Spatial distribution characteristic of Chinese airports: A spatial cost function approach

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1. Introduction

Airports located in specific locations serve China’s transportation network as feeders of a hub-and-spoke system and as origins or destinations of point-to-point services (Button, 2002). The airport network service contributes to China’s economic growth and regional development (Wells and Young, 2004). Research conducted on China’s airports has generally focused on efficiency and productivity, while neglecting the role of space in the study of airport activity (Fung, 2008; Fung et al., 2008a, 2008b; Fan et al., 2014). Therefore, the locations of airports and its spatial effects are needed to be included into consideration to study airport benchmarking and policy review (Lian and Ronnevik, 2010; Fröhlich and Niemeier, 2011; Fan et al., 2014; Pavlyuk, 2016). The present research aims at filling this gap and analyze Chinese airports using spatial models; a cost function is estimated for the period from 2002 to 2012 that takes into account the spatial effects measured by latitude and longitude of the airports analyzed.

The motivations behind the present research are the following. First, China is an extensive country, and airports are a core asset for connecting the country and regions; therefore, an understanding of the spatial distribution of airports around the country is important. As the connectivity of China’s airports is complementary rather than competitive in nature, establishing a balance of competition and cooperation (Derudder et al., 2010), it is important to understand the spatial correlations that may exist on airports (Miller, 1999). Second, China’s airports have recently undergone several reforms since Deng Xiaoping’s policy changes. In this context, an analysis of the cost of China’s airports, as well as of their observed spatial characteristics, is justified, as it may help clarify the role that transportation networks play in cost, and thus allow for analysis that proposes optimal cost controls. Third, built on the deregulation of China’s air transportation, the hub airports also faced increasing competition for hub passengers because of the adoption of hub-and-spoke models for organizing route structures (Button, 2002). This factor justifies the focus on cost efficiency and the adoption of spatial analysis to identify spatial correlations. Finally, while research has noted the significant effects of location on an airport’s performance or productivity, no study has used spatial models in its methodology. Rather, the existing literature mainly focuses on the technical efficiency or productivity of Chinese civil airports with traditional SFA (Stochastic Frontier Analysis), which ignore independence between observations. This paper is innovative and make use of the spatial models found in the SFA to examine the cost efficiency of Chinese airports.
The present research analyzes the cost functions of Chinese airports during the period from 2002 to 2012 using five alternative spatial models, which (to reiterate) no study on Chinese airports had done before. It also provides certain policy implications for improving cost efficiency that should be considered before a new round of construction of civil airports begins (Hyard, 2013). This research is of particular interest at this time (Chang et al., 2013; Fan et al., 2014; Jiang and Zhang, 2014; Wang et al., 2015).

The remainder of paper is organized as follows: Section 2 describes the background of Chinese civil airports; Section 3 surveys the literature on the topic; Section 4 presents the methodology framework and the data; Section 5 presents the results, and finally Section 6 presents the discussion and conclusion.

2. Background of Chinese civil airports

With the rapid development of China’s economy in the last three decades, more people and cargo than ever now moves from one place to another (see Fig. 1), causing China’s civil airports to become increasingly important in the national infrastructure. The number of civil airports has been doubled, increasing from 83 in 1987 to 180 in 2012 (See Fig. 1). However, the overall progress of civil airports in China may create some problems. According to the government reports, the majority of Chinese airports still lost money, the demand for airport services still outweighs supply, and many civil airports are overloaded at present (Wang et al., 2014). Therefore, more research is needed in order to study how to improve corporate governance. Using information derived from a number of sources, the study points to functional divisions among airports, both in terms of their geographical scale (e.g., national, regional and international airports) and their specific role in the airline network (e.g., origin/destination versus hub airports). Papathanodorou and Arvanitis (2009) explore the evolution of airport passenger traffic in Greece during the period from 1978 to 2006 and find that despite air transport liberalization, spatial concentration of traffic and asymmetry remains high and has not decreased significantly over time. Moreover, Greece is still short of traffic generated by low-cost carriers especially outside the main metropolitan airports, restricting the regional development. Martin and Voltes-Dorta (2009) analyze airline hubs in relation to spatial concentration indices and conclude that the spatial concentration does not explain by itself the main features of the network hubs; in other words, this study distinguishes between connection and concentration. More related to the present research, Novak et al. (2008) apply a spatial linear regression to predict outbound freight generation in the United States. Fu and Kim (2016) also complete similar work. Meanwhile, Pavlyuk (2016) pays attentions to the implication of spatial heterogeneity in European airports. In a word, from the existing research on airport efficiency or performance, the spatial factors are widely recognized in the airport industry and should be ignored in studies.

Until recent years, more research began to focus on the civil airports of China and their performance or productivity (Fung et al., 2008a, 2008b; Chi-Lok and Zhang, 2009; Chang et al., 2013; Fan et al., 2014; Jiang and Zhang, 2014; Wanke et al., 2015). Several studies have noticed the importance of locational or spatial effects on the performance or efficiency of airports (Chi-Lok and Zhang, 2009; Chang et al., 2013). They just introduced dummy variables or polytomous variables as spatial proxy, which can be considered as observed spatial heterogeneity (Pavlyuk, 2016). However, Barros (2008b) and Pavlyuk (2016) argue that the unobserved spatial heterogeneity is also essential for affecting airport performance. As we know, even the careful selection of these observed factors will still leave unobserved spatial heterogeneity out of a model. The spatial econometrics explicitly deals with spatial dependence and is able to fully take account of unobserved spatial heterogeneity (Pavlyuk, 2016). However, it is rarely applied to analyze the airports performance or efficiency.

Moreover, while much research has concentrated on the management of airport efficiency, no literature has analyzed the cost efficiency of Chinese airports with SFA (Stochastic Frontier Analysis) model. Fan et al. (2014) employs a directional distance function to evaluate the technical efficiency of twenty major Chinese airports during the period from 2006 to 2009 within a joint production framework of desirable and undesirable outputs (i.e., flight delays). Fung (2008), Chow and Fung (2009), Chi-Lok and Zhang (2008) and Zhang et al. (2012) also use the traditional DEA (Data Envelopment Analysis) method to estimate the technical efficiency of Chinese airports in different periods. They compare the difference in efficiency relative to the different characteristics of Chinese airports. However, comparing to the cost efficiency, the technical just takes account of the productivity ignoring the information of...
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