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Container port efficiency in emerging and more advanced markets

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The literature on container port efficiency has typically centered on ports in advanced markets or comparisons within regions. This study compares the efficiency of port operations in emerging markets (BRIC and the Next-11) with the more advanced markets (G7). We use data envelopment analysis to evaluate the container ports based on the import and export cargo volumes in 2005. Our results suggest that none of the ports in the advanced markets are role models for the field. This study provides a first step towards gaining insights into port efficiency in emerging markets.

1. Introduction

As the economies of the newly emerging countries grow and fuel infrastructure development, demand for commodities in these countries such as Brazil, Russia, India, and China (BRIC) has risen markedly. Wilson and Purushothaman (2003) have identified three common characteristics of the BRIC economies, namely, plentiful natural resources, relatively young populations, and large land areas, that have prompted analysts to classify them as markets that will significantly alter the global landscape. Despite the scholarly attempts to measure a country's productivity or efficiency, a working definition remains elusive (Kao et al., 2008). O'Neill et al. (2005) have looked at the economic development potential of another set of developing countries, referred to as "The Next Eleven (N-11)", which collectively have the potential to rival or even surpass the BRIC nations. The N-11 are South Korea, Indonesia, Vietnam, the Philippines, Pakistan and Bangladesh in Asia, Nigeria and Egypt in Africa, Mexico in North America, Iran in the Middle East, and Turkey. O'Neill et al. (2005) estimate that, by 2050, the combined gross domestic product (GDP) of the N-11 would equal that of the United States or four Japans.

Cognizant of these economic development trends, many multinational corporations have made these emerging markets, such as BRIC, their primary investment choices, with an eye to reducing production and labor costs thereby gaining a decisive competitive advantage. Clearly, these investments have in turn fuelled the development of the logistics sector in those markets. Razzaque (1997) indicated that logistics is an important component of a country's economy since it affects productivity (and hence competitiveness), distribution efficiency, interest rates, energy availability and energy costs. With the rise of China and her attendant hunger for raw materials and her propensity to export finished goods in containers, other emerging markets, especially the non-landlocked ones, will also realize the importance of an emphasis on trade and logistics, and the volumes of their import and export cargo will inevitably expand.

Indeed, some scholars assert that port efficiency is an important criterion for a country in international competitiveness (Tongzon, 1989; Chin and Tongzon, 1998). Thus far, container port operations have attracted significant attention from academics and practitioners alike (Kim et al., 2003; Lee et al., 2007; Li et al., 2009; Parola and Sciomachen,

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2005; Rodríguez-Álvarez et al., 2007). According to UNCTAD (2007), the global containership fleet increased by 17 million dead weight tons or 15.5% y-o-y, with the high growth rate reflecting greater international trade in manufactured goods and increasing containerization. For this reason, improving port efficiency or productivity has become a critical yet challenging task in the development of many countries (Turner et al., 2004). As ports are an important link in the logistics chain, the level of port efficiency affects to a large extent a country's productivity and competitiveness. Countries need to focus on the factors that affect the efficiency of their ports and benchmark on the degree of efficiency, both between ports within a region and with the ports of other regions (González and Trujillo, 2008). However, few international studies have been conducted on the port industry in emerging markets either for the lack of data or interest.

Hence, spawned by the recent economic growth of emerging markets such as those of India and China, exploring issues relevant to the port sector of such markets is of considerable importance, despite the dearth of literature. This research thus seeks to evaluate the efficiency of container ports in emerging and advanced markets. We first review and discuss the container port efficiency of the various countries of interest. Next, we apply the DEA technique to measure the efficiency of container ports. Lastly, the paper analyzes the results, and presents conclusions and some suggestions for the port sector.

2. Measures of port efficiency

The methodologies employed in estimating container port efficiency include Stochastic Frontier Analysis (SFA) (Cullinane and Song, 2003; Cullinane et al., 2002; Estache et al., 2002; Liu, 1995), DEA (Barros and Athanassiou, 2004; Cullinane et al., 2005a; Kaisar et al., 2006; Roll and Hayuth, 1993; Valentine and Gray, 2001), multiple linear regression (Tongzon, 1995), Total Factor Productivity (TFP) (Estache et al., 2004; Cheon et al., 2010), and Free Disposal Hull (FDH) (Wang et al., 2003; Cullinane et al., 2005a).

González and Trujillo (2008) use a translog distance function to gauge if 10 Spanish ports improved their technical efficiency during three waves of reforms. The study not only found clear changes in the development of port activities, it also observed a substantial improvement in the use of technology in the case of Spain.

Liu (1995) used SFA to study ports in the UK, with data from 1983 to 1990 to compare the technical efficiency and evaluate the impact of privatization and nationalization on port operations efficiency. Estache et al. (2002) used three SFA models in their study (Cobb-Douglas, Translog – no technological change, and Translog – no technical inefficiency) to evaluate the technical and allocative efficiencies of 11 Mexican ports between 1996 and 1999. Cullinane et al. (2002) adopted stochastic frontier production models in their study, for three distributions (half-normal, exponential, and truncated normal) to compare the efficiency of 15 container ports and terminals in Asia between 1989 and 1999. Cullinane and Song (2003) also applied the same assumptions in their study to compare the productivity of two Korean container terminals and three UK container terminals between 1978 and 1996.

Later, Tongzon (1995) used multiple linear regression to build a model of port efficiency and estimated the relative efficiency of 23 international container ports. Recently, Estache et al. (2004) used the TFP Malmquist Index to evaluate the state of operations at 11 major Mexican ports from 1996 to 1999. Most recently, González and Trujillo (2009) systematized existing studies to assess the economic efficiency and productivity of the port industry. However, due to the organizational complexity that exists across multiple port activities, the paper only highlighted the efficiency of container ports for emerging and advanced markets.

On the DEA models to study the efficiency of container ports, Roll and Hayuth (1993) have used the CCR model, based on constant returns to scale, to evaluate and determine the efficiency of ports for advanced economies; and their work was treated as a theoretical exploration of applying DEA to the port sector rather than as an actual application since no data were collected or analyzed. The CCR model was later favored by Kaisar et al. (2006), Valentine and Gray (2001). Martinez-Budria et al. (1999) used the DEA-BCC model to evaluate 26 Spanish ports, collecting data from 1993 to 1997, to compare their relative efficiencies consequently dividing them into three tiers.

In addition, some studies have combined two or three methods, with the research becoming more complex and explicit. For instance, Itoh (2002) used the CCR, BCC models and the DEA Window analysis to evaluate the relative performance of eight international ports in Japan between 1990 and 1998. Cullinane et al. (2004) applied the DEA Window analysis to compare the world's top 30 leading container ports (ranked in 2001) to adduce relative efficiency over time. Further, Al-Eraqi et al. (2008) determined the relative efficiency of 22 cargo ports in the Middle East and Africa through a DEA cross-sectional data and Window analysis. An important advantage of such a window analysis is that it increases the discriminatory power of DEA by increasing the total number of decision making units (DMUs), i.e. the number of ports, providing results capable of tracking recent changes in performance and the stability of the port over time (see Charnes et al. (1994) for the details).

Andersen and Petersen (1993) have proposed the A&P model, capable of differentiating the relative efficiency levels of DMUs with efficiency ratings of one. In the evaluation of container port efficiency, Lin and Tseng (2007) applied the A&P model to discriminate among the major container ports in the Asia–Pacific that were rated as efficient under the DEA-CCR model. Similarly, Wu and Lin (2008) ranked the efficiency of container ports in India, the G7, and the BRIC nations, differentiating their relative strengths and weaknesses through the A&P model.

From the perspective of international container ports, So et al. (2007) applied the output-oriented CCR and BCC models to examine the efficiency of 19 major container ports in Northeast Asia including Korea, China, and Japan. As the facilities and scales of these container ports were similar, the selected DMUs were adequate for analysis. Tongzon (2001) chose the