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Connectivity at Chinese airports: The evolution and drivers

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ABSTRACT

This study calculates the connectivity of 69 Chinese airports and identifies the underlying drivers of the variation in airport connectivity over a period 2005–2016. Our connectivity model incorporates multiple discount factors including capacity and velocity penalties to correct for the quality of a connection. We find that Chinese airports experienced a great increase in air connectivity over the study period. Beijing Capital, Shanghai Pudong and Guangzhou Baiyun are far ahead of other airports in terms of overall connectivity and especially so in terms of international connectivity. However, the growth of some tourism cities and small cities has been stagnant and they suffered losses of connectivity at times. Airport competition measured by HHI, average fare, investment in local city's fixed asset investment and airport facilities, macroeconomic conditions, and population are found to be closely associated with an airport's connectivity. We also find that the presence of low-cost carriers is conducive for air connectivity, while HSR has the effect of decreasing airport connectivity.

1. Introduction

Air transport has been an increasingly important transport means in China with the rapid increase in national income. In March 2017, the Civil Aviation Administration of China (CAAC) declared that 74 new airports would be built in the next few years, which will bring the number of civil airports to 260 by 2020, and to 370 by 2025. By the end of 2016, China had 218 certified civil airports, 216 of which were serviced by regular public transport (RPT) flights (CAAC, 2017). In 2016, there were 28 airports that handled more than 10 million passengers, and the passenger throughput of these 28 airports accounted for 79.1% of the nation's total passenger traffic. Beijing Capital International Airport handled about 90 million passengers while Shanghai's two airports processed more than 100 million. The passenger throughput at the airports of Beijing, Shanghai and Guangzhou accounted for 26.1% of the nation's air passenger traffic volume. The geographic distribution of the air passengers was very uneven: in 2016 domestic passengers flying out of and into the airports in East China made up 29% of the total passengers. Airports in Central and South China handled 23.8% of the total, followed by Southwest region's 16.9% and North China's 15.3%. The percentages of the passengers going through, departing and arriving at the airports in Northwest China, Northeast China, and Xinjiang were 6.2%, 6.1%, and 2.7%, respectively.

The benefits of RPT air services to local economy have been well understood by Chinese governments at all levels. A large amount of money has been poured into airport construction and aviation infrastructure upgrading across the country.

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Beijing has commenced the construction of its second civil airport.[1] Constructing the second airport has been the top agenda for Chengdu, Qingdao, Xiamen, and Dalian as well. Almost every local government has set aside a special fund to subsidise new air services and to enhance city connectivity, the lack of which could be a significant barrier to the movement of goods and people, and international trade (Brugnoli et al., 2016). Calatayud et al. (2016) note that improving connectivity is increasingly a topic at the centre of the international trade and transport policy agendas.

However, after an extensive survey, Calatayud et al. (2016) found that connectivity has various definitions and thus exhibits a variety of meanings in different academic fields. In transport economics, much literature defines connectivity based on infrastructure availability and capacity. The complex systems theory has been applied in these studies. For example, the airport network consists of a set of locations (airports, cities, regions, or countries) called nodes (or vertices), linked by flights connecting them named edges (Malighetti et al., 2016; Hossain and Alam, 2017). Based on this theory, Burghouwt and Redondi (2013) define connectivity as the degree to which nodes in a network are connected to each other.

Airports are usually compared and benchmarked in terms of the passenger and traffic as well as operation efficiency (e.g., Oum et al., 2003; Malighetti et al., 2009; Martini et al., 2013). Although these indicators are valuable, they do not directly give information about the level of air accessibility and the airports' competitive positon in the air transport networks (Burghouwt and Veldhuis, 2006; Burghouwt and Redondi, 2013). An appropriate connectivity measure is needed to assist policy makers and airport management to benchmark and monitor the network performance against that of other airports (Burghouwt and Redondi, 2013). Calatayud et al. (2016) note that different variables have been used to estimate connectivity in previous studies such as the number of direct and indirect connections between two airports, capacity of aircraft, minimum and maximum connecting times, average travel time, travel cost, and shortest path length, etc. A good summary of the commonly used connectivity models can be found in Burghouwt and Redondi (2013). They include the shortest path length accessibility model (Shaw, 1993; Shaw and Ivy, 1994; Malighetti et al., 2008), the quickest path length accessibility model (Paleari et al., 2010), the weighted number of connections model (Burghouwt and de Wit, 2005), and the NetScan connectivity unit model (Veldhuis, 1997; Burghouwt and Veldhuis, 2006; Veldhuis and Kroes, 2002; De Wit et al., 2009). An air freight connectivity model (NetCargo) based on the NetScan model was developed in Boonekamp and Burghouwt (2017).

The policy implications of connectivity have been well articulated in previous studies (Bowers et al., 2015). A large volume of literature has reported the causality relationship between transportation infrastructure and local economy (e.g., Li and Qi, 2016, and studies cited therein), and that air accessibility has a significant impact on GDP, employment, regional development, tourism, international trade and foreign direct investment (FDI) (e.g., Brueckner, 2003; Basile et al., 2006; Zhang, 2012, 2015; Banno and Redondi, 2014; Zhang and Findlay, 2014; Brugnoli et al., 2016). In particular, Blonigen and Cristea (2015) provide strong evidence that a 50% increase in an average city's air traffic growth could result in an additional 7.4% increase in real GDP using the US data. Baker et al. (2015) report significant bi-directional relationship between regional economic growth and regional air transport services using the Australian data.

There have been a number of studies examining airport connectivity in China (e.g., Li and Cai, 2004; Paleari et al., 2010; Lin, 2012; Wang et al., 2014; Wu and Dong, 2015; Zhu et al., 2017). For example, Wu and Dong (2015) examine the evolution of China's airport network during 1980–2000 s and found that Beijing, Shanghai and Guangzhou have played a central role in the network evolution process, while the connectivity and centrality of most provincial airport hubs still need to be strengthened. Wang et al. (2014) analyse the evolution process of the air transport network of China from 1930 to 2012 and report a six-stage evolvement: scattered development, trunk line connection, circular linkage, hub formation, a complex network structure and emerging multi-airport systems. Paleari et al. (2010) compare the airport networks of the US, Europe and China in terms of accessibility and shortest travel times. They report that the Chinese network has the highest speeds as a result of the small number of airports per inhabitant and high proportion of direct connections. However, studies on the drivers of connectivity, and especially those on Chinese airport connectivity remain sporadic. Using a comprehensive approach that considers both the quantity and quality elements of connectivity, this research contributes to the literature that investigates China's airport development by examining the evolution of, and determinants of, Chinse airport connectivity.

It should be noted that although there exist three types of connectivity, namely, direct connectivity, indirect connectivity and hub connectivity (De Wit et al., 2009), in China's domestic market major airlines have not developed a hub-and-spoke system yet (Zhang, 2010; Zhang and Zhang, 2016). The rapid growth of China's high-speed rail (HSR) networks has made indirect connections much less attractive. In fact, apart from a few provinces like Yunnan where the surface transport infrastructure is under-developed and thus the capital city is usually used as transit hub for passengers to fly to the tourism resorts in the province, most Chinese passengers tend to use direct flights for their domestic travel and it is also the local governments' goal to attract more direct air services when giving subsidisation to airlines.[2] Therefore, this research will only consider direct connections (including flights with one stopover but with the same flight number) given that they are the primary concern for both passengers and local governments.

The next section gives a description about the models used to calculate airport connectivity as well as the model used to investigate the drivers behind the changes in airport connectivity. Data sources will also be presented. The findings are reported and analysed in Section 3. Section 4 contains concluding remarks.

[1] Beijing actually has two airports at this moment: Beijing Capital and Nanyuan. However, Nanyuan is a military airport and is only used by China United Airlines, a subsidiary of China Eastern Airlines.

[2] We understand that major airlines are developing Beijing, Shanghai and Guangzhou as international transit hubs. But even for these cities, people seldom use them as a transit hub for domestic travel purposes.