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# Tacit collusion between two terminals of a port

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ABSTRACT

With the recent deregulation of container service rates and the establishment of more joint venture terminals in China, the separation of ownership and operation of container terminals will make price competition fierce in one port area. In this study we present an analysis of the price competition between two container terminals using a two-stage non-cooperative game theoretical model. Our main finding is that price-matching strategies facilitate tacit collusion between container terminals. Numerical simulation is applied to the container terminals at the Yangshan Deepwater Port in Shanghai, China.



## 1. Introduction

In recent years, with the rapidly growing intercontinental container shipping service, China's container throughput, which increased up 6.1% annually to 200.93 million TEUs in 2014, has been maintaining the first of world for eleven consecutive years (Liu et al., 2015). Among the world's 10 largest container port throughput rankings, China's container ports including Hong Kong take seven seats on the list of 2014. Especially, Shanghai Port has retained its title as the world's busiest container port for five consecutive years, which increased by 5.0% annually to 35 million TEUs in 2014 (Bao and Jiang, 2015).

To capture a larger share of global shipping, many coastal ports of China are investing heavily on container terminals to expand the capacity to serve as a hub port. Therefore, more and more regional imbalance is emerging, such as excess capacity, underutilized berths, rising costs, resulting in fierce price competition among port clusters, even in one port area. Container terminal operators usually negotiate with liner companies in September or October every year and eventually sign the lump-sum rates of terminal charges for the next year. In this process of price negotiation, the priority considerations of a liner company are the economic hinterland, operational capacity, and the efficiency of a container terminal, but not sensitive to the terminal charge, which holds a small proportion of the liner company's total cost. Therefore, terminal operators are often in a relatively stronger position compared to liner companies and have a better chance to improve their operational performance.

Meanwhile, a dual-track system has been implemented on port charges in mainland China for the past many years. The vast majority of ports refer to the standard rate specified by China's Ministry of Transport, which released the container stevedoring rates for the first time on September 1, 1976. Among the container stevedoring rates, one TEU loaded general cargo was only 70.6 Chinese Yuan (RMB). After total 13 times of the rate adjustment, the latest was modified on December 24, 2001. The stevedoring rate of one TEU loaded general cargo was adjusted to 425.5 RMB, which increased up 502.7% compared to the rate in 1976, but still at a lower level comparing with the international average (Xiao and Yang, 2005).

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After 2005, container terminals of joint ventures have the right to price their stevedoring rate according to the regulation of China's Ministry of Transport, while other container terminals should comply with the standard container rates modified in 2001, with 20% float ratio of up and down. Therefore, the actual rates of major container terminals in China are quite different. For example, the lump-sum rates of Tianjin, Dalian, and Qingdao are generally 5% higher than their standard rates, while the rate of Ningbo-Zhousan is approximately 5% lower than Shanghai in Yangtze River Delta (Zhai, 2011).

Because container terminals have some typical characteristics, such as oversea oriented, global network, and natural monopoly, the level of container stevedoring rates is usually determined by the development of regional economy and industry. In addition, different investors have their own investment expectations and management tools, causing different stevedoring rates of container terminals. Most state-owned container terminals want to take low-rates policy, while joint ventures and wholly foreign-owned container terminals adopt higher rates. With the majority of ports has been delegated to the local government, unreasonable rates are emerging under the asymmetric information.

On November 22, 2014, Notice of Liberalization Port Competitive Service Charges was issued by China's Ministry of Transport and National Development and Reform Commission, transforming the rates from government guidance into market regulation from January 1, 2015. In accordance with providing personalized service, the container terminals can set different lump sum rates. With this service rate deregulation and more joint venture terminals established in China, the separation of ownership and operation of container terminals will make price competition fierce among container terminals in the same port area. In the context of intra-port competition, how should each container terminal set its price with the consideration of possible reaction by other terminals in the same port area?

This work is motivated by the popularity of price-matching guarantee policies in retailing. Price-matching guarantees often take the form that sellers offer consumers who buy their products to match competitors' lower prices for identical products (i.e. same name, model, and color), provided that they have a proof that an identical product is sold by a competitor within a well-defined time period. Many firms today declare that they will match the price of their competitors. This policy covers a wide range of products such as electronics, kitchen appliances, pharmaceuticals, diamonds, auto-parts, tires, and prescription drugs (Mago and Pate, 2009). Retailers such as Sears, Staples, and Canadian Tire all offer price-matching guarantees. If two container terminals locate in the same port area, the services provided by them are basically identical to shippers, which makes it possible for container terminals to use price-matching guarantees. Although price-matching guarantees seem eligible to container terminals, it is not clear whether they will employ price-matching policies or not. From port management's perspective, what is the consequence if its terminals adopt price-matching policies?

To address these emerging research questions, we propose a game theoretical model to investigate the behavior of terminals in one port area. Given the paucity of research on intra-port competition, our primary aim in this study is to develop an analytical model dealing with charging terminal rates in a competitive environment. In addition to being the first to introduce the popular price-matching strategy in retail industry to port competition, the main contribution of this paper to port competition literature is to build a two-stage game theoretical model to specifically investigate intra-port competition.

The rest of this paper is organized as follows. Section 2 gives a literature review on inter-port and intra-port competition as well as price-matching guarantees. In Section 3, we present main theoretical results of our paper. In Section 4, we apply our model to two container terminals in Yangshan Deepwater Port of Shanghai, China. Conclusions and directions for future research are summarized in Section 5.

## 2. Literature review

There is a substantial body of literature on port competition, focusing mainly on economic efficiency, port choice, and market share division. We refer the reader to a recent paper by Yip et al. (2014) for relative literature on this stream of research. Research on port competition using game theory is limited. Anderson et al. (2008) develop a game-theoretic best response framework and apply their model on competition between the ports of Busan and Shanghai. Zhang (2008) examines both quantity and price competitions between ports through analyzing competition between alternate intermodal transportation chains. They find that when ports compete in quantities, an increase in corridor capacity will increase own port's output and reduce the rival port's output. De Borger et al. (2008) study duopolistic pricing by ports that share the same overseas customers and have each a downstream, congestible transport network to a common hinterland. In the two-stage game analyzed by them, capacity decisions are public but pricing is private. Luo et al. (2012) develop a two-stage duopoly model that comprises the pricing and capacity decisions of two ports serving an increasing market. They apply their model to explain the past container port market transition and evolution in the Pearl River Delta region in southern China and demonstrated possible future outcomes from port competition between Shenzhen Port and Hong Kong Port. Ishii et al. (2013) construct a non-cooperative game theoretic model where each port selects port charges strategically in the timing of port capacity investment. They derive the Nash equilibrium and apply their results to the case of inter-port competition between the ports of Busan and Kobe. Bae et al. (2013) develop a two-stage duopoly game of container port competition for transshipment cargos. In their non-cooperative game, ports act as upstream players through choosing their prices and shipping lines act as downstream players. Zhuang et al. (2014) model port competition using both a simultaneous game and a leader–follower game. In both games, two ports compete on their output volumes, not prices. Their results suggest that if there is a clear market leader, government intervention may not be necessary. Álvarez-SanJaime et al. (2015) model competition