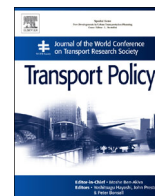




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Modeling the effects of competition on seaport terminal awarding

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ABSTRACT

In the maritime transport industry, a terminal concession often specifies the competition conditions during the concession period. This study proposes a game model with which the effects of competition for seaport terminal awards can be studied. The modeling results suggest that (a) a terminal operator always prefers to control more terminals in the region; (b) if all terminal operators expand their operations to every port, they will be worse off due to an increase of inter- and intra-port competitions, a situation similar to the prisoners' dilemma; and (c) when a port authority has significant market power, it prefers to introduce inter- and intra-port competition, rather than allowing one operator to monopolize all terminals. (d) multiple equilibria may be observed in concession awarding depending on market characteristics associated to a particular market. Anecdotal observations consistent with these modeling results are presented and discussed.

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1. Introduction

Most modern container terminals are run under a concession agreement model. A concession is an agreement between the port authority and a terminal operator to operate certain port facilities over a certain period. Gradually, however, terminal concessions in many countries have become popular privatization schemes (Baird, 2002). In the UK, recent privatizations of port terminals have constituted an unrestricted and irrevocable transfer of port land from the public to the private sector. Therefore, port privatization in the UK did not create new and improved port infrastructure or facilities (Baird and Valentine, 2006). In most other situations around the globe, terminal concession allows the port authority to be involved in the operations, and a terminal concession agreement is considered a temporary or partial privatization. The concession agreement defines the relationship between the government and the private sector. Unlike other types of privatization contracts, concession agreements often specify the competition conditions during the concession period (World Bank, 2007).

Terminal concessions in seaports have recently attracted some academic attention, and a special issue of *Maritime Policy and Management* was recently devoted to this subject (Notteboom et al., 2012), in which various conceptual and empirical approaches

were discussed. Studies such as those by Notteboom (2006), Pallis et al. (2008) and Theys et al. (2010), Lam et al. (2013) have identified a detailed research agenda on issues such as concession allocation mechanisms, the determination of concession terms and concession fees, the inclusion of special clauses, concession site selection, division of risks and investments, performance targets, etc. Theys et al. (2010) pointed out that so far, insights from established economic theories have rarely been applied to terminal concessions in seaports. The literature on seaport concessions lacks modeling, with an exception of the model by de Borger et al. (2008), which concluded that investment in ports increases congestion for their regional hinterlands. Therefore, there is a need to conduct detailed investigation and modeling analysis. This paper aims to contribute to this burgeoning literature by proposing a game theoretical model with which the effects of competition on the awarding of seaport terminal concessions can be analyzed.

Following the work by Goss (1990), a substantial body of literature on port competition has been developed, focusing mainly on economic efficiency, port choice and market share division. Murphy et al. (1992) and Murphy and Daley (1994) identified a list of important determining variables through a survey. According to Fleming and Hayuth (1994), geographical location is vital to explaining a port's competitive success. Tongzon (1994) examined the determining factors of overall port performance and productivity, including location, frequency of ship calls, economic activity within the sector, labor and capital productivity and work practices within a port. Fung (2001) tried to measure the

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competition between the ports of Singapore and Hong Kong. Wang et al. (2012) examined the factors determining port competition and/or cooperation by using an analytical model. Bichou and Gray (2005) reviewed the terminologies used in this field, providing a descriptive starting point for model variables. Another group of quantitative studies have been conducted to study port choice and port competition. Winston (1981) used a multinomial probit analysis to predict the demand for domestic ocean container services, and Tsamboulas and Kapros (2000) used a combination of statistical methods to correlate inter-modal transportation behavior with the physical and economic criteria of each mode. Veldman and Buckmann (2003) used a logit model to quantify factors affecting cargo routing decisions for major ports around Rotterdam. Brooks and Button (1996) provided the determinants of shipping rates. Tiwari et al. (2003) used a nested discrete choice method to analyze shippers' behavior regarding containerized cargo in China. Nir et al. (2003) used a logit model to capture the distribution of export activity among Taiwan's three ports. In other studies, competition among ports has been explicitly considered, although the main objectives were to study issues such as port capacity, pricing, network connectivity or pollution control (see, for example, Asteris and Collins (2009), Lam (2011), Lam and Yap (2011a, 2011b), Luo et al. (2012), Xiao et al. (2012), Homsombat et al. (2013), and Zhuang et al. (2013)).

Several studies have proposed that competition between terminal operators, or the so-called "within port" or "intra-port" competition, also has important effects on port performance and operations. According to the definition by the World Bank (2007), "Intra-port competition refers to a situation where two or more different terminal operators within the same port are vying for the same market. In this case, the terminal operator has jurisdiction over an entire terminal area from berth to gate, and competes with other terminal operators." Goss (1990) pointed out that intra-port competition is beneficial in that it prevents (monopolistic) rent seeking by port service providers. De Langen and Pallis (2006) supported the introduction of intra-port competition, which they claimed leads to specialization, flexible adaptation and innovation of terminal operators. Using an approach of co-operative game modeling, Saeed and Larsen (2010) studied possible coalitions among the terminal operators in the port of Karachi. These researchers found that a "grant coalition" among the three terminal operators has led to a maximum total payoff. However, the real winners have been the terminals in nearby ports, who have earned higher profits without joining the coalition. Yip et al. (2011) provided empirical evidence that multi-terminal operators are more efficient than individual terminal operators. They also found that port efficiency is likely to be statistically lower if the number of terminal operators increases.

All of these studies have provided valuable insights on the effects of port competition. In addition, a group of studies have examined port concession problems in general. For example, see the studies by Asteris and Collins (2006, 2007) and Vining and Boardman (2008). However, few researchers have analyzed the effects and roles of port competition in determining terminal concession awards. De Borger et al. (2008) studied two congestible ports that were competing for overseas shipments as local governments made optimal investments in their port and hinterland capacities. In these authors' models, the local governments and terminal operators were all independent, and consequently the port investments tended to increase hinterland congestion. Theys et al. (2010) pointed out that intra-port competition may be introduced if concessions are awarded to different operators, but they did not discuss the conditions under which port and terminal operators would prefer such concession awards. Neither was it clear how such practices would affect the payoffs of ports and terminal operators. Sauri and Robuste (2012) studied the

concession relationship among port authorities, terminal operators and stevedores on the basis of principal-agent models. According to these authors, terminal productivity in single port systems could be improved through incentive mechanisms.

There is an urgent need to fill the research gap on this subject, as most ports around the world are facing competitive pressure from nearby ports, and many ports have introduced intra-port competition over the last two decades. This is particularly evident in China, where virtually all major ports have awarded concessions to multiple operators. The ownership structures of the major container ports in China are summarized as in Table 1. Unlike previous studies, we explicitly model intra-port competition in the awarding of concessions.

The introduction of intra-port competition appears to have encountered more challenges in Europe, particularly from the maritime transport industry (Van Reeve, 2010). On 13 February 2001, the European Commission adopted the communication *Reinforcing quality service in sea ports: A key for European transport*. In this communication, the port services directive identified the introduction of intra-port competition as one of the main objectives. Nevertheless, this directive has been rejected twice by the European Parliament. This is remarkable, as only three legislative proposals were rejected between 1999 and 2004. The representatives of the port authorities (ESPO and FEPORT), dockworkers (ITF, ETF and IDC), tug owners (ETA), maritime pilots (EMPA), and boatmen (EBA) campaigned against the directive, arguing that competition between ports (or so-called inter-port competition) would keep sufficient pressure on efficiency. Van Reeve (2010) studied the effects of vertical separation between port authorities and terminal operators in ports where intra-port competition was present. Using a horizontal product differentiation model in which two ports competed for cargo trans-shipments, he showed that the separation of port authorities and terminal operators (the landlord port model) produces a Nash Equilibrium that yields the highest profits for the port industry and the highest prices for its customers. The introduction of intra-port competition into the landlord port model reduces industry profits and prices, which makes the port industry reluctant to open itself to such competition. The modeling results of Van Reeve (2010) are consistent with the actions taken by the European maritime transport industry. Nevertheless, this response does not fully explain why intra-port competition has been well accepted in some of the biggest ports, including the newly developed ports/terminals in China. Especially in China, many ports/terminals are run by multiple terminal operators, and the same operators are allowed to expand through winning concessions in competing ports.

This paper proposes an analytical non-cooperative game theory model to investigate the effects of competition on seaport terminal awards. Unlike most previous port concession studies which have mainly focused on concession procedures and processes (Defilippi, 2004; Van Niekerk, 2005; Notteboom, 2009; Pallis et al., 2008), we aim to study the dynamic effects of competition for the port authorities and terminal operators. By modeling the profits for two terminal operators serving two adjacent ports, we show that (a) a terminal operator's profits increase with its market power in the region. As a result, an operator always prefers to control more terminals. *Ceteris paribus*, a terminal operator can increase its profit by expanding its operation into nearby ports. However, we also find that (b) when all terminal operators expand to other ports, they are worse off due to an increase of inter- and intra-port competition. This situation is similar to the classic prisoners' dilemma. Terminal operators would be better off if they could avoid encroaching on their competitors' territories, although expansion in the region is their dominant strategy. In addition, we find that (c) when a port authority has significant market power and can thus charge a high price, or share a large proportion of the terminal operators' revenue, then the

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