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Strategic integration of the inland port and shipping service for the ocean carrier

Zhijia Tan[a,*], Qiang Meng[b], Fan Wang[c], Hai-bo Kuang[d]

[a] School of Maritime Economics and Management, Dalian Maritime University, Linghai Road 116026, Dalian, PR China
[b] Department of Civil and Environmental Engineering, National University of Singapore, Singapore 117576, Singapore
[c] Sun Yat-sen Business School, Sun Yat-sen University, Guangzhou 510275, PR China
[d] Collaborative Innovative Center for Transpiration Studies, Dalian Maritime University, Linghai Road 116026, Dalian, PR China

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ABSTRACT

This study analytically investigates the competition and alliance strategies between one ocean carrier (OC) and one inland shipping company (IC) in a vertical container shipping chain. The OC decides the freight rate of the deep-sea shipping service, while the IC determines the freight rate of the inland waterway service including the charges of both shipping and port services. We examine and compare the outcomes under three strategies: vertical separation, vertical–horizontal competition and alliance. The if-then entry threat and excess revenue-sharing contract mechanisms for the OC to exercise the vertical-horizontal competition and alliance strategies are proposed, respectively.

1. Introduction

Inland and ocean shipping services usually form a shipping chain for transporting intercontinental containers. In the chain, an inland shipping company (IC) transports the intercontinental containers from their origins to a sea hub port on a river followed by an ocean carrier (OC) transporting these containers from the sea hub port to an overseas port. The integration and diversification into inland shipping, port terminal operation and logistics for ocean carriers have been recognized since the early 1980s. The shipping alliance strategy in the ocean container shipping industry has already been implemented, resulting in a few large shipping alliances such as 2 M Alliance (Maersk and MSC) and Ocean Three Alliance (CMA CGM, CSCL, UASC). The benefits of the integration include increasing market share and economies of scale and scope, sharing creativity along the logistical process, improving the flexibility of routing among various transport modes, as well as providing the door-to-door transport services (Panayides and Cullinane, 2002; Notteboom and Rodrigue, 2005; Konings, 2006; Fremont, 2009; Meng et al., 2016). Therefore, it is of practical significance to quantitatively investigate various competition and alliance strategies between the OC and the IC in a vertical container shipping chain, which is the focus of this study.

1.1. Relevant studies

The existing studies mainly focused on the competition and alliance among ocean carriers (Song and Panayides, 2002; Lee and Song, 2017). Slack et al. (2002) evaluated the effect of container shipping alliances on the level of service, ship deployment and standardization of the industry. From modelling perspective, Lei et al. (2008) built the mixed integer programming models to

* Corresponding author.
E-mail addresses: zjatan@hust.edu.cn (Z. Tan), ceemq@nus.edu.sg (Q. Meng), fanwang@gmail.com (F. Wang), khb@dmu.edu.cn (H.-b. Kuang).

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compare non-collaborative, slot-sharing as well totally collaborative policies. Agarwal and Ergun (2008, 2010) considered container shipment assignment and network design in a shipping alliance network with capacity allocation among alliance members. Zheng et al. (2015) extended the above work to the shipping network design and capacity exchange for liner shipping alliances with fixed and variable container demands. Wang et al. (2014) presented the non-cooperative game theoretical models to analyse the competition between two container shipping lines for a new emerging container shipping market. Gelareh et al. (2010) proposed a mixed integer programming model to examine the competition between one entrant and one incumbent with a hub-and-spoke shipping network.

The cooperation between shipping lines and port terminals is the common practice in the transport chain integration (Franc and Van der Horst, 2010). The leading terminal operators can offer the door-to-door service by integrating the logistical services. In practice, there are various ways adopted by the operators in the transport chain integration involving maritime activities. Heaver et al. (2000) overviewed the co-operation agreements between the port and shipping industries in Europe, including alliance, conferences, involvement of shipping companies in terminal management, and extending interests in inland transport of shipping companies. Notteboom (2004) listed several European cases for the terminal operators integrating the inland terminals in the corresponding logistic network. De Borger and De Bruyne (2011) investigated the implication of vertical integration of profit-maximizing trucking firm and the welfare-maximizing terminal operator. The latter decides the port access fee and concession tolls. Li and Zhang (2015) examined the vertical market with one carrier and two freight forwarders and studied the capacity-sharing between the two forwarders. Álvarez-SanJaime et al. (2013) focused on the competition between the oligopolic maritime sector and the competitive road transport industry. They derived the market equilibrium without and with the horizontal integration between two shipping lines. Song et al. (2016) developed a non-cooperative game model to study a two-ports-one-ocean carrier system involving both hinterland shipments and transshipments from a transport chain perspective. Wang et al. (2017) concentrated on a vertical integration problem in which the OC competes with the IC to canvass the cargoes.

Álvarez-SanJaime et al. (2015) examined the economic and welfare implications to the port activities with inland transport services under inter-ports competition. Two ports compete to each other for their freight demand, which spatially distributes along the gateway hinterland. The inland transport service is exogenously given. In other words, Álvarez-SanJaime et al. (2015) focused on the horizontal competition between two inter-ports with the exogenously vertical hinterland transport services. The inland transport service provider is not passively integrated by the ocean carrier (OC), but positively competes to the OC. There are three types of players including shippers, ICs and OCs in inland waterway transportation. In addition, there is broad evidence about the competition in the inland shipping line market. For example, COSCO (China Ocean Shipping Company) Group provides inland shipping services covering almost all the inland river ports in Yangtze River via its subsidiary, Shanghai Puhai Shipping Co. Ltd. In the meanwhile, many local small inland shipping companies, such as, Wuhan Changwei, ally with their local port operators to compete to those powerful ocean rivalries.

Differentiating to the previous studies on the horizontal competition between the inter-ports or ocean carriers, the current paper investigates the competition between the OC and IC by incorporating the various kinds of the shipping chain structures. The IC provides the inland shipping service including the waterway transportation service and port service, while the OC selects various strategies to consider whether or not entering the inland shipping market and how to compete or ally with the inland shipping company. Furthermore, As Wang et al. (2016) and Tan et al. (2015), the cargo shipment demand is spatially distributed along the inland river, which is the hinterland of the transportation chain. Therefore, the cargo shippers make their own transportation choice facing the alternative transportation modes to the sea hub port for their export cargos to the oversea market: pure road transportation, road and inland waterway transportation.

1.2. Objectives and contributions

The primary objective of this study is to deal with the two fundamental issues for an OC in the vertical shipping chain for transporting the intercontinental containers: (a) what is the value of the vertical shipping integration with an IC? (b) what are the effective mechanisms to integrate with an IC? To do so, a fundamental vertical shipping framework incorporating the potential effect of the road container transport mode is proposed first: one inland shipping company (IC) controlling the upstream inland shipping market and one OC controlling the downstream deep-sea shipping market. The OC can adopt possible three strategies with respect to the inland shipping service: (I) vertical separation by only providing deep-sea shipping services; (II) alliance with the IC by jointly setting the freight rates for both deep-sea and inland shipping services; (III) horizontal competition with the IC by providing both deep-sea and inland shipping services. The problems of the separable vertical and vertical-horizontal competition are examined by the one-shot game theoretical model and formulated by the mathematical programming approach. The alliance problem is captured by a bi-objective programming model and further investigated by the Pareto optimal approach. The alliance strategy with excess revenue-sharing contract is proposed to implement one of the practical Pareto optimal solutions. We also put forward the entrant threaten strategy for the OC to exercise the vertical-horizontal competition and improve her outcome in comparison to the separable competition. Finally, the optimal mechanism is investigated by comparing among all the outcomes associated with the above mathematical programming models, and the impact of the location of the inland river port on the optimal selection of the mechanisms is also analyzed. In comparison with Álvarez-SanJaime et al. (2015), who investigated the competition between two inter-ports to integrate the vertical transportation service, we studied whether or not the inter-port to provide the vertical transportation service when facing the competition of the existing vertical transportation service company.

The main contributions of this study are threefold. First, a nice analytical framework is developed to investigate the competition and alliance mechanisms between the ocean carrier and inland shipping company in a vertical structure shipping chain. The