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The effects of new international airports and air-freight integrator's hubs on the mobility of cities in urban hierarchies: A case study in East and Southeast Asia

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ABSTRACT

This paper examines international air traffic flows from, to and within East and Southeast Asia, and in turn the hub status of cities over the years from 1982 to 2012. Its focus of attention is the effects of new international airports and integrator's hubs on the mobility of cities in a region's urban hierarchy. The results reveal that Hong Kong, Shanghai, Guangzhou, Bangkok, Kuala Lumpur and Seoul are strengthening their positions as international air traffic hubs, all of which opened a new international airport. Meanwhile, three global air-freight integrators have constructed a global or regional hub in most of these cities. In contrast, Tokyo is downgraded from a top ranked global city during the period analyzed.

1. Introduction

Aviation market has drastically expanded over the past decades in Asia with strong economic growth and economic integration at both the global and regional levels. Passengers from, to and within Asia are expected to account for nearly half of global passenger traffic in the next 20 years, with an overall market size of 2.9 billion. Among the highlights is the expectation that traffic from, to and within China will account for 1.3 billion passengers, overtaking the US as the world's largest passenger market by 2030 (IATA, 2014a). This region will also lead the world in the growth of air cargo traffic. Domestic China and intra-Asia markets will expand at the annual growth rate of 6.7% and 6.5%, respectively, while Asia-North America and Asia-Europe markets will grow slightly faster than the world average growth rate (IATA, 2014b). In particular, international express market has been drastically growing. It continues to outpace the annual growth rate of international air cargo traffic, with its share from 4.1% in 1992 up to 17.0% in 2013 (Boeing, 2014).

Meanwhile, there are changes in hub roles as airlines shift toward mid-sized long-haul aircrafts, which are better suited to serving smaller cities (O'Connor and Fuellhart, 2015). These aircrafts can provide point-to-point links by-passing some hubs. That change may be facilitated by the construction of new airports in some cities. Asia has seen many examples of that, many of which are within the second ranked cities, positioned below the top ranked global cities. This can be seen in the opening of new international airports in the 1990's and 2000's in Shenzhen (1991), Osaka/Kansai (1994), Macau (1995), Kuala Lumpur (1998), Seoul/Incheon (2001), Guangzhou (2004), Nagoya/Chubu (2005), Tianjin (2005) and Bangkok/Suvarnabhumi (2006). The big hubs added new international airports in Hong Kong (1998) and Shanghai/Pudong (1999), while Tokyo/Narita, Tokyo/Haneda and Singapore/Changi responded by expanding their capacities, including new runways or terminals. Beijing and Ho Chi Minh City are scheduled to start a new international airport in 2019 and in 2023, respectively. Meanwhile, three global air-freight integrators, DHL, FedEx and UPS, have been developing their hub-and-spoke networks in this region by constructing global and regional hubs. Their Asian hubs are drastically changing the urban pattern of international air cargo transport within this region. Hence, there has been a major re-alignment in hub roles, providing the potential to change the hierarchical structure of hub cities.

This paper provides a contribution by showing the emerging global cities in East and Southeast Asia over the last thirty years with a focus on the second ranked cities. It employs a regression model incorporating a hub effect as an explanatory factor of its level of international air traffic. This will establish the strength of this factor in comparison with the broadly based influences of GDP per head and population. This model was developed by Matsumoto (2004, 2007), which confirmed the supremacy of Tokyo, Hong Kong and Singapore, using the data on international air passenger and cargo flows up to

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2000. The current paper explores the effects of new international airports and integrator's hubs on the mobility of cities in a region's urban hierarchy. The analysis will be carried out for 2012 and over the period from 1982 to 2012.

The remainder of this paper is organized as follows. The next section provides an overview of the literature on global urban hierarchies and world cities. In Section 3, a model is specified to explain international air traffic flows between cities, followed by a discussion of the results. Finally, the paper ends with a conclusion with future work in Section 4.

2. Literature review

To date, the issue of global urban hierarchies and world cities has been frequently discussed especially after the initial work of Friedmann (1986), mainly using two indexes: aviation networks (Smith and Timberlake, 1995; Taylor et al., 2007; Derudder et al., 2008; Grubesic et al., 2009; Lee, 2009) and corporate networks (Taylor et al., 2002; Alderson et al., 2010; Liu et al., 2014). These two criteria practically identify the same hierarchies of cities. Keeling (1995) underpinned that hierarchies of global cities in terms of international air traffic flows closely matched the location of headquarters of multi-national firms. Sassen (2012) showed that the connections between the operations of multinational firms and global advanced producer services (APS) together would influence air connections between cities. Liu et al. (2013) explored the co-evolution of the geographies of aviation and corporate networks and confirmed that cities with well-developed aviation networks attract more globalized business service firms, while globalized business service firms in turn stimulate the development of aviation networks.

Much attention has been focused on world cities, which are significant clusters of multi-national firms and global business service firms and so play a prominent role in international air traffic. Thus, in the analyses of Asian cities, Matsumoto (2004, 2007) confirmed the prominent roles of Tokyo, Hong Kong and Singapore, while Mahutga et al. (2010) found that the most upwardly mobile city between 1977 and 1995 was Hong Kong and also found that Shanghai and Beijing ascended to the first and second ranked positions between 1995 and 2005, respectively. However, O'Connor (2003) and Sismanidou et al. (2013) showed that international air passenger movements began to favor a group of second ranked cities between 1990 and 2000. Asian examples included Seoul and Osaka. O'Connor and Fuellhart (2013) also found a shift in favor of a group of next largest cities over the period from 2005 to 2010, identifying Mumbai and Guangzhou, in particular. As such, Asia is experiencing the dynamic change in a region's urban hierarchy. We can draw on other substantial studies that confirmed it (Douglass, 2000; Shin and Timberlake, 2000; Ng and Hills, 2003) and also studies focusing on individual world cities: Hong Kong (Wang and Cheng, 2010), Shanghai (Yusuf and Wu, 2002), Tokyo (Saito and Thornley, 2003), Seoul (Shin and Timberlake, 2006) and Taipei (Wang, 2003). Smith and Timberlake (2001) and Derudder et al. (2010) showed how connections between world cities changed over time.

3. Analyses of international air traffic flows

3.1. Model

A gravity model is employed to analyze international air traffic flows in this paper. The model is frequently used to determine the spatial orders or organization of air passenger and cargo flows (Harvey, 1951; Taaffe, 1962; Long, 1970; Wojahn, 2001; Grosche et al., 2007; Hwang and Shiao, 2011). The approach adopted here is a development of that used by Matsumoto (2004, 2007). These previous studies examined international air passenger and cargo flows within and among the Asian, European and American regions from the standpoint of global urban hierarchies and revealed the hub status of major cities worldwide for the period from 1982 to 1998 and to 2000, respectively. The results for Asia confirmed that Tokyo, Hong Kong and Singapore were positioned as key international air traffic hubs, and found that Hong Kong and Seoul experienced an extreme rise in their hub effects. Matsumoto et al. (2016) explored international air traffic connections, including business connectivity, alongside GDP per head, population and distance, into the model. The choice for using a gravity model for our goal could be justified because of the data availability and applicability on this scale and scope.

The present paper develops Matsumoto (2004, 2007) by: (1) focusing on East and Southeast Asia, which has experienced the most intense airport competition in the world. The significant growth of Chinese cities since 2000 will be embedded in the analyses; (2) using the extended data-set up to 2012. These studies haven't captured the effects of new international airports and integrator's hubs on the mobility of cities in a region's urban hierarchy after 2000. The changes in importance of the second ranked cities in terms of air transport will also be traced. Another improvement on data is the inclusion of much more observations of city-pairs; and (3) incorporating into the analyses all international air traffic flows from, to and within East and Southeast Asia. The previous studies analyzed international air traffic flows within and among regions separately. This change leads to the inclusion of international air traffic flows from/to East and Southeast Asia to/from other regions than Europe and America (the Middle East, Africa etc.).

The dependent variables are international air passenger and cargo flows between cities on the segment level (T). The explanatory variables include GDP per head (G), population (P) and distance (D). In addition, city-dummy variables (C) are embedded into the model to examine the hub status of cities (see Table 1 for a listing). The entry rule for introducing them is their rank as a global city classified above gamma minus by GaWC (2012) in this region (see Appendix A for the classification of cities in Asia by GaWC (2012)). Ho Chi Minh City, Hanoi, Shenzhen and Tianjin are exempt from this rule because no data on international air traffic flows has been reported. This makes a list of thirteen cities for this variable. We give a number of ‘e’ to city-dummy variables when either or both of cities in a city-pair correspond to one of these thirteen cities, so 0 value is given if neither are among them. The size of ‘e’ raised to the power of a city-dummy parameter gives an indication of its hub status, as it accounts for passenger or cargo movements above those accounted for by GDP per head, population and distance. For example, an effect of transferring passengers is included in this value. If one flies from Osaka to Ulan Bator via Seoul, two tickets are issued: Osaka to Seoul and Seoul to Ulan Bator. In this case, Seoul functions as the hub airport, and thus the value for Seoul becomes larger.

The structure of the model is as follows:

$$T_{ij} = A\frac{(G_iG_j)^{\alpha}(P_iP_j)^{\beta}\exp(\delta C_1)\exp(\varepsilon C_2)\exp(\zeta C_3)\cdots\exp(\xi C_{11})\exp(o C_{12})\exp(\pi C_{13})}{(D_{ij})^{\gamma}} \tag{1}$$

After transforming Eq. (1) into log form, ordinary least-squares (OLS) regression analysis is used.

Table 1
City-dummy variables.

C_1	C_2	C_3	C_4	C_5	C_6	C_7
Hong Kong	Singapore	Shanghai	Tokyo	Beijing	Kuala Lumpur	Seoul
C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	
Jakarta	Bangkok	Taipei	Guangzhou	Manila	Osaka	