



# Selection behavior of the global container shipping industry for carrier-owned and leased containers



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## ABSTRACT

In container shipping practices, containers owned by the shipping lines and leasing companies are generally regarded as homogeneous factor inputs and can substitute each other perfectly in providing the shipping service. Based on industry-wide data, this study surprisingly finds that the behavior of container selection for container shipping lines does not follow the pattern of perfect substitution, but rather the pattern of fixed proportions technology, through a constant elasticity of substitution production function. Combined with the observed relationship between the approximately constant leasing rates and the shrinking price premiums for leasing companies over the past two decades, the empirical results suggest that concerns with both the capital cost and strategic means may play key roles in determining the mix of owned and leased containers for the shipping lines. Several strategic concerns including the long-term leasing contract, supplier diversity program, and option contract are discussed and suggested as approaches that can be applied by the shipping lines to arrange their leasing policies with lessors and to moderate the competition of these two parties in expanding their container fleets. These approaches not only can reduce the costs and the associated risks for the shipping lines, but can also alleviate the situation of over-supplied containers in the global container shipping industry.

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## 1. Introduction

It is a common practice for container shipping lines to construct their container fleets by mixing the containers owned by themselves (hereinafter referred to as owned containers) with the containers owned by leasing companies (hereinafter referred to as leased containers). However, the highly volatile demand in the container shipping market increases the difficulties faced in container capacity planning. In fact, it is extremely difficult for the shipping lines to forecast the market demand and to maintain a balance between the demand for and supply of containers (Liu et al., 2013). In shipping practice, an aggressive attitude toward container fleet development may lead to idle containers scattered at the ports of call and an additional capital burden associated with holding these excess containers. By contrast, a conservative attitude may incur substantial business opportunity losses due to container shortages. Therefore, the management of a container fleet is a critical and complicated issue for shipping lines to determine a proper mix of owned and leased containers to support

their operations and services along the port network in which they call.

In the literature, Dong and Song (2012) stress that empty container repositioning, container leasing-in/leasing-off, and container fleet sizing play key roles in the decisions regarding container fleet management. Meanwhile, most studies related to container fleet management have mainly focused on the issue of empty container repositioning. Rodrigue (2009), Song and Carter (2009), and Theofanis and Boile (2009) demonstrate that empty container repositioning caused by the trade imbalance between the eastern and western hemispheres since the 1980s is a highly cost-consuming problem for container shipping lines and leasing companies. The empty container repositioning may reduce container waiting time and increase container utilization, but it incurs additional transportation and handling costs and occupies valuable vessel space (Dong and Song, 2009).

Since the beginning of containerization in the 1970s, the container leasing industry emerged to offer an alternative way in container fleet management, thereby enabling shipping lines to cope with temporal and geographical demand fluctuations (Rodrigue, 2009). In fact, container leasing has been playing a significant role in enabling container shipping lines to achieve operational and cost efficiency. The use of leased containers enables shipping lines to improve their control over the container fleet and

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to alleviate the shock of container surplus or shortage caused by market fluctuations (Sahara and Watanabe, 2011). Accordingly, the container leasing decision faced by shipping lines is closely related to that involving empty container repositioning. In order to analyze the operator's efficiency and profits in container control, methodologically, Gao (1994) and Moon et al. (2010) construct models to minimize the total cost incurred by the container purchasing and leasing, the storage and repositioning of empty containers, and the maintenance, repair and insurance of containers. In addition, shipping lines may also negotiate with leasing companies for different lease terms to reduce the repositioning of empty containers and improve container utilization (Dong and Song, 2012).

As observed from shipping practice, the strategy of constructing a container fleet by mixing owned and leased containers has been widely utilized by shipping lines to reduce the huge burden of the capital cost associated with holding a large number of owned containers and to avoid suffering from a devalued container price under market conditions characterized by low demand. Conceptually, it will be helpful for shipping lines, container leasing companies and researchers to foresee the market development of the global container leasing industry if the characteristics of the elasticity of substitution between owned and leased containers and the determinants of container selection behavior can be thoroughly clarified.

Compared to the ample research that focuses on empty container repositioning, the number of studies investigating the selection behavior between owned and leased containers is fairly limited. The work by Wang (2014) is a rare example in the literature of the application of the dual theory of production and cost functions in economics to show the perfect substitution between owned and leased containers in shipping operations. Wang concludes that a linear production function with its associated Leontief cost function is a good model to reflect the perfect substitution of the two types of containers. However, the theoretical implication of Leontief cost – that only the type of containers with lower holding cost will be used – fails to explain the coexistence of owned and leased containers prevailing in the container shipping market.

This paper is mainly motivated by the proposed perfect substitution between owned and leased containers in providing shipping services. The coexistence of owned and leased containers and the roughly constant ratio of owned to leased containers that is observed implies that shipping lines may not obey economic theory by completely utilizing the type of containers with relatively low cost if the two types of containers are regarded as mutually perfect substitutes. The main purpose of this paper is to examine the elasticity of substitution between owned and leased containers, and in turn to analyze the selection behavior of containers for shipping lines.

The paper is organized as follows. In Section 2, some observations regarding the practice of container leasing are discussed. The respective daily costs of holding owned and leased containers are measured to study the changes in the cost structures and leasing rates. In Section 3, the definitions and theoretical implications of the elasticity of substitution in different scenarios are discussed. Based on the concept of the marginal product of factor inputs, a two-step approach is proposed to estimate the parameters in a CES production function in Section 4. The estimated parameters are utilized to test the hypothesis of perfect substitution between owned and leased containers. Based on the empirical results, some strategic concerns regarding harmonizing the competition between the shipping lines and leasing companies in expanding their container fleets are discussed. Conclusions are drawn in Section 5. Finally, the limitations and recommendations for further research are discussed in Section 6.

## 2. Practical observations and theoretical implications

### 2.1. The practice of container leasing

Due to the tremendous burden of capital costs associated with operating a large number of containers, there are only a few shipping lines, especially in the early stages of containerization, that are able to afford the cost of expanding their container fleets without sacrificing the growth of their vessel fleets (Cullinane and Khanna, 2000; Rodrigue, 2009; Talley, 1990; Wang, 2014). In practice, the emergence of a container leasing business offers the flexibility for shipping lines to develop their own container fleets and to solve the problems associated with a container shortage or surplus. Shipping lines usually lease a significant portion of their containers from leasing companies. As a result, an active container leasing industry has significantly improved the flexibility of container fleet management for shipping lines.

Under operational and cost considerations, container shipping lines generally construct their container fleets with both owned and leased containers. Operationally, leased containers are used to meet short-run peaks in demand, unplanned requirements in specific locations, or the provision of potentially temporary new service, for example, a newly-developed market segment served by a feeder service. In addition, the rising bunker price has incited container shipping lines to reduce the operational speed of vessels, a practice known as slow steaming. In turn, the resulting longer voyage time has tied up more containers in transit. Hence, slow steaming implies that shipping lines are in need of more containers and have to rent additional containers to satisfy operational requirements (Container Supply Review, 2011; Containerisation International Yearbook, 2013, p. 37).

On the other hand, cost considerations also play another key role in the making of decisions regarding container leasing. Utilizing leased containers usually reduces the burden of initial capital expenditures and increases the liquidity of the assets of shipping lines. This is the initial motivation for shipping lines to use leased containers to make up for the shortage of containers for seasonal or geographical reasons. Meanwhile, container leasing may also lead to savings in the storage charges for unused containers stored in depots and the cost for dropping off or returning containers to lessors. In addition, the cost of repositioning empty containers is also a critical factor that encourages the shipping lines to use leased containers (Sahara and Watanabe, 2011).

Furthermore, it is perceived that strategic concerns also play important roles in the container leasing decisions of shipping lines. In practice, shipping lines usually keep a portion of the container fleet with carrier-owned containers to support their shipping services. These owned containers are actually treated as the base to satisfy the minimum requirements of containers in their shipping operations and serve to maintain the market power to resist the dominance of leasing companies in setting the rental rates (Wang, 2014).

Historically, the container leasing companies have owned approximately 45% of the global container fleet (Dong and Song, 2012; Karmelic et al., 2012; Wehrheim, 2011). In general, the container leasing agreements between shipping lines and leasing companies are classified into two major categories by leasing terms: the fixed-term agreement and the master lease agreement. The fixed-term lease primarily consists of a long-term lease and a short-term lease, which typically have terms of three to eight years and less than three years, respectively. Meanwhile, a small proportion of long-term agreements are finance leases under which the lessees have either an option or obligation to purchase the containers at the end of the lease term rather than return them to the lessors. By contrast, the master lease agreement is usually negotiated under a term of less than one year. Sometimes, a

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