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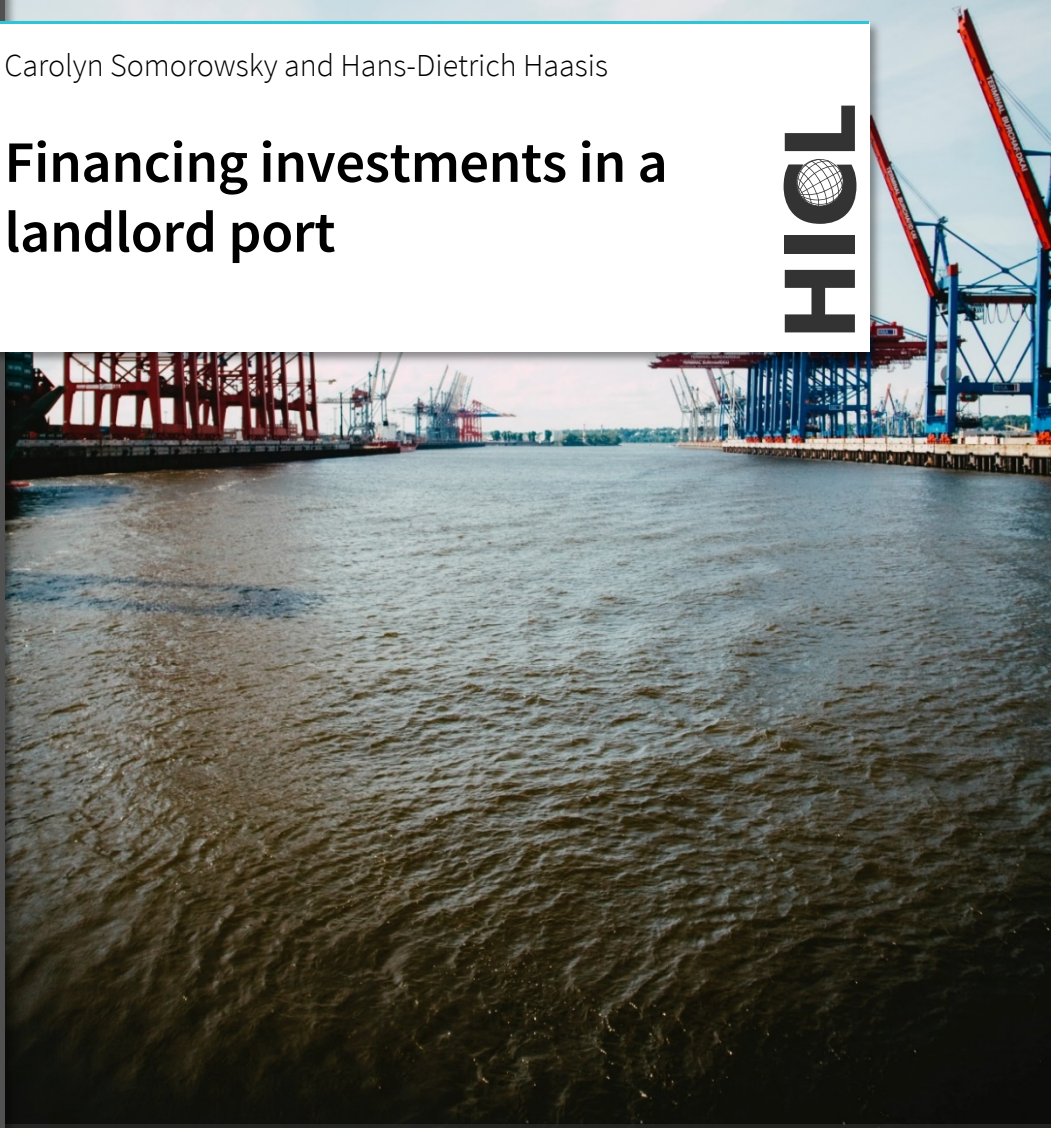

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Financing investments in a landlord port

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Purpose: Given of a landlord port model, private operating companies have to invest in superstructure, equipment and labor to maintain and improve the physical and non-physical flow of goods. The purpose of this paper is to examine interdependencies as well as existing collaborative strategies between operators in ports and to develop a collaborative concept for financing such investments.
Methodology: A literature review on supply chain management, port and collaboration is applied with a focus on vertical inter-organizational integration and collaborative strategies of financing investments. Based on the idea of cooperative game theory, a new collaborative concept for financing investments in ports is developed.
Findings: In literature, collaboration and the supply chain perspective are gaining in importance. However, collaborative approaches for financing investments that are necessary for the improvement of the value chain are almost completely left out of consideration.
Originality: Academic literature on network structures in ports as well as vertical inter-organizational integration is limited. This paper emphasizes the importance of collaboration in port structures and in a first attempt, discusses how joint financing provides added value for the logistics chain.

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1 Introduction

Since the 1980s, the port administration model changed due to the changing shipper practices resulting from technology advances and the need for cost-efficiency and improved service networks (Juhel, 2001; Munim, Saeed and Larsen, 2019). Private participation in port financing plays a major role in port development. One of the most applied models for large and medium-sized container ports is the landlord port (Zhang, 2016). The Port Authority is the owner of the land and infrastructure, which is leased to private operating companies. The Port Authority is responsible for the maintenance and the long-term improvement of the land and infrastructure, e.g. accessibility to roads, quay facilities, and berths. The private companies own and maintain the superstructure and equipment necessary for the port operation and employ dock labor (Brooks, 2004). In the last decade, the supply chain management (SCM) approach as a source of competitive advantage has gained in importance for ports (De Martino and Morvillo, 2008). A port, together with its terminals and logistics service providers, is offering a service to its customers such as cargo handling, transportation, storing, distribution, and information exchange (Dekker and Verhaeghe, 2012). These port functions are part of a chain system which is characterized by intra- and inter-organizational business processes and are carried out by port terminals (Robinson, 2002). Thus, terminal operations representing a part of the logistic chain are central to the competitive strategy rather than the whole port (Heaver, 1996). Improved integration and collaboration between port actors involved in the logistic chain lead to competitive advantage since business processes needs to be connected. Further, it is not just important to have a good location of a port, but also to offer a good

service and a good logistic network. To provide fast and efficient services to customers, investments in specialized handling equipment, information and communication technology (ICT), and human capital are needed. Investments may create value for the logistic chain, for example through increased productivity, increased capacity, or reduced cost. Private investments in the previous mentioned areas are mainly financed with revenues from handling fees. A major challenge concerning necessary investments are the associated investment and finance risk. Most investments are capital intensive, have a long-term character (Dekker and Verhaeghe, 2012; Notteboom, 2004), which leads to a growing cost of superstructure. With the financial crisis in 2008, banks increased their lending rates and became more selective in approvals leading to a lack of finance or high cost of finance. The worse the financial condition of a company the higher the capital lending rate. The cost of capital rate reflects the risk of a financial default. A financial default or even bankruptcy of a partner in a chain may result in a disruption of the physical and non-physical flow. Cases of filling companies or a hostile relationship between port actors from the recent past have shown what consequences it may have for a port or a logistic chain. In 2016, the South Korea Shipping liner Hanjin have gone bankrupt due to financial difficulties. Ports refused the handling of loaded cargo due to the fear of non-payment (The Guardian, 2016). With the loss of a customer, ports had less volume of cargo to work with, which can be seen as a loss of business (Margaronis, 2016). In 2020, the International Longshore and Warehouse Union (ILWU) faces bankruptcy after the loss of a dispute with the International Container Terminal Services Inc. (ICTSI). The ILWU, a labor union complaining about safety conditions and urged jurisdiction for

the handling of refrigerated containers, slowed down coordination and called for strikes at the Port of Portland (Read, 2020; Randles, 2020). The dispute caused the Port a loss of major customers like the Hanjin and the Westwood Shipping Line. Further, exporters of goods had additional costs of about $15 million a year due to the transport of goods to other ports (Njus, 2017). Moreover, downward pricing pressure caused Premium Transportation Services Inc. (TTSI), one of the largest port trucking companies of South California, to file for bankruptcy in 2016. On the one hand, major clients demanded lower prices and on the other hand, cost of litigation with independent drivers of the company who felt they are being treated unfairly and claimed to be treated as full-time employee led to financial difficulties (Phillips, 2016). Due to the implementation of the clean-truck program in 2006, independent drivers had to buy new trucks for at least $100,000, compared to former costs of $20,000 for used trucks. TTSI offered a lease-purchase contract to drivers who could not afford the costs of a new truck, which were now dependent on TTSI (Mongelluzo, 2016).

However, the return of investments depends on the future economic situation and the competitiveness of the port and terminals. Therefore, the creation of relationships between port actors and the improvement of the offered service by collaboration, which means the sharing of risk, cost and benefit, is mandatory for the competitiveness of the logistic chain and the port as well as the return on investment, which is discussed in the following.

2 Supply chain management applied to ports

2.1 Supply chain management

The supply chain management strikes for the coordination of business functions and business activities within and across organizations (Mentzer et al., 2001; Werner, 2017; Stentoft, Stegmann Mikkelsen and Rajkumar, 2018). Since the supply chain consists of more than one interdependent organization an inter-organizational integration needs to be achieved improving the flow of goods, information and finance (Mentzer et al., 2001; Fandel, Giese and Raubenheimer, 2009, p.4; Werner, 2017; Stentoft, Stegmann Mikkelsen and Rajkumar, 2018, p.28). The objective of a supply chain is to maximize the total value, which is the difference between customer value and supply chain costs, as well as to improve the profit of each organization and the supply chain as a whole (Chopra and Meindl, 2014, p.4; Stentoft, Stegmann Mikkelsen and Rajkumar, 2018, p.28). Customer value can be increased by increasing the service or quality of a product or service and decreasing the cost and time of delivery. In a supply chain, the value chain of an organization is part of a value system and is represented in Figure 1.

Figure 1: The value system (Porter, 1985)

The value system consists of the value chains of all organizations involved in the creation of a product or service. The output of the supplier is the input of the organizational value chain. Thus, the supplier influences the value

chain of the organization. In reality, an organization is rather connected to multiple organizations upwards and downwards the supply chain corresponding to a network structure (Coyle et al., 2017).

For the inter-organizational coordination and integration, the relationship between the operators of a supply chain is important. The relationship between supply chain operators is concerned with commitment, trust building, sharing of know-how and information, and increasing transparency referring to a cooperative or collaborative behavior (Mentzer et al., 2001; Clott and Hartman, 2016; Werner, 2017, p.21). Characteristics of such a relationship are the sharing of risks, costs, rewards and information, the synchronization of decisions as well as joint actions and process integration with the aim of long-term partnerships (Mentzer et al., 2001; Christopher, 2016, p.125). Due to the synonymous use of the terms "cooperation" and "collaboration" in context of SCM in literature, this paper uses the terms synonymously as well and refers to a collaborative behavior.

The following section provides an overview about inter-organizational relationships in a container port.

2.2 Inter-organizational relationships in a port

In a supply chain, the terminal operator and the logistics service provider can be considered as some kind of third party logistic provider (3PL), which is a market-focused organization managing all activities in order to satisfy customer needs (Robinson, 2002; De Martino and Morvillo, 2008). It represents a business system competing against other ports (Musso, Ferrari and Benacchio, 2006). Since several organizations are involved in the handling of cargo and thus, in the creation of the service, the port can be seen as a

network of port operators co-producing value. Operators in a container port are for example the terminal operator, shipping company, shippers, feeder operator, freight forwarder, road haulers and rail operator (De Martino and Morvillo, 2008; Martin and Thomas, 2001; Vitsounis and Pallis, 2012; Carbone and Martino, 2003). For better understanding how port operators are producing value it is important to understand the interdependencies between them.

Interdependencies between port operators can be distinguished between sequential, pooled, and reciprocal interdependencies (Thompson, 1967; Borys and Jemison, 1989; De Martino and Morvillo, 2008; Vitsounis and Pallis, 2012). In sequential interdependencies the output of an activity is the input of the activity of another actor. It is related to Porter's firm value chain system and it is the basis for the supply chain concept, which is the achievement of economies of integration (De Martino and Morvillo, 2008). Figure 2 represents an example of sequential interdependencies between port operators. A shipping company is carrying out an activity such as the transportation of containers to a port, which represents the input of the terminal operator's activity, e.g. the handling of the containers within the port area. In turn, the output of the activity of the terminal operator is the input of the activity of the freight forwarder, who transports the containers from the port area to another destination. These interdependencies work the other way around as well (Vitsounis and Pallis, 2012).

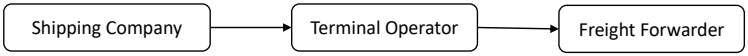

Figure 2: Sequential interdependencies in a port

In case an activity uses two resources, or two activities use the same resource it represents a pooled interdependency. This certain interdependency can be investigated in supply networks and lead to economy of scope or scale, when the two activities are identical or similar (Thompson, 1967; Borys and Jemison, 1989; De Martino and Morvillo, 2008; Vitsounis and Pallis, 2012) as shown in Figure 3.

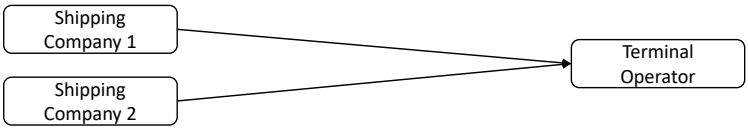

Figure 3 : Pooled interdependencies in ports

For example, a terminal operator is handling more than one ship to reach a certain throughput of containers. Also, to fill the capacity of a ship of a shipping company a certain amount of containers is necessary (Vitsounis and Pallis, 2012), which are delivered from several freight forwarders and works in the other direction, from the freight forwarder over the terminal operator to the shipping company.

The third type of inter-organizational interdependency is the reciprocal interdependency. It refers to the mutual exchange of input and output between two operators and is represented in Figure 4. The activity of one actor is dependent on the activity of another actor and it corresponds to economies of innovation, agility, and reactivity to changes. A change in activity of an actor can just be made if the other actor changes its activity as well

(Thompson, 1967; Borys and Jemison, 1989; De Martino and Morvillo, 2008; Vitsounis and Pallis, 2012).

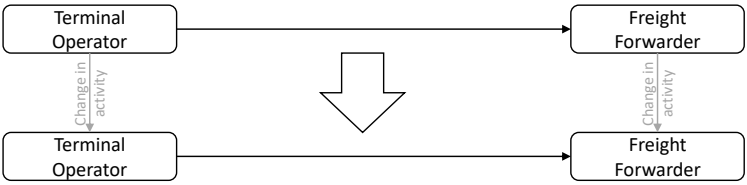

Figure 4: Reciprocal interdependencies in ports

By investigating the relationships between port operators, it is possible to determine a supply network for a port. For simplicity reasons the network considered in these papers consists of the main port operators: the shipping company (SC), the terminal operator (TO), and the freight forwarder (FF) and is presented in Figure 5.

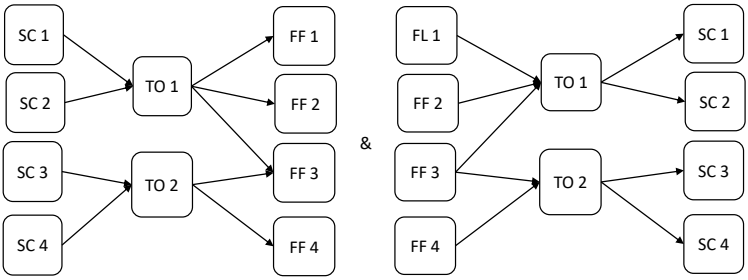

Figure 5: Supply network of a port

In case the activities are not well coordinated, e.g. containers to be loaded on the ship are not arriving on time or it takes too long to unload the ship, it might happen that the shipping company is looking for another port even

though the location of the port might be beneficial for the shipping company. Further, storage space in a port is limited which is why the transportation of the containers through the freight forwarder or the shipping company is essential (Musso, Ferrari and Benacchio, 2006). The dwell time, the time cargo spends in a port, needs to be reduced, because the longer it takes, the higher the costs for all parties. But cost-effective port operations is the basis for low freight rates, which lead to competitive advantage (Martin and Thomas, 2001; Juhel, 2001). Thus, it is important to improve the activities continuously and work collaboratively from time to time, which can be achieved through investments in ports that have to be financed.

3 Financing investments in ports

According to Musso, Ferrari and Bernachio (2006), the profitability and the financing of investments are seen as one of the most critical factors in the chain of a port. Promising investments (Inv) in port assets have the potential to increase the level of service (s.l.) and the level of throughput Th (per unit and total of time) and is shown in Figure 6.

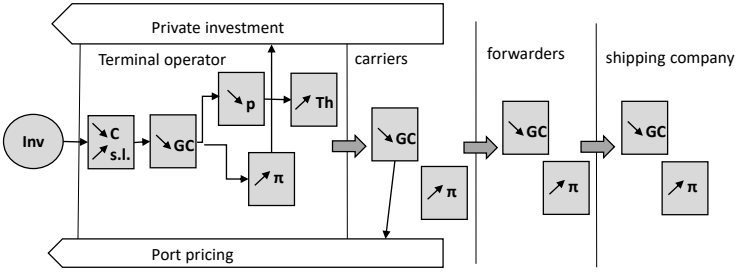

Figure 6: Port Investments and its microeconomic consequences following (Musso, Ferrari and Benacchio, 2006)

The increase of the service level is directly related to the investment (Inv). Further, investments in assets improving the activities in a port result in a reduction of cost C which reduces the generalized cost GC. In case of high competition, the price p will be reduced which will cause higher throughput and an increase in profit π resulting from increasing return of scales. The lower the competition, the higher the profit. In addition, all operators involved in the port activities of a chain will benefit from a reduction in generalized cost or price. Lower prices will cause higher throughput which results in higher profits. Thus, it can help to improve the competitive position

of a port (Juhel, 2001; Meersman, 2005; Musso, Ferrari and Benacchio, 2006; Dekker and Verhaeghe, 2012).

Due to a restriction of public finance in numerous countries and the growing cost of infra- and superstructure by reasons of an increasing size of ships and rapid development of goods handling and processing technologies, investments in port projects with private participation have been encouraged in the need to find cost-effective solutions (Juhel, 2001; Musso, Ferrari and Benacchio, 2006). Considering terminals as commercial entities and therefore, emphasizing the importance of profitable prices for the offered services, the private sector has become more involved in investing in ports since 1990 (Meersman, 2005; Musso, Ferrari and Benacchio, 2006) and is shown in Figure 7.

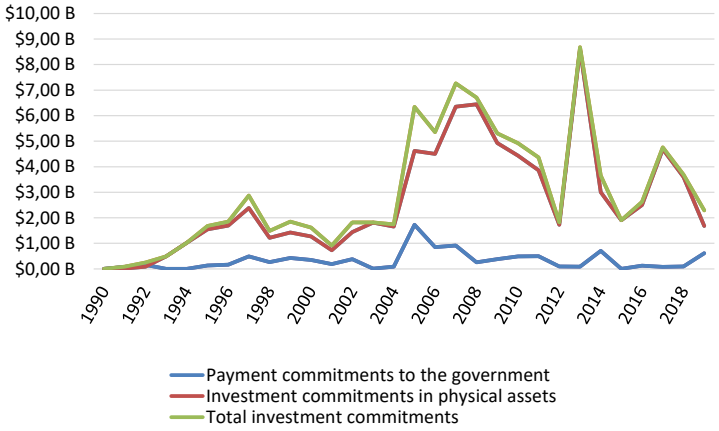

Figure 7: Investments with private participation in ports in billions of US dollars according to the World Bank's Private Participation in Infrastructure (PPI) Project Database

Especially, the increased competition and the traffic volatility in the port market in combination with the fast development of goods handling technologies support the financial significance of superstructure over infrastructure (Musso, Ferrari and Benacchio, 2006).

However, a major challenge for the implementation of investments in ports is the financing. Not uncommonly, port investments are capital intensive, have a long lead time, often have to be adapted and therefore, are considered to be risky (Notteboom, 2004; Dekker and Verhaeghe, 2012). Also, after the financial crisis in 2008 banks become more selective in approvals and increased the lending rates resulting in difficulties to obtain loans or high cost for financing for port operators (Cruz and Marques, 2012). Thus, there is a lack of investments leading to a deterioration in competitiveness of the port which in turn enhances the risk of a default of a port operator. A default or even a bankruptcy results in a supply chain disruption which causes a further deterioration in competitiveness (Vázquez, Sartal and Lozano-Lozano, 2016).

A relatively young research field dealing with the improvement of the financial flows in a chain system is supply chain finance (SCF). The objective is to maximize the profit of a single or several organizations by lowering costs, avoid bankruptcy, share risk and rewards and reach financial stability along the chain. SCF emphasizes a collaborative approach since supply chain operators are connected and thus, are dependent from each other. Non-collaborative financial practices, e.g. pushing costs up- or downstream the supply chain, just lead to financial instability and increases the risk of a disruption (Vázquez, Sartal and Lozano-Lozano, 2016; Somorowsky and Haasis, 2018).

4 Literature review

In this research, a literature review according to (Fink, 2014) is applied. The review examines articles dealing with collaborative approaches in ports on the microeconomic level. Due to the characteristic that more than one port operator is involved in the carrying out of port activities, the search will include supply chain management as well. It should be noted that articles dealing with cooperative behavior in context of SCM and ports are included as well since there is no significant difference in the use of the terms *collaboration* and *cooperation*. The papers were examined based on its content according to the following questions:

Which port operators are involved in existing collaborative approaches applied in ports?

What flows of the supply chain, e.g. flow of goods, flow of information or financial flow, are at the heart of collaborative approaches?

What are the qualities of collaborative approaches?

An emphasis will be on collaborative approaches and on financial practices to implement investments in ports. It will be interesting to see whether financial practices are seen to be value generating activities in the context of ports.

4.1 Selection process

A systematic literature search was conducted in the library databases Scopus and Web of Science looking for strings (e.g. port AND "supply chain management", "value chain" AND collaboration, cooperation). The search

criteria used were language (English), source type (article, conference review), and year (1960-2020). From 1960 to 2020, 76 articles could be identified, and 39 articles were eliminated due to duplication or no accessibility. From this basis, the 37 identified articles were read carefully. Papers focusing just on governmental investment decisions were excluded as this paper focuses on private investments on a microeconomic level. In a landlord port, private companies are responsible for investments in superstructure. The financing of such investments is of interest, since they are required for activity improvements and thus, value generating. Papers discussing financial flows and especially the exchange of financial flows between port or supply chain operator are selected. Also, papers focusing on investment decisions on a company level, ignoring the links between other port operators or operators of the supply chain, were excluded. Since supply chain management and supply chain finance supporting the collaborative approach where supply chain operators are interdependent, looking at the enterprise level in isolation is not supporting the management approach needed. In the end, the following 5 papers were selected for a closer examination due to a focus on investments in superstructure, financial flows, the supply chain management on a microeconomic level excluding articles dealing with a governmental perspective, and the discussion of collaborative approaches.

Table 1: Paper selection

Author, Year	Title
(Dong et al., 2010)	Analyzing inland-orientation of port supply chain based on advertising-R&D model
(Ascencio et al., 2014)	A Collaborative Supply Chain Management System for a Maritime Port Logistics Chain
(Islam and Olsen, 2014)	Truck-sharing challenges for hinterland trucking companies: A case of the empty container truck trips problem
(Robinson, 2015)	Cooperation strategies in port-oriented bulk supply chains: aligning concept and practice
(Liu et al., 2016)	Supply chain cost minimization by collaboration between liner shipping companies and port operators

4.2 Findings from literature

First, the analysis deals with the identification of port operators involved in collaborative approaches applied in a port environment. Afterwards, the flows that are investigated and the qualities that are necessary to create and maintain collaboration are examined.

The approaches discussed in the selected papers are involving port operators such as carrier and shipping lines (Islam and Olsen, 2014), or shipping lines and port operator (Liu et al., 2016). The carrier assumes the function of the onward inland transport. The other papers are considering the port

as one entity being part of the global supply chain and focusing on the relationships between port operator and inland port (Dong et al., 2010) as well as between exporter, terminal operator, importer, and government (Ascencio et al., 2014; Robinson, 2015). Table 2 shows the result of the involved port operators identified from the selected papers.

Table 2: Involved port operators

Author, Year	Shipping company	Terminal operator	Freight forwarder	Port as one entity
(Dong et al., 2010)			X	X
(Ascencio et al., 2014)				X
(Islam and Olsen, 2014)	X		X	
(Robinson, 2015)				X
(Liu et al., 2016)	X	X		

In many cases, the port is seen as one entity being part of the value creation process of the supply chain (Ascencio et al., 2014; Robinson, 2015), whereby Dong et al. (2010) distinguish between inland port, e.g. port activities on the land side, and the gateway port, e.g. port activities on the water side. However, as the works of Islam and Olsen (2014) and Liu et al. (2016) emphasize, many different port operators are involved in port activities relevant for the supply chain and for the port as whole to gain competitive advantage. So far, there is no approach available discussing investments and financing

decisions where more than two port operators are involved. Since port activities are interdependent usually involving more than two port operators, an approach going beyond a dyadic relationship is required.

All authors emphasizing the importance of the improvement of the flow of goods and of information and Dong et al. (2010), Islam and Olsen (2014), and Liu et al. (2016) are focusing on the financial flows as well. Robinson (2015) focuses on the stockpiles of coal and the need to minimize the queue length and demurrage costs where the terminal operator is acting as a coordinator to ensure coal availability and achieve shorter queue length. Beside of the optimization of operational efficiency there is a need for long term efficiency and thus, a need for investments eliminating bottlenecks. Necessary investments should be funded from federal government and the collaborating parties could benefit from their own improved business. A similar idea to encourage port operators to work collaboratively in prospect of improved businesses are coming from Ascencio et al. (2014). The authors introduce a framework for an inland coordination of the port logistics. It includes the management of port logistics governance which is responsible for the communication between the different port operators and the improvement of international trade procedures, a port logistics operations model which determines the available infrastructure and the logistics processes, and a logistics management platform system which supports the port activities in terms of conceptualization of the planning, scheduling, and controlling the physical and information flows. The system consists of a demand, orders, and vehicles management. It focuses on a good coordination between terminal operator and carriers picking up or delivering

cargo from and to the port resulting in reduced waiting times for truck drivers and capacity and service level improvements of the terminal operator. The financing of the system is not discussed. Another collaborative approach where the collaborating parties can benefit from shared resources and thus, achieving a better utilization is introduced by Islam and Olsen (2014). The collaboration is taking place between carries having difficulties reducing empty truck trips. In this approach, jobs that are not suitable to be combined with other jobs to enhance high utilization can be offered to other carries. In return for a payment of a fee, another carrier which can combine the offered job overtake the job and benefit from higher utilization. Further, the port benefits from better removal or delivery of cargo. Who and how the system needed to communicate and offer the jobs is financed is not discussed.

A collaborative approach between a shipping line and a terminal operator where the shipping line is compensating the terminal operator for additional cost is introduced by Liu et al. (2016). Additional costs of the terminal operator are resulting from higher port productivity, for example from the operation of additional quay cranes. Thus, the shipping line can save time at the port and reduce the speed on sea resulting in a reduction of demurrage cost and a reduction of fuel cost. The use of cost subsidies and profit allocation arrangements in collaboration is presented by Dong et al. (2010). The inland port and port operator have the opportunity to invest in research and development to achieve higher flexibility and productivity. In the cooperative setting the port operator may provide cost subsidy to the inland port to maximize overall profit of the port chain and its own profit.

The authors could show that there exists a Nash equilibrium of the cooperative strategy compared to a non-cooperative strategy. Thus, a cooperative strategy and the providing of cost subsidies result in better profits for the two ports.

Table 3: Flows of the supply chain between port operators

Author, Year	Flow of goods	Flow of information	Financial flows
(Dong et al., 2010)	X	X	X
(Ascencio et al., 2014)	X	X	
(Islam and Olsen, 2014)	X	X	X
(Robinson, 2015)	X	X	
(Liu et al., 2016)	X	X	X

Approaches that also involve financial flows can be distinguished between financial flows on the operational level (Islam and Olsen, 2014; Liu et al., 2016) and on a strategic level (Dong et al., 2010). Nonetheless, as the work by Dong et al. (2010) emphasizes, financial flows on the strategic and on the operational level are dependent. Especially, when it comes to the question who should finance the investment and who is overtaking the financial risk, the strategic level cannot be left out of consideration. Financial risk is not taken into account by any of the selected papers. The qualities of collaboration mentioned are similar among the presented approaches and are shown in Table 4. First, a systematic perspective needs to be applied considering the interdependencies between different port operators. Thus, the physical and information flow need to be coordinated in terms of available infrastructure, the use of common resources, sharing of information, col-

laborative decision-making, and continues improvement on the operational and strategical level (Dong et al., 2010; Ascencio et al., 2014; Islam and Olsen, 2014; Robinson, 2015; Liu et al., 2016).

Table 4: Qualities of collaborative approaches

Author, Year	Sharing of			Info. exchange	Joint action	Trust	Decision sync.
	risk	cost	profit				
(Dong et al., 2010)	X	X	X	X	X		X
(Ascencio et al., 2014)				X	X		X
(Islam and Olsen, 2014)			X	X	X	X	X
(Robinson, 2015)			X	X	X		X
(Liu et al., 2016)		(X)		X			X

Dong et al. (2010) were the only ones dealing with risk and the sharing of the investment costs. The risk considered is demand risk, since the freight market demand is elastic, where the port competes with other transport modals such as rail, air, or truck. Due to this, the expected profit of all participants should be large enough to make investments reasonable. Financial risk and its consequences are not investigated. Further, through cost subsidy and a profit allocation arrangement, the collaboration is beneficial

in terms of maximizing profit. Liu et al. (2016) suggest to use a higher handling rate to share the investment cost. However, there is a problem to maintain relationship between port operator and shipping company, because the shipping company is free to choose another port and thus, the cost sharing is no longer possible. Since the development and the maintaining of long-term relationships, trust and commitment are essential, there is a need for a provision of incentives for the participating parties (Islam and Olsen, 2014). It is important that the incentives set are fair as collaboration only works if the port operators are willing to work together (Robinson, 2015; Liu et al., 2016). Agreements based on contracts can help to build trust as well as making decisions on the basis of cost-benefit analysis, which can be called *calculative trust* (Islam and Olsen, 2014; Robinson, 2015).

5 Development of a concept for collaborative financing investments in ports

Many approaches provide ideas on how collaboration can be beneficial for port operators, which are based on the need of investments in superstructure, equipment, or labor and thus, based on the need of financing these investments. The idea of compensation or subsidy introduced by Dong et al. (2010) and Liu et al. (2016) are an attempt to determine the financial effort of involved port operators, but the question remains how much everyone should pay and who else is financially advantaged or disadvantaged, e.g. through the emergence of bottlenecks. Financial issues such as the risk of a default or the cost of capital are left out of consideration. The long-term financing of investments still remains on a company level. In the worst case, companies are not investing in value-generating activities or the investment leads to a disruption due to financial distress or opportunistic behavior, e.g. bankruptcy of Hanjin or strikes at the Port of Portland. Due to the inter-dependencies between several port operators, the financing of an investment should take place on a supply chain level following a collaborative approach going beyond a dyadic relationship. There is a need for port operators to maintain the relationship in the long term. Since financial decisions must be made where more than one port operator is involved, game theory can be used to facilitate the decision.

5.1 Cooperative game theory

Game theory is used to analyze the rational decision-making behavior in situations where more than one party is involved. The payoff of one party

depends on the behavior or actions of other parties, which refers to strategies and can be of competition or cooperation. It can be divided into cooperative and non-cooperative game theory. The cooperative game theory focuses on the coalition building and the payoff and communicated agreements can be enforced, whereas the non-cooperative game theory is strategy oriented and understands players as self-interested and unable to follow agreements (Prisner, 2014, p.1). A cooperative game, or more precisely transferable utility game (TU game), is defined by a finite set of players and a characteristic function, which measures the benefit or cost of every coalition of players representing subsets of the initial set of players which refers to the grand coalition (Wiese, 2005, p.89). It can be used to examine the problem of profit allocation and the determination of a stable coalition, which is of interest in supply chains. In a stable coalition, there exists an allocation such that no one of the players would like to leave the coalition as they cannot achieve the profit on its own or in smaller groups (Meca and Timmer, 2008). A solution concept of the cooperative game theory that deals with stable coalitions is the *Core*. The core allocates payoff distributions to coalitions. Such a payoff needs to be feasible, individual and coalitional rational. A payoff distribution is feasible if the coalition members receive not more than the grand coalition can generate. Individual and coalitional rational applies if no individual player and the grand coalition oppose the assigned payoffs. No coalition member should find themselves worse off than before and the generated profit of the coalition needs to be fully assigned (Wiese, 2005, pp.143–147).

5.2 Cooperative game theory applied to finance private investments in ports

The collaborative concept for financing investments in ports can be subdivided into network investment appraisal, determination of current financial situation of the port operators, calculation of the financial contribution, and allocation of the total profit and is illustrated in Figure 8.

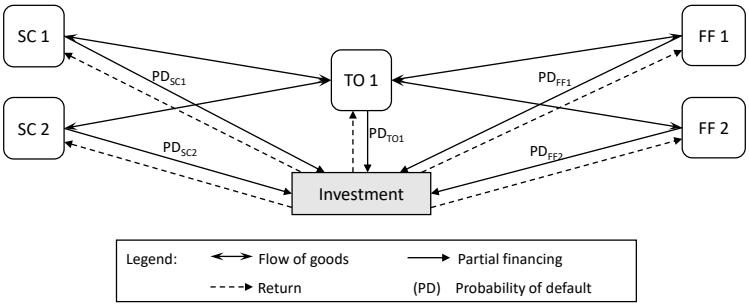

Figure 8: Collaborative approach for financing investments in ports

Taking the example of section 3, where competition is high. The profitability of an investment for all port operators needs to be evaluated. This can be done with the characteristic functions representing the profit functions of all port operators in a network structure, where the output of a port operator is the input of a following port operator. Just profitable investments should be selected, e.g. the sum of the profits of all port operators is positive. For example, an investment located at the terminal operator is increasing its service level, which in turn reduces the costs following a reduction in the generalized costs. The terminal operator will reduce the price in order to increase throughput which increases the profit. The profit of the

shipping companies and of the freight forwarder will increase as well, as they benefit from the reduction of the price or generalized costs. Since joint actions will improve trust and the maintenance of the relationship, the financing of the investment should be shared. The sharing of the investment cost, the profit, and the financial risk have to be considered. The determination of the financial situation can be observed by the credit rating of the port operator. On basis of the credit rating, the height of the capital cost can be determined, which is defined by the capital cost rate in combination with volume and duration. Further, the credit rating is an indicator for the risk of default. It is assumed that a default results in a suspend of service, which reduces profit. Given the financial structure, the profitability of the investment, and the cost of investment including capital cost, the partial financing can be calculated for each possible coalition. Members with a poor credit rating are blocked by the coalition members since the risk of a default would increase much faster with additional financial burdens compared to members with a good credit rating. The value generated by the grand coalition is assumed to be best since it contains the profits obtained by all port operators. Now, the payoffs for the port operators depend on their marginal contributions obtained by the financial and operational abilities. Members with higher contributions get more of the total profit compared to members with lower contributions. Members with no financial contribution are likely not to receive anything from the additional profit.
This concept might be a mechanism for financing investments in ports. Further, this concept can be used as an incentive scheme as an improvement of financial stability and an optimization of the operations would lead to higher contributions and higher payoffs.

6 Conclusion

The objective of the port is to gain competitive advantage, which can be achieved through investments. Since several port operators are involved in the creation of the service, the port can be seen as a network of port operators co-producing value, where direct and indirect relationships among the port operators exist. Promising investments in port assets increase the performance of the port actor, where the investment is carried out, and of the other port operators being involved in the activities of the port related supply chain. Usually, the investment is financed by the port actor where the investment is carried out. This might cause problems in terms of high cost of finance, higher risk of default, or the creation of displeasure and stagnation in case of a feeling to be treated unfairly. A collaborative approach, where resources and risk is shared and where a systematic view is applied might help to overcome these problems and improve the performance of each port actor and the whole system. One question in supply chains is to find a setting in which collaboration is working. Everyone is better off with the coalition than on its own or in smaller groups. Cooperative game theory provides a solution concept for this question. It is to be noted that solution concepts of cooperative games are limited to a certain number of players due to computational reasons. Further, there is a need for side payments and agreements based on contracts, which would be suitable for port operators looking for long-term relationships.

References

Ascencio, L.M., González-Ramírez, R.G., Bearzotti, L.A., Smith, N.R. and Camacho-Vallejo, J.F., 2014. A collaborative supply chain management system for a maritime port logistics chain. Journal of Applied Research and Technology, 12(3), pp.444–458.

Borys, B. and Jemison, D.B., 1989. Hybrid Arrangements as Strategic Alliances: Theoretical Issues in Organizational Combinations. Academy of Management Review, 14(2), pp.234–249.

Brooks, M.R., 2004. The Governance Structure of Ports. Review of Network Economics, 3(2).

Carbone, V. and Martino, M. De, 2003. The changing role of ports in supply-chain management: an empirical analysis. Maritime Policy & Management, 30(4), pp.305–320.

Chopra, S. and Meindl, P., 2014. Supply Chain Management : Strategie, Planung und Umsetzung. Pearson.

Christopher, M., 2016. Logistics & Supply Chain Management. 5. ed. Pearson Education Limited.

Clott, C. and Hartman, B.C., 2016. Supply chain integration, landside operations and port accessibility in metropolitan Chicago. Journal of Transport Geography, 51, pp.130–139.

Coyle, J.J., C. John Langley, J., Novack, R.A. and Langley, C., 2017. Supply Chain Management : a Logistics Perspective. Cengage Learning.

Cruz, C.O. and Marques, R.C., 2012. Risk-Sharing in Seaport Terminal Concessions. Transport Reviews, 32(4), pp.455–471.

Dekker, S. and Verhaeghe, R.J., 2012. Port Investment and Finance. In: W.K. Talley, ed. The Blackwell Companion to Maritime Economics. Wiley-Blackwell.pp.623–637.

Dong, G., Wu, Q., Zliu, D., Li, J. and Li, X., 2010. Analyzing inland-orientation of port supply chain based on advertising-R&D model. In: Proceedings of the World Congress on Intelligent Control and Automation (WCICA). pp.3024–3027.

Fandel, G., Giese, A. and Raubenheimer, H., 2009. Supply Chain Management: Strategien - Planungsansätze - Controlling. Springer.

Fink, A., 2014. Conducting research literature reviews: from the internet to paper. 4th ed. SAGE PublicationsSage CA: Los Angeles, CA.

Heaver, T.H., 1996. The opportunities and challenges for shipping lines in international logistics. In: 1st World Logistics Conference. London Heathrow.

Islam, S. and Olsen, T., 2014. Truck-sharing challenges for hinterland trucking companies: A case of the empty container truck trips problem. Business Process Management Journal, 20(2), pp.290–334.

Juhel, M.H., 2001. Globalisation, Privatisation and Restructuring of Ports. International journal of maritime economics, 3(2), pp.139–174.

Liu, Z., Wang, S., Du, Y. and Wang, H., 2016. Supply chain cost minimization by collaboration between liner shipping companies and port operators. Transportation Journal, 55(3), pp.296–314.

Margaronis, S., 2016. Hanjin Bankruptcy Will Have Global Impact. [online] American Journal of Transportation. Available at: <https://www.ajot.com/insights/full/blog-hanjin-bankruptcy-will-have-global-impact> [Accessed 20 Mar. 2020].

Martin, J. and Thomas, B.J., 2001. The container terminal community. Maritime Policy and Management, 28(3), pp.279–292.

De Martino, M. and Morvillo, A., 2008. Activities, resources and inter-organizational relationships: Key factors in port competitiveness. Maritime Policy and Management, 35(6), pp.571–589.

Meca, A. and Timmer, J.B., 2008. Supply chain collaboration. In: Khalid Al-Mutawah and Vincent Lee, eds. Supply Chain, Theory and Applications. Vienna, Austria: I-Tech Education and Publishing.pp.1–18.

Meersman, H.M.A., 2005. Port Investments in an Uncertain Environment. Research in Transportation Economics, 13, pp.279–298.

Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D. and Zacharia, Z.G., 2001. Defining Supply Chain Management. Journal of Business Logistics, 22(2), pp.1–25.

Mongelluzo, B., 2016. LA-LB drayage company arises after misclassification suits. [online] JOC.com. Available at: <https://www.joc.com/trucking-logistics/drayage/la-lb-drayage-company-arises-after-misclassification-suits_20160720.html> [Accessed 20 Mar. 2020].

Munim, Z.H., Saeed, N. and Larsen, O.I., 2019. 'Tool port' to 'landlord port': a game theory approach to analyse gains from governance model transformation. Maritime Policy & Management, 46(1), pp.43–60.

Musso, E., Ferrari, C. and Benacchio, M., 2006. Port Investment: Profitability, Economic Impact and Financing. Research in Transportation Economics, 16, pp.171–218.

Njus, E., 2017. Port of Portland to split with ICTSI, seek new life for idled shipping terminal. [online] The Oregonian/ Oregon Live. Available at: <https://www.oregonlive.com/business/2017/02/port_of_portland_splits_with_t.html> [Accessed 20 Mar. 2020].

Notteboom, T.E., 2004. Container Shipping And Ports: An Overview. Review of Network Economics, 3(2), pp.86–106.

Phillips, E.E., 2016. Port Trucking Company Files for Bankruptcy Protection. [online] The Wall Street Journal. Available at: <https://www.wsj.com/articles/california-port-freight-hauler-files-for-chapter-11-1458169628> [Accessed 20 Mar. 2020].

Porter, M.E., 1985. Competitive advantage: creating and sustaining superior performance. New York : London: Free Press ; Collier Macmillan.

Prisner, E., 2014. Game Theory Through Examples. The Mathematical Association of America.

Randles, J., 2020. Judge Cuts $93 Million Award Against West Coast Dockworkers Union. [online] The Wall Street Journal. Available at: <https://www.wsj.com/articles/judge-cuts-93-million-award-against-west-coast-dockworkers-union-11583538625?mod=searchresults&page=1&pos=4&ns=prod/accounts-wsj> [Accessed 20 Mar. 2020].

Read, R., 2020. A West Coast union faces bankruptcy. Here's why unions nationwide are unnerved. [online] Los Angeles Times. Available at: <https://www.latimes.com/business/story/2020-01-28/longshore-union-ilwu-bankruptcy> [Accessed 20 Mar. 2020].

Robinson, R., 2002. Ports as elements in value-driven chain systems: The new paradigm. Maritime Policy and Management, 29(3), pp.241–255.

Robinson, R., 2015. Cooperation strategies in port-oriented bulk supply chains: aligning concept and practice. International Journal of Logistics Research and Applications, 18(3), pp.193–206.

Somorowsky, C. and Haasis, H.-D., 2018. How Blockchain Technology can help to overcome the challenges of financing the International Supply Chain : a general overview. In: J. Schöneberger and S. Nerlich, eds. 26. Verkehrswissenschaftliche Tage. Dresden.pp.517–534.

Stentoft, J., Stegmann Mikkelsen, O. and Rajkumar, C., 2018. Supply chain management : sources for competitive advantages. Hans Reitzel.

The Guardian, 2016. Hanjin Shipping bankruptcy causes turmoil in global sea freight. [online] The Guardian. Available at: <https://www.theguardian.com/business/2016/sep/02/hanjin-shipping-bankruptcy-causes-turmoil-in-global-sea-freight> [Accessed 20 Mar. 2020].

Thompson, J.D., 1967. Organization in Action. 5. ed. New York, New Jersey: Transaction Publishers.

Vázquez, X.H., Sartal, A. and Lozano-Lozano, L.M., 2016. Watch the working capital of tier-two suppliers: a financial perspective of supply chain collaboration in the automotive industry. Supply Chain Management: An International Journal, 21(3), pp.321–333.

Vitsounis, T.K. and Pallis, A.A., 2012. Port Value Chains and the Role od Interdependencies. In: D.-W. Song and P.M. Panayides, eds. Maritime Logistics. Emerald Group Publishing Limited.pp.157–173.

Werner, H., 2017. Supply Chain Management. Wiesbaden: Springer Fachmedien Wiesbaden.

Wiese, H., 2005. Kooperative Spieltheorie. Oldenbourg Wissenschaftsverlag GmbH.

Zhang, J., 2016. Quasi-landlord port financing in China: Features, practice and a contract theory analysis. Transportation Research Part A: Policy and Practice, 89, pp.73–88.