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The estimation of minimum efficient scale of the port industry

Young-Joon Seo [a], Jin Suk Park [b,*]

[a] Plymouth Graduate School of Management, Plymouth University, PL4 8AA, United Kingdom
[b] School of Economics, Finance and Accounting, Coventry University, CV1 5FB, United Kingdom

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ABSTRACT

Terminal scale has been the subject of discrete episodes of hotly contested policy debates. From the perspective of port authorities or governments, knowing the Minimum Efficient Scale (MES) is salient, because they sometimes determine the port development or expansion based on the port capacity or the existing size of the terminal. Notwithstanding the importance of knowing the exact MES, extant literature has not managed to estimate MES in the port industry. This study aims to estimate the MES in the port industry in South Korea in order to identify whether Container Terminal Operators (CTOs) are under economies of scale, constant economies of scale or diseconomies of scale; we explore a bottom point of the average cost curve in order to suggest an adequate scale for the port industry in Korea. The finding demonstrates that undercapacity may be a strong issue in Korean container ports. However, CTOs in Busan port are in an overcapacity area given the market demand of container throughput in 2013, which is approximately 25 times larger than the estimated MES; in fact, all CTOs in Busan port operate at more than 20% of MES. This study then can provide port policy makers with a helpful tool to derive *ex-ante* MES level at the terminal designing stage and to adjust *ex-post* port investment decisions at the additional port capacity designing stage, which may contribute to avoiding overcapacity.

1. Introduction

Rapid port development in North-East Asia which sought to dominate the market ahead of adjacent countries and achieve hub-port status has triggered severe competition between container ports. Although South Korea (hereafter Korea) has played a crucial role in the international shipping and port industry as an economy that handled the fourth largest global container port throughput of approximately 23 million TEU in 2013 and owned the fifth largest fleet in terms of dead weight tonnage with leading container shipping lines such as Hanjin shipping and Hyundai Merchant Marine and the second largest shipbuilding industry globally (UNCTAD, 2014), Container Terminal Operators (CTOs) particularly in Korea have suffered overcapacity problems which are unprecedented (Korea Shipping Gazette, 2014). This has devastated CTOs' financial status, since a number of factors such as the increased bargaining power of shipping lines stemming from mergers and acquisitions, strategic alliances amongst major shipping lines, withdrawal of sales from particular CTOs, and new entrants into existing ports have had a negative impact on container terminal markets overall. As a result, the terminal handling charge per TEU in ports was significantly less than in both China and Japan (Korea Shipping Gazette, 2013). This causes a loss of profits and an outflow of national wealth from Korea's viewpoint.

Terminal scale has been the subject of discrete episodes of hotly contested policy debates (Asteris and Collins, 2010). From the perspective of economic theories, CTOs should be keen on a scale that is equivalent to the minimum efficient scale (MES), which is defined as the long-run output where the internal economics of scale have been fully exploited (Kaselimi et al., 2011). CTOs are essentially interested in identifying the terminal scale in order to enter the market and compete with other CTOs, although the scale may vary according to locations with different costs (Kaselimi et al., 2011). From the perspective of port authorities or governments, knowing the MES is vital, because they sometimes determine the way in which existing assets should be subdivided for port concession. In addition, they may utilise this information regarding the MES, when they plan to develop new ports based on the port capacity or the existing size of the terminal. Central or regional governments or port authorities have strived for the optimal port capacity, because it is directly connected to both national and regional economics as an economic springboard (Tongzon and Heng, 2005; Bottasso et al., 2013; Deng et al., 2013; Song and van Geenhuizen, 2014; Chang et al., 2014; Park and Seo, 2016). Underestimation of port capacity results in constructing too many berths and equipment, whereas the overestimation leads to vessel congestion (Chang et al., 2012). For example, if the CTO

* Corresponding author.
E-mail addresses: Y.Seo@plymouth.ac.uk (Y.-J. Seo), jin.park@coventry.ac.uk (J.S. Park).

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pursues 100% berth utilisation, it can minimise its costs per ship for ship owners, but it generates costs due to waiting for berth (De Weille and Ray, 1974). Also, if the CTOs construct and operate many berths to minimise the vessels' waiting time, they have to face high costs of constructing and operating the berths (De Weille and Ray, 1974). In fact, the relationship between the port capacity and waiting time is a trade-off. In this regard, Jansson and Shneerson (1982) pointed out that the decisions on port investment should be in concert with the long-run total cost, incorporating port development costs and waiting costs of ships and cargo. Identifying the optimum port capacity is not easy, because it is required to reflect multiple perspectives of related players (e.g. ship owners and CTOs). This sometimes results in compromised port capacity rather than the optimum one. Accordingly, various stakeholders seek awareness of when the market becomes sufficiently large for the new terminal construction in the same ports via the estimation of the MES (Kaselimi et al., 2011).

The estimation of MES for the service sector such as sea transport, aviation, travel, insurance, and land transport is rare owing to the difficulty of making such estimates, and MES for the service sector is likely to be lower than the manufacturing sector (Pratten, 1988). In the port context, some extant studies investigate the concept of 'global optimum size' of a terminal or a notion of critical mass of the container terminal (Musso et al., 1999; Wiegmans et al., 2009). Interestingly, Kaselimi et al. (2011) have attempted to identify the preferred scale of the container terminals, but they failed to find solutions due to different port governance, market size, structure and operational considerations. Surprisingly, notwithstanding the importance of knowing the exact MES (Theys et al., 2010; De Langen and Pallis, 2006), extant literature has not managed to estimate the MES in the port industry. A paucity of extant works on the MES in the port stimulated this study. Therefore, bearing in mind this research gap, the main purpose of this study is to estimate the MES in the port industry in Korea in order to identify whether CTOs are under economies of scale, constant economies of scale or diseconomies of scale so that we can explore a bottom point of the average cost curve. By doing so, this study can provide port planners and port policy makers with a helpful tool to derive *ex-ante* MES level at the terminal designing stage and to adjust *ex-post* port investment decisions at the additional port capacity designing stage, which may contribute to mitigating overcapacity. This study deals with the real issues in Korea, but the approach of this study might be applied to other regions of the world that suffer overcapacity issues (e.g. port of Colombo in Sri Lanka, see Galhena (2015)).

Section 2 reviews the literature on overcapacity and the MES. Section 3 explains the main methodology this study employed. Section 4 presents the results. Finally, the research implication and conclusions are drawn in Section 5.

2. Literature review

2.1. The overcapacity issues and MES

Traditionally, industrial organisations have been concerned with the optimum firm size and industrial plant capacity in order to minimise costs and maximise profits. Market structure is generally categorised into perfect competition, oligopoly, duopoly and monopoly. Such a structure is determined by the number of firms within the industry, the distribution of the firm size, product differentiation and entry condition. Amongst them, the number of firms may be a major determinant for the industry's structural characteristics such as monopoly and perfect competition. Also, entry barrier, minimum capital for optimum scale and MES affect the market structure. In the area of industrial organisation the MES concept is of paramount importance, because large MES can significantly reduce unit cost and might cause high concentration and significant entry barriers (Caves et al., 1975; Cory, 1981). In this paper, the main focus lies in capacity issues as well as MES.

Overcapacity occurs due to the misallocation of resources and a situation where superfluous infrastructure exists (Barzdukas et al., 2000). Haralambides (2002) pointed out that higher competition may bring a greater need for overcapacity of ports, and highlighted that the competition and overcapacity mix is an explosive cocktail. The advent of containerisation forces ports to remain capital-intensive and make tremendous investment in both port infrastructure and container handling equipment. Furthermore, the long life of terminals, capital indivisibilities, shipping liners' interest in minimising ship waiting time, economies of scale in port construction and the optimism of port planners may be attributed to the risk of excess capacity of ports (Haralambides, 2002; Heaver, 1995).

According to Porter (1998), expanding capacity is the most important strategic decision confronting firms in terms of the capital and the complexity of the decision-making problem since capacity adding requires lead times for years and capacity persists for a long time. Therefore, thorough expectations such as future demands and competitor's future behaviour should be made before capacity expansion. There would be hostile consequences if a large number of competitors participate in expanding capacity. It is worth noting here that unlike a manufacturing sector which is able to produce for the future and manage capacity and demand by storing the products, transport service industries such as port, shipping, airline and rail are likely to face capacity issues due to the fact that the services they offer are not storable (De Weille and Ray, 1974). In most container ports in Korea, terminal markets seem to be oligopoly (Korea Shipping Gazette, 2013), in which CTOs are mutually inter-dependent. Each CTO strategic movement is centred on enhancing market share, while avoiding overcapacity. In general, ports decide to expand their facilities based on an expectation of a future cargo throughput, and internally-driven and customer-compelled strategies of each terminal may result in excessive duplication and overcapacity (Slack, 1993). Overcapacity would result in inefficient use of port infrastructure (Chang et al., 2012). In the port sector, there always exists a conflict between monopoly power and concern for excess capacity (Heaver, 1995). Monopoly tends to hinder innovation and efficiency while overcapacity results in inefficiencies due to superfluous duplication, which wastes high capital investment (Barzdukas et al., 2000).

Knowing the MES would play a vital role in providing the most efficient and effective service at a minimum cost (Chang et al., 2012), especially when CTOs are likely to provide homogenous service and compete based on the cost reduction. In terms of differentiation, CTOs tend to provide homogeneous services: the transfer of boxes between ship and ashore (Ashar, 2001). The fact that services are not differentiated makes cost reduction important to their competition. The overcapacity problem often occurs when competitors aim at preemptive behaviour in pursuit of a cost advantage and the MES because larger plants are likely to be more efficient than smaller plants. The MES of a container terminal is defined as "the smallest scale at which output can be produced at minimum average long run cost" (Kaselimi et al., 2011, p. 72). If the MES of a current CTO is large compared with the market size, potential or new entrants may encounter competitive disadvantage owing to a smaller scale or need for building a similar capacity to that of the CTO (De Langen and Pallis, 2007). This may lead both of them to the possibility of price war and profit loss because of the considerable excess supply (De Langen and Pallis, 2007).