenvatting (in Dutch)

Containerisatie heeft geleid tot intensievere concurrentie tussen havens en een grotere druk op het gebruik van de schaarse achterlandinfrastructuur. Goede coördinatie van alle betrokken actoren in het achterlandvervoer is, naast een goede infrastructurele toegang tot het achterland, vereist om succesvol te zijn in de concurrentie tussen containerhavens. In achterlandketens bestaan om verschillende redenen diverse coördinatieproblemen. Om deze coördinatieproblemen op te lossen, ontwikkelen publieke en private partijen verschillende coördinatiearrangementen. Het doel van dit proefschrift is om beter te begrijpen hoe de actoren in achterlandketens coördinatie verbeteren. De kern van dit proefschrift bevat vijf artikelen. In de artikelen worden verschillende onderwerpen rond coördinatie in achterlandketens behandeld. Dit gebeurt met behulp van inzichten uit interorganisatorische theorieën met de institutionele economie als uitgangspunt. Het proefschrift introduceert een raamwerk om coördinatie in achterlandketens te analyseren. Het raamwerk is een hulpmiddel voor het omgaan met de complexiteit van coördinatie in achterlandketens en om verschillende onderwerpen rond coördinatie systematisch te onderzoeken.

Het eerste artikel laat zien dat er verschillende coördinatieproblemen bestaan in het wegvervoer, het spoorvervoer en de binnenvaart. Deze coördinatieproblemen ontstaan als gevolg van een onbalans in de kosten en baten van coördinatie, een gebrek aan bereidheid om te investeren, strategische overwegingen van de betrokken actoren en risicomijdend gedrag. Op basis van literatuuronderzoek, desk research, interviews en bestudering van diverse coördinatiearrangementen in de haven Rotterdam komen we tot een typologie van vier categorieën van coördinatiearrangementen. Deze typologie is geïnspireerd door transactiekosteneconomie, property rights-theorie en collective action-theorie. De vier categorieën zijn: het introduceren van incentives, het aangaan van allianties, het veranderen van de scope en het creëren van collective action. In het empirische deel worden verschillende

coördinatiearrangementen in de containerbinnenvaart in de haven van Rotterdam besproken in relatie tot de relevante coördinatieproblemen.

Het tweede artikel bestudeert coördinatiearrangementen in de haven van Rotterdam uitvoeriger. Hierbij wordt voortgebouwd op de typologie uit het eerste artikel. Belangrijke kenmerken zijn gedefinieerd rond de complexiteit van de transactie (aantal betrokken actoren, groepskarakter, en het op te lossen coördinatieprobleem) en de coördinatiearrangementen (type coördinatiearrangementen, functie van de betrokken actoren, de functie van de initiator, machtsbasis van de initiator, transportmodaliteit en het gebruik van ICT). Uit de analyse blijkt dat achterlandvervoerders de belangrijkste initiatiefnemers zijn van coördinatiearrangementen. Het Havenbedrijf Rotterdam en de terminal operators spelen ook een belangrijke rol. Het artikel gaat uit van een relatie tussen het gekozen coördinatiearrangement en de complexiteit van de transactie. Meer betrokken actoren leiden tot een hogere complexiteit en een meer hiërarchische aansturing van de keten. Ook de betrokkenheid van publieke actoren of het havenbedrijf verlagen de transactiekosten. Wanneer de groep groot is hoeven initiatiefnemers van coördinatiearrangementen deze niet af te dwingen, maar fungeren zij vooral als een stimulator of leader firm. De analyse laat zien dat ICT wordt toegepast om het gebrek aan operationele coördinatie op te lossen en bij een grote groepsgrootte van actoren.

Het derde artikel verkent één van de vier categorieën van coördinatiearrangementen, namelijk 'het veranderen van de scope'. De studie richt zich op twee actoren: rederijen en terminal operators. De studie helpt om beter te begrijpen waarom rederijen en terminal operators verticaal integreren in intermodaal vervoer en inland terminals. Hierbij wordt gebruik gemaakt van inzichten uit de transactiekosteneconomie en de resource-based view. Het artikel bespreekt een aantal cases waarin rederijen en terminal operators actief in de Hamburg-Le Havre range hun scope van activiteiten hebben veranderd. Na de theoretische en empirische analyse trekt het artikel conclusies over de verklarende waarde van de theorieën. Vanuit theoretisch oogpunt en op basis van de empirie toont de studie aan dat drie aanvullende aspecten relevant zijn in de analyse van verticale integratie van rederijen en terminal operators: de geografische schaal van verticale integratiestrategieën, macht en cultuur van de betrokken bedrijven en de rol van de formele institutionele omgeving.

Het vierde artikel benadrukt de rol van de institutionele omgeving en de dynamiek in de analyse van coördinatie in achterlandketens. Op basis van empirische observaties uit een uitgebreide studie naar coördinatie in de geliberaliseerde spoormarkt in de haven van Rotterdam, wordt de transactiekostenbenadering aangepast naar een dynamisch raamwerk. Dit raamwerk is geïnspireerd door het werk van Douglas North over economische en institutionele veranderingen. De studie stelt dat een dergelijk raamwerk relevant is voor havengerelateerd spoorvervoer dat is veranderd van een constellatie met één homogene actor naar een constellatie met meerdere heterogene actoren. In het aangepaste raamwerk wordt de institutionele omgeving niet alleen gezien als een beperking, maar ook als een middel dat nieuwe mogelijkheden creëert voor coördinatieverbetering. Het raamwerk staat interactie toe tussen het coördinatiearrangement en de institutionele omgeving.

Het laatste artikel bestudeert de oorzaken van coördinatieproblemen in de containerbinnenvaart in de haven van Rotterdam uitgebreider. Op basis van een multidisciplinaire analyse worden mogelijke institutionele redenen onderzocht die coördinatieproblemen veroorzaken. De studie toont aan dat de containerbinnenvaart een groot track record heeft ten aanzien van coördinatie. De sector kent een geschiedenis met veel verticale en horizontale allianties. Hoewel de binnenvaartsector kan worden gekarakteriseerd als conservatief en individualistisch, zijn binnenvaart operators ondernemend, adaptief en toekomstgericht. De relatief hoge organisatiegraad onder binnenvaartoperators en binnenvaartterminaloperators is een goede conditie voor de verbetering van coördinatie in de toekomst. De huidige eigendoms- en beslisrechten vormen een slechte conditie voor de toekomstige verbetering van coördinatie. Contracten tussen de binnenvaart operator en de deep-sea terminaloperator en tussen de binnenvaartoperator of de schipper en de infrastructuurbeheerder ontbreken. Dit is op korte termijn moeilijk te veranderen.

Dankwoord

So eine Arbeit wird eigentlich nie fertig, man muß sie für fertig erklären, wenn man nach Zeit und Umständen das Möglichste getan hat (Johann Wolfgang von Goethe, 1749-1832).

Ik blik met trots en opluchting terug op dit proefschrift. Trots ben ik op het werk dat er ligt en op de kans die ik heb gekregen zoveel te leren. Opluchting omdat het nu af is.

Peter de Langen heeft een belangrijke rol gespeeld bij de start van dit promotieonderzoek. Met hem begon ik in 2005 het onderzoek naar achterlandbereikbaarheid. Dit resulteerde in ons eerste artikel in 2008. Ik denk daar met veel plezier aan terug. Het artikel heeft de afgelopen jaren veel aandacht gekregen, maar was vooral het officiële startschot om een proefschrift over dit onderwerp te schrijven. In hetzelfde jaar nam John Groenewegen mij aan als 'buiten-AiO' bij zijn onderzoeksgroep Economie van Infrastructuren aan de TU Delft. John, jouw inhoudelijke en methodologische inzichten hebben enorm bijgedragen aan mijn ontwikkeling als onderzoeker. Ik kijk met veel plezier terug op onze discussies over onderdelen van het proefschrift die altijd genoeg motivatie gaven om weer een volgende stap te zetten.

Met Larissa van der Lugt heb ik de afgelopen jaren aan projecten gewerkt die samenhangen met dit proefschrift. Deze samenwerking leidde tot twee artikelen die onderdeel zijn van dit proefschrift. Bedankt voor de samenwerking en het op je nemen van het vaak complexe projectmanagement. Ook Bart Kuipers mag niet onvermeld blijven. Bedankt voor jouw grenzeloze enthousiasme en de samenwerking bij (binnenvaart)projecten- en gezamenlijke papers. Ik bedank Michiel Nijdam voor de mogelijkheid om bij Regionale, Haven- en Vervoerseconomie (RHV BV, Erasmus Universiteit Rotterdam) te mogen (samen)werken en elke dag bezig te zijn op het raakvlaak van advieswerk, onderwijs en wetenschap: een mooie

combinatie. Ik wil alle collega's en oud-collega's van de RHV-club bedanken voor de prettige werksfeer en collegialiteit.

Dit proefschrift is tot stand gekomen in de 'kantlijn' van tal van onderzoeksprojecten over achterlandvervoer bij RHV BV. Ik bedank alle bedrijven en organisaties die ik de afgelopen jaren heb mogen interviewen of met wie ik heb mogen samenwerken. Speciale dank gaat uit naar Pierre Franc (coauteur van hoofdstuk 4) en Harry Geerlings en Michiel Kort voor de samenwerking in de binnenvaartstudie IDVV die tevens heeft geleid tot hoofdstuk 6.

Mijn laatste woorden van dank gaan naar Viola en mijn ouders. Bij het schrijven van dit proefschrift– waar de lijnen tussen werk en privé tamelijk vaag waren – ben ik blij dat ik altijd op jullie kon terugvallen. Viola, bedankt voor jouw geduld, tijd, hulp en liefde in de afgelopen jaren. Ik kijk uit naar de jaren die voor ons liggen. Mijn ouders bedank ik voor hun onvoorwaardelijke steun in alles wat ik doe. Dankzij jullie is dit proefschrift nu af.

Curriculum Vitae

Martijn van der Horst is a senior researcher and lecturer in Port Economics at Erasmus University Rotterdam. Martijn has an educational background in Logistics Engineering (BEng, 2000) and Economics (MSc, 2003). He worked for a consultancy company and taught logistics and transport economics at 'Hogeschool Rotterdam' - a school for higher professional education. Since 2008, he joined the faculty of Technology, Policy and Management at Delft University of Technology as a guest PhD candidate.

Martijn is experienced in market-based research and policy advice, Bachelor and Master Education and scientific research. He participates in a wide range of national and international research projects like sector studies, port development studies and studies related to port-related container transport. He combines his research with teaching port-related subjects at MSc and BSc level. Martijn is member of the International Association of Maritime Economists (IAME) and associate member of PortEconomics.eu.

Martijn lives in Rotterdam together with his fiancée Viola. Together, they love to discover the culinary and cultural life of this port-city. By running medium and long distances, Martijn relaxes and gets good ideas for research and education. He is also a tuba player in a concert band.

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