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Analysing passenger network changes: The case of Hong Kong

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ABSTRACT

Passenger throughput at Hong Kong International Airport (HKIA) has shown steady growth since its opening. Various aspects relating to HKIA have been studied in prior literature. This paper investigated changes in HKIA’s passenger network for the period of 2001–2012 and used the gravity model to examine the key factors explaining its passenger traffic flows. The findings suggested that HKIA’s passenger network has changed significantly and expanded to many new different destinations. Two regions (East Asia and Southeast Asia) were the most important markets for HKIA, and most key destinations connected by Hong Kong showed healthy growth. Nine factors could explain passenger traffic flows between Hong Kong and its key destinations: Hong Kong GDP per capita, GDP per capita of destinations connected by HKIA, distance, airport hub status of the destination airport, tourist destinations connected by HKIA, numbers of passenger airlines in service, bilateral trade flows, speaking a common language and having strong cultural/colonial links with Hong Kong, and the route presence of Cathay Pacific.

1. Introduction

Hong Kong is one of the key international financial and banking centres worldwide and one of the main international hub airports in the Asia-Pacific region, as well as the gateway to the Pearl River Delta (PRD) in Mainland China (García-Herrero, 2011; Tsui et al., 2014). Hong Kong International Airport (HKIA) has maintained steady growth since its opening in July 1998, except for the periods covering the Asian economic crisis, the September 11 terrorist attacks in the United States (US), the outbreak of Severe Acute Respiratory Syndrome (SARS), and the global economic downturn (McKercher and Hui, 2004; Sadi and Henderson, 2000; Siu and Wong, 2004; Tsui et al., 2014; Tsui and Fung, 2015). These exogenous shocks caused significant declines in passenger traffic travelling through HKIA. In addition, HKIA faces fierce competition from nearby airports in the region, including sub-national competition from the other A5 Group airports in the Pearl-River Delta (PRD) Region, national competition from three major Chinese international hub airports (Beijing, Shanghai/Pudong, and Guangzhou Airports), and regional competition from the major Asian international gateway hub airports (Bangkok, Seoul/Incheon, Kuala Lumpur, Tokyo/Narita, Singapore, and Taipei/Taoyuan Airports) (Williams, 2006; Zhang, 2003; Zhang et al., 2004).

To date, a substantial body of literature has investigated various aspects relating to HKIA and Hong Kong's aviation sector such as tourist arrival demand and forecasting (Cheng, 2012; Cho, 2003; Song et al., 2003; Tsui et al., 2014), business travel (Tsui and Fung, 2015), air cargo hub status (Wang and Cheng, 2011; Zhang, 2003; Zhang et al., 2004), HKIA’s performance and service standards (Lam et al., 2003, 2009; Tam and Lam, 2004), HKIA’s network connectivity and competitiveness (Burghouwt et al., 2009; de Wit et al., 2009; Park, 2003), and the Hong Kong aviation sector's economic contributions (Fung et al., 2006; Yeung et al., 2010). The important points arising from these studies are as follows:

(1) Tourist arrivals and business visitors to Hong Kong have a significant impact on HKIA’s passenger throughput, and tourism is one of the key business activities facilitating the growth of Hong Kong’s aviation sector.

(2) HKIA is maintaining itself as the leading international air cargo hub airport worldwide; however, its long-term success will depend on the future development processes of other international air cargo hub airports in Mainland China and around the Asia-Pacific region.

(3) HKIA offers relatively good quality services to attract international travellers using Hong Kong as a stopover to their destinations.
(4) HKIA has built a strong and extensive flight network and connectivity for air travellers to different cities worldwide.

(5) Hong Kong’s aviation sector is a significant contributor in supporting the development of Hong Kong’s economy.

However, researchers have not paid much attention to the empirical assessment of HKIA’s passenger network and traffic flows; to our best knowledge, this empirical study is one of the first studies to investigate this issue. The knowledge gained about the factors explaining the changes in HKIA’s passenger traffic flows will assist policy makers in Hong Kong to maintain HKIA’s status as a key aviation hub in Asia. This study investigated these factors by using a gravity model.

The format of this paper is structured as follows: Section 2 analyses the changes in HKIA’s passenger network for the period of 2001–2012, along with the performance and contributions of Hong Kong-based carriers; Section 3 uses the gravity model to investigate the significant factors that influence HKIA’s passenger traffic flows; and Section 4 summarises what are believed to be the key results and highlights the key contributions and limitations of this study.

2. Passenger network changes in Hong Kong

The list of HKIA’s top 45 routes (direct routes) represented a share of at least 85% of HKIA’s total passenger traffic between 2001 and 2012 although air passenger traffic slipped from the peak of 91% in 2005 to 85% in 2012 (see Table 1). The decline suggests that HKIA’s flight network has expanded to new destinations recently, as HKIA’s passenger throughput also maintained healthy growth during the study period. Again, this indicates that the relative importance of the top 45 routes towards the growth of HKIA’s passenger throughput is diminishing. With regard to the total passenger numbers of HKIA’s top 45 routes, there was a 74% increase during the study period, equaling approximately 6% growth per annum. Among 11 regions, East Asia and Southeast Asia were the two largest regions served by HKIA, followed by Northeast Asia and North America.

East Asia decreased its share of HKIA’s passenger throughput from 35% in 2001 to 31% in 2012, but it was still the busiest region connected by HKIA over the years. In this region, Taipei/Taoyuan was the busiest route for HKIA over the years but showed a decline after 2005: passenger numbers fell from 6.56 million in 2005 to 6.06 million in 2012. This was as the result of the establishment of direct air links across the Taiwan Straits (Chang et al., 2011; Lau et al., 2012; Zhang et al., 2004; Tsui and Fung, 2015). In addition, HKIA’s connectivity to the two key Chinese hubs (Shanghai/Pudong and Beijing) remained robust. Shanghai/Pudong became the second busiest route for HKIA after 2005, but showed a 6% fall in passenger numbers between 2010 and 2012 due to the competition of Shanghai/Hongqiao. Another key Chinese hub airport (Guangzhou) exited the top 45 list in 2012. Fewer Chinese cities appear in the list—12 in 2001 and decreasing to seven Chinese routes in 2012.

Southeast Asia’s market share was relatively stable and maintained a level of 22–25% of HKIA’s passenger throughput throughout the study period, with this region’s total passenger numbers reaching 13.9 million in 2012. Bangkok, Manila, and Singapore were the most popular cities in the region over the years, having approximately 39%, 2%, and 20% growth in passenger numbers, respectively, between 2010 and 2012. Moreover, passenger numbers for Denpasar and Phuket (the tourist destinations) grew by approximately 61% and 73% between 2010 and 2012. Kota Kinabalu also joined the list in 2012.

Northeast Asia maintained more than 10% of HKIA’s passenger throughput and the total passenger numbers grew over the years. Seoul/Incheon overtook Tokyo/Narita in 2012, becoming the busiest route in the region served by HKIA, followed by Osaka. More importantly, Tokyo/Narita showed significantly negative growth (−33%) between 2010 and 2012 as Hong Kong carriers preferred Tokyo/Haneda (its convenient location being near the centre of Tokyo metropolitan) over Tokyo/Narita; this decline was the largest negative growth among HKIA’s top 45 destinations in recent years. Additionally, Busan (a tourist destination) appeared in the list in 2012.

South Asia has become another important market for HKIA mainly because of India’s large population. Its share of HKIA’s passenger throughput demonstrated remarkable growth prior to 2010 (having a fivefold increase from 0.4% in 2001 to 2% in 2010), but decreased slightly to 1.5% in 2012 (passenger traffic at Delhi and Mumbai dropped by 18% and 13% between 2010 and 2012). It should be noted that Mumbai has appeared in the list since 2005, representing recent rapidly growing air transport demand in the Indian market.

North America had approximately 5–6% of HKIA’s passenger throughput over the study period; this region maintained healthy growth over the years and the largest growth (23%) occurred between 2010 and 2012. Five cities (Los Angeles, New York/JFK, San Francisco, Toronto, and Vancouver) continuously appeared in the list. In 2012, San Francisco and New York/JFK replaced Vancouver’s leading position in the region, handling more than 0.80 and 0.59 million passengers, respectively. Also, Vancouver showed a decline (−0.4%) in air passenger volumes in 2012.

London/Heathrow was the only destination in Northern Europe. It had approximately 3–4% of HKIA’s total passenger volumes during the study period, and also increased by more than 57% between 2001 (0.95 million passengers) and 2012 (1.49 million passengers). It is worth noting that London/Heathrow was the seventh busiest route of HKIA across the study years, but suffered negative growth (−7%) in 2012. In addition, Western Europe’s market share fell slightly from 3.5% in 2001 to 2.6% in 2012; Frankfurt showed a −3% decline for the period of 2010–2012. Furthermore, Zurich dropped out the list after 2005, whereas three routes (Amsterdam, Frankfurt, and Paris) retained their significance as the most popular destinations in the region. For Southern Europe, Rome only appeared once in the list in 2005.

Furthermore, Australasia took a share of 3.6% of HKIA’s passenger throughput in 2001, and rapidly slipped from 4.6% in 2005 to 3.4% in 2012. Melbourne and Sydney were the two most important markets for HKIA in the region, followed by Auckland. Auckland experienced negative growth of −13% between 2010 and 2012, and Brisbane dropped out the list in 2012.

The Middle East’s market remained relatively small and continued to increase from 0.6% to 1.4% of HKIA’s passenger throughput during the study period. Dubai was the only destination in this region that appeared in the list over the years, and the recorded growth was more than fourfold between 2001 and 2012. Africa was always the smallest market connected by HKIA among all of the regions with minimal connectivity. Johannesburg showed significant growth prior to 2005 but air passenger traffic dropped by over 13% from 2010.

2.1. Performance and contributions of Hong Kong-based carriers

In 2012, the four Hong Kong-based carriers (Cathay Pacific Airways, Dragonair, Hong Kong Airlines, and Hong Kong Express Airways) largely dominated (50% or more) passenger traffic between Hong Kong and any of the 11 regions, except for the Middle East (see Fig. 1). In the previous years, they had control over just three regions in 2001 (Africa, Australasia, and the Middle East), seven

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1 The top six busiest routes for HKIA consist of Taipei/Taoyuan, Shanghai/Pudong, Beijing, Bangkok, Singapore, and Manila over the years (see Table 1).
Table 1
HKIA’s top 45 routes and shares of Hong Kong-based carriers (2001–2012).

| Route | 2001 | Cathay Pacific | Dragonair | Hong Kong Airlines | Hong Kong Express | Cathay Pacific | Dragonair | Hong Kong Airlines | Hong Kong Express | Cathay Pacific | Dragonair | Hong Kong Airlines | Hong Kong Express |
|-------|------|----------------|-----------|--------------------|------------------|----------------|-----------|--------------------|------------------|----------------|-----------|--------------------|------------------|
| Route total ('000) | Route total ('000) | Route total ('000) | Route total ('000) | Route total ('000) | Route total ('000) | Route total ('000) | Route total ('000) | Route total ('000) | Route total ('000) | Route total ('000) | Route total ('000) | Route total ('000) | Route total ('000) |
| East Asia | | | | | | | | | | | | | |
| Beijing | 1058 | 48.5% | 1734* [65.8%] | 2315 | 7.5% | 2315 | 7.5% | 2315 | 7.5% | 2748* [77.3%] | 2748* [77.3%] | 2748* [77.3%] | 2748* [77.3%] |
| Chengdu | 158* [54.4%] | 215* [54.4%] | 296 | 46.3% | 296 | 46.3% | 473* [81.7%] | 473* [81.7%] | 473* [81.7%] | 473* [81.7%] |
| Fuzhou | 285 | 24.9% | 295 | 18% | 317* [63.1%] | 317* [63.1%] | 378* [72%] | 378* [72%] | 378* [72%] | 378* [72%] |
| Guangzhou | 314 | | 357 | 0.8% | 214* [74.8%] | 214* [74.8%] | | | | |
| Guilin | 162* [53.1%] | 20% | | | | | | | | | | | |
| Haikou | 120 | | | | | | | | | | | | |
| Hangzhou | 254* [51.2%] | 421* [65.8%] | 584* [66.6%] | 156 | 40.7% | 156 | 40.7% | 156 | 40.7% | 649* [73.3%] | 649* [73.3%] | 649* [73.3%] | 649* [73.3%] |
| Kunming | 132 | 37.1% | 214 | 40.7% | 228* [41.7%] | 228* [41.7%] | 41% | 41% | 41% | 41% | 41% | 41% |
| Nanjing | 201 | 47.8% | 286 | 48.6% | 344* [73%] | 344* [73%] | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% |
| Ningbo | | | 249 | 22.1% | | | | | | | | | |
| Qingdao | 121 | 38% | 163 | 43.6% | | | | | | | | | |
| Shanghai/Hongqiao | 1724* [53.7%] | | | | | | | | | | | | |
| Shanghai/Pudong | 3014* [54.7%] | | | | | | | | | | | | |
| Xiamen | 286 | 34.6% | 307 | 16.3% | 535* [63.7%] | 535* [63.7%] | 6% | 6% | 6% | 6% | 6% | 6% |
| Kaohsiung | 1016* [50.7%] | 1065 | 47.8% | | | | | | | | | | |
| Taichung | | | 341 | | | | | | | | | | |
| Taipei/Taoyuan | 5428 | 39.4% | 6567 | 38% | 6105 | 41% | 8.6% | 8.6% | 8.6% | 8.6% | 8.6% | 8.6% |
| Subtotal | 11,259 | 19% | 23.4% | 14,887 | 20.5% | 27.8% | 0.1% | 0.1% | 35.6% | 1.5% | 1.5% | 1.5% |
| % of HKIA’s total | 35.2% | 27.4% | | | | | | | | 31.4% | | |
| Southeast Asia | | | | | | | | | | | | | |
| Bangkok | 2517 | 30.1% | 2643 | 31.5% | | | | | | | | | |
| Phuket | | | | | | | | | | | | | |
| Cebu | 144* [79.2%] | 184* [99.5%] | 289* [68.5%] | | | | | | | | | |
| Manila | 1376* [53.4%] | 1753* [61.2%] | 2318* [49.3%] | 1.9% | 3.5% | 2360* [51.1%] | 2.4% | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% |
| Denpasar | 218* [100%] | 195* [100%] | 351* [76.1%] | 0.9% | 16.8% | 365 | 43.9% | 41.2% | 41.2% | 41.2% | 41.2% | 41.2% | 41.2% |
| Jakarta | 316* [54.4%] | 461* [52.1%] | 758* [57.4%] | | | | | | | | | |
| Hanoi | 155 | 27.1% | 150 | 0.1% | 286* | 36.7% | 27.3% | | | | | | |
| Ho Chi Minh | 229* [61.6%] | 331* [59.8%] | 604* [59.7%] | | | | | | | | | |
| Kota Kinabalu | | | | | | | | | | | | | |
| Kuala Lumpur | 781 | 43.9% | 846* [53.3%] | | | | | | | | | |
| Penang | 1040 | 33.8% | 1453 | 39.2% | 1887 | 39.6% | 0.6% | 0.6% | 0.6% | 0.6% | 0.6% | 0.6% |
| Singapore | 1854 | 25.7% | 2196 | 40.6% | 2837 | 42.5% | | | | | | |
| Subtotal | 7590 | 39.5% | 8759 | 46.4% | 11,537 | 44.9% | 2.5% | 1.3% | 1.2% | 1.2% | 1.2% | 1.2% |
| % of HKIA’s total | 23.7% | 22% | | | | | | | | 24.9% | | |
| Northeast Asia | | | | | | | | | | | | | |
| Busan | 358 | | | | | | | | | | | | |
| Seoul/Gimpo | 1040 | 43.8% | 1453 | 39.2% | 1887 | 39.6% | 0.6% | 0.6% | 0.6% | 0.6% | 0.6% | 0.6% |
| Fukuoka | 163 | 47.2% | | | | | | | | | | | |
| Hokkaido | | | | | | | | | | | | | |
| Nagoya | 219* [100%] | 291* [99.7%] | 296* [100%] | | | | | | | | | |
| Osaka | 725 | 41.1% | 593* [57.7%] | 776* [64.9%] | 0.6% | 817* [70.5%] | 8% | | | | | |
| Tokyo/Haneda | | | | | | | | | | | | | |
| Tokyo/Narita | 1763 | 33.3% | 1986 | 34.9% | 1979 | 46.1% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% |
| Subtotal | 4268 | 35.9% | 4735 | 43.9% | 35.5% | 5168 | 47.7% | 0.1% | 0.1% | 0.1% | 5792 | 47.2% | 1.7% | 1.5% | 1.5% |
| % of HKIA’s total | 13.3% | 10.9% | | | | | | | | | | | |
| South Asia | | | | | | | | | | | | | |
| Delhi | 136 | 42.6% | 185* [73.5%] | 529 | 48.6% | 432* [54.2%] | | | | | | |
| Mumbai | 180* [55.6%] | 475 | 40% | 415 | 49.6% | | | | | | | |

(continued on next page)
| Route | 2001 | Cathay Pacific | Dragonair | 2005 | Cathay Pacific | Dragonair | 2010 | Cathay Pacific | Dragonair | 2012 | Cathay Pacific | Dragonair |
|-------|------|---------------|-----------|------|---------------|-----------|------|---------------|-----------|------|---------------|-----------|
|       | 000  | ('000)        | ('000)    |      | ('000)        | ('000)    |      | ('000)        | ('000)    |      | ('000)        | ('000)    |
| Subtotal | 136  | 42.6%         | 365       | 64.7%| 1004          | 44.5%     |      | 847           | 51.9%     |      | 51.9%         |           |
| % of HKIA's Total | 0.4% | 0.9%          | 2%        |      | 1.5%          |           |      | 1.5%          |           |      |               |           |
| North America |         |               |           |      |               |           |      |               |           |      |               |           |
| Chicago | 185  |               | 238       | 0.003%| 478* [100%]   |           | 389  | 44.5%         |           |      |               |           |
| Los Angeles | 472* | [72.5%] | 551* [92.7%] | 478* | [100%] | 531* [100%] | 591* [100%] | 800* [57.1%] |          | 511* [60.9%] | 559* [63.5%] | 800* [57.1%] |
| New York/JFK | 284 | 33.8% | 365* [70.7%] | 788* | [62.4%] | 381* | 33.8% | 471* [70.7%] | 531* [100%] | 591* [100%] | 800* [57.1%] | 559* [63.5%] |
| Toronto | 229* | [67.5%] | 352       | 48.9%| 462* [57.4%] |           |      | 511* [60.9%] |           |      | 559* [63.5%] |           |
| Vancouver | 547* | [52.1%] | 473* [66.8%] | 561* | [56.3%] | 559* | [63.5%] |           |           |      |               |           |
| Subtotal | 2162 | 47.1%         | 2515      | 60.1%| 2760          | 73.3%     |      | 3381          | 71.5%     |      |               |           |
| % of HKIA's total | 6.8% | 6.3%          |           |      | 5.5%          |           |      | 6.1%          |           |      |               |           |
| Western Europe |         |               |           |      |               |           |      |               |           |      |               |           |
| Amsterdam | 270  | 40.7%         | 348       | 48.3%| 430* [56.5%] |           | 395* | [52.2%] |           |      | 432* [53%] |           |
| Frankfurt | 456  | 48.9%         | 506* [56.3%] | 447* | [53.5%] | 603 | 44.9% | 623 | 49.9% |           |               |
| Paris | 381* | [57.2%] | 430* [57.4%] | 603 | 44.9% | 623 | 49.9% |               |               |      |               |           |
| Subtotal | 1236 | 46.6%         | 1284      | 54.5%| 1480          | 50.9%     |      | 1450          | 51.4%     |      |               |           |
| % of HKIA's total | 3.9% | 3.2%          |           |      | 3%            |           |      | 2.6%          |           |      |               |           |
| Southern Europe |         |               |           |      |               |           |      |               |           |      |               |           |
| Rome | 156* | [99.93%] |           |      | 156           |           |      |               |           |      |               |           |
| Subtotal | 156  |               |           |      | 156           |           |      |               |           |      |               |           |
| % of HKIA's total | 0.4% |               |           |      |               |           |      |               |           |      |               |           |
| Northern Europe |         |               |           |      |               |           |      |               |           |      |               |           |
| London/Heathrow | 947 | 47.2% | 1448      | 45.9%| 1603* [56.1%] |           | 1489* | [56.7%] |           |      | 1489* [56.7%] |           |
| Subtotal | 947  | 47.2%         | 1448      | 45.9%| 1603* [56.1%] |           |      | 1489* [56.7%] |           |      |               |           |
| % of HKIA's total | 3%   | 3.6%          |           |      | 3.2%          |           |      | 2.7%          |           |      |               |           |
| Australasia |         |               |           |      |               |           |      |               |           |      |               |           |
| Auckland | 222* | [63.5%] | 372* [70.4%] | 411* | [69.3%] | 387* | [69.3%] |           |               |      | 395* [52.2%] |           |
| Brisbane | 277  | 48.4%         | 421* [59.4%] | 505* | [78.2%] | 536* | [70.5%] |           |               |      | 559* [63.5%] |           |
| Sydney | 644  | 46.6%         | 811* [53.3%] | 983* | [56.5%] | 987* | [57%] |           |               |      | 987* [57%] |           |
| Subtotal | 1143 | 50.3%         | 1821      | 58.9%| 2176          | 64.8%     |      | 1880          | 61.6%     |      |               |           |
| % of HKIA's total | 3.6% | 4.6%          |           |      | 4.4%          |           |      | 3.4%          |           |      |               |           |
| The Middle East |         |               |           |      |               |           |      |               |           |      |               |           |
| Dubai | 195  | 48.7%         | 366* [50.5%] | 603 | 49.1% | 800 | 34.4% |           |               |      | 800 | 34.4% |           |
| Subtotal | 195  | 48.7%         | 366       | 50.5%| 603           | 49.1%     |      | 800           | 34.4%     |      |               |           |
| % of HKIA's total | 0.6% | 0.9%          |           |      | 1.2%          |           |      | 1.4%          |           |      |               |           |
| Africa |         |               |           |      |               |           |      |               |           |      |               |           |
| Johannesburg | 184* | [52.2%] | 342* [50.6%] | 357* | [53.8%] | 306* | [59.5%] |           |               |      | 309 | 59.5% |           |
| Subtotal | 184  | 52.2%         | 342       | 50.6%| 357           | 53.8%     |      | 309           | 59.5%     |      |               |           |
| % of HKIA's total | 0.6% | 0.9%          |           |      | 0.7%          |           |      | 0.6%          |           |      |               |           |
| Number of routes | 45  | 45            |           |      | 45            |           |      |               |           |      |               |           |
| Total (top 45 routes) | 29,120 | 36,266 | 42,858 | 47,291 | 56,622 |           |      |               |           |      |               |           |
| HKIA's total | 32,001 | 39,777 | 49,747 | 55,622 |           |      |               |           |      |               |           |
| % of HKIA's total | 91%  | 91.2%         |           |      | 86.2%         |           |      | 85%           |           |      |               |           |

Remarks: * indicates that 50% or more of the route traffic was controlled by Hong Kong-based carriers. [ ] denotes that 50% or more of the route traffic was controlled by Cathay Pacific. { } denotes that 50% or more of the route traffic was controlled by Dragonair. Data were taken from the Hong Kong Airport Authority.
regions in 2005 (Africa, Australasia, North America, South Asia, Southern Europe, the Middle East, and Western Europe), and six regions in 2010 (Africa, Australasia, East Asia, North America, Northern Europe, and Western Europe).

Hong Kong-based carriers also successfully controlled and dominated most trunk routes during the study period. Specifically, the total number of routes controlled by Hong Kong-based carriers has gradually increased over the years: 17 routes in 2001, 26 routes in 2005, 32 routes in 2010, and 33 routes in 2012 (see Table 1). Hong Kong-based carriers have also improved their performance against increasing competition from foreign airlines serving HKIA’s top 45 destinations; this is extremely important for HKIA, which needs strong support from local airlines to continuously improve its operations and enhance its role as one of the leading aviation hubs in the Asia-Pacific region and the primary gateway to Mainland China.

Hong Kong-based carriers have faced intensified competition in serving four destinations and have never captured more than 50% of passenger traffic in these areas (Bangkok, Dubai, Seoul/Incheon, and Singapore). They managed to control Tokyo/Narita and Taipei/Taoyuan after 2010, with nearly 57% and 53% of each route’s passenger traffic, respectively. However, the key tourist destinations (Phuket, Taichung, and Busan) have never been dominated by Hong Kong-based carriers over the years.

Specifically, Cathay Pacific had approximately 38–42% of the Taipei/Taoyuan route’s passenger traffic (HKIA’s busiest passenger route) over the years. After 2010, it also dominated six Southeast Asian destinations (Cebu, Ho Chi Minh, Jakarta, Kuala Lumpur, Manila, and Penang) and most North American routes. Furthermore, it had a relatively strong presence in Western Europe and Northern Europe (its share of London/Heathrow grew to 57% of passenger traffic in 2012). For Australasia, it dominated all of the key destinations within the region.

Its competitiveness in the Middle East market declined in 2012. This roused alarm bells for the Hong Kong Airport Authority and Cathay Pacific, suggesting that fewer international travellers actually selected HKIA as a stopover, or chose Cathay Pacific as the preferred airline for travelling to their destinations, mostly because of the rapid growth of Dubai International Airport in handling a significant amount of connecting passengers to different destinations worldwide, together with intensified competition from its hub-based airline (Emirates). Cathay Pacific also faced tough competition when operating in Northeast Asia, particularly the Korean routes. Its share of Seoul/Incheon traffic plummeted to 36% in 2012.

Cathay Pacific did not serve the lucrative Chinese routes prior to 2004 due to the policy of ‘one route, one airline’ implemented by the Hong Kong government in 1986 (Robinson, 2006); this route policy has played a crucial and positive role in maintaining healthy competition between two major Hong Kong-based carriers (Cathay Pacific and Dragonair) in the past. Taking advantage of the cancellation of this route policy, Cathay Pacific entered the Chinese market and provided scheduled flight services to Beijing, Shanghai/Pudong, and Xiamen, capturing significant passenger traffic shares of Beijing (12%) and Shanghai/Pudong (16%) in 2012, and Xiamen (5%) in 2010.4

2.1.1. Cathay Pacific Airways

Cathay Pacific is the flag-carrier of Hong Kong, which had at least 29% of HKIA’s passenger traffic between 2001 and 2012. It has been in a competitive position against other airlines in transporting international travellers across all the regions, expect for East Asia and the Middle East (see Table 1). Its performance has improved and it has gained effective control of more routes over the years: 23 routes in 2012. This shows Cathay Pacific’s hub dominance1 in serving the majority of HKIA’s key routes; its strong presence has greatly influenced HKIA’s connectivity, passenger throughput, and resulting revenue (Homsombat et al., 2011; Kahn, 1993).

2.1.2. Dragonair

Dragonair is a regional carrier and it is a wholly owned subsidiary of Cathay Pacific; both airlines collaborate in management and strategies in further developing their alliance-networks and

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1 Hub dominance indicates that Cathay Pacific accounts for 50% or more of passenger traffic of a route connected by HKIA.

4 Cathay Pacific ceased its passenger flight services to and from Xiamen in 2012.
Hong Kong as an international aviation hub in the Asia-Pacific region. Its flight network is oriented toward Asian countries (mainly Mainland China and Southeast Asia). Its share of HKIA’s passenger throughput increased from 8% in 2001 to 11% in 2012. Dragonair dominated five routes in 2012 (see Table 1). It has its strongest presence in serving East Asia (with a share of 23–36% of the region’s passenger traffic) among the four Hong Kong-based carriers. It also controlled HKIA’s Chinese destinations and Kaohsiung. However, its dominance began to weaken over recent years, declining from 36% in 2010 to 32% in 2012; this was largely because of two smaller local airlines (Hong Kong Airlines and Hong Kong Express Airways) gradually entering into Dragonair’s stronghold markets (the lucrative Chinese routes), together with more Chinese airlines (full service carriers and/or low-cost carriers) increasing their presence at HKIA to serve the major Chinese cities.

Dragonair also flew more international passengers and holidaymakers to and from destinations in Northeast Asia and Southeast Asia (e.g. Busan, Hanoi, Kota Kinabalu, Tokyo/Narita, and Phuket) after 2010. However, it had just a small share of the Southeast Asian market. Importantly, Dragonair’s contribution towards HKIA’s passenger throughput growth has largely resulted from its dominance in serving the Chinese cities, together with recently established routes in Southeast Asia and Northeast Asia.

2.1.3. Hong Kong Airlines

Hong Kong Airlines is a smaller full service carrier, offering scheduled passenger services to destinations in Mainland China, (Seoul/Incheon and Osaka) and in Southeast Asia (Kota Kinabalu). Hence, it played the smallest role in supporting HKIA’s passenger throughput growth with its smaller flight network serving only a few Asian countries. Even with such a minor contribution, its importance for the future growth of HKIA’s passenger throughput should not totally be ignored, as it has successfully converted its business model to the low-cost carrier (LCC) model in late 2013, aiming to target and explore Hong Kong’s low-cost market potential.

3. Estimation of Hong Kong International Airport’s passenger traffic flows

In the context of air transport, the gravity model is a causal method that has been widely applied to estimate airport demand or to explain a city-pair’s air traffic density. The gravity model is built upon the notion of a relationship between an airport’s demand and the casual factors. Prior studies relating to airport traffic demand or a city-pair’s air traffic density were examined to identify the potential variables for estimating HKIA’s passenger traffic flows (see Table 2). An attempt was also made to apply other principles (e.g. international trade flows) to the specification of gravity model, which assisted in developing other relevant explanatory variables for this study.

This study applied the gravity model to analyse passenger traffic flows between Hong Kong and its top 45 destinations for the period of 2001–2012. The gravity model (a reduced-form augmented gravity model) can be written as shown in Equation (1):

\[
\ln(\text{passenger numbers})_i,t = \alpha + \beta_1 \ln(\text{HKG GDP per capita})_i,t + \beta_2 \ln(\text{GDP per capita of the destination})_i,t + \beta_3 \ln(\text{distance})_i,t + \beta_4 \ln(\text{fuel prices})_i,t + \beta_5 \ln(\text{airport hub status of the destination})_i,t + \beta_6 \ln(\text{tourist city})_i,t + \beta_7 \ln(\text{numbers of passenger airlines in service})_i,t + \beta_8 \ln(\text{low cost carriers in operation})_i,t + \beta_9 \ln(\text{bilateral trade flows})_i,t + \beta_{10} \ln(\text{common language and cultural/colonial links})_i,t + \beta_{11} \ln(\text{travel visa})_i,t + \beta_{12} \ln(\text{Cathay Pacific presence})_i,t + \epsilon_i,t
\]

Asia, and Europe. Its share of HKIA’s passenger throughput showed fast-paced growth from 0.03% in 2005 to 3.9% in 2012. Such growth made an increasingly significant contribution to supporting the growth of HKIA’s passenger throughput recently. As of 2012, it had at least approximately 8% of East Asia’s passenger traffic and served most key routes in the region, except for Taichung and Xiamen. Also, it had a significant share of the four key East Asian destinations (Shanghai/Hongqiao, Beijing, Shanghai/Pudong, and Taipei/Taoyuan). Regarding Southeast Asia, it has relatively strong presence in the markets of Denpasar, Phuket, and Bangkok. It also offered flight services to Northeast Asia after 2010 and successfully captured 6% of Tokyo/Haneda’s passenger traffic in 2012. Thus, Hong Kong Airlines has facilitated HKIA’s passenger throughput growth with its rapidly expanding flight networks to Mainland China and Southeast Asia in recent years.

2.1.4. Hong Kong Express Airways

Hong Kong Express Airways is another smaller full service carrier, providing a non-overlapping flight network as its sister airline–Hong Kong Airlines (both airlines are operated by the same management team appointed by Hainan Airlines). It had less than 1% of HKIA’s passenger traffic between 2005 and 2012.

In 2012, its main destinations covered Beijing, Hangzhou and Taichung, as well as tapping into the major cities in Northeast Asia (Seoul/Incheon and Osaka) and in Southeast Asia (Kota Kinabalu). The gravity model was established to estimate the panel data involving the passenger traffic flows of HKIA’s top 45 routes during the period of 2001–2012 (a total of 12 years).

\[\text{HKG's gross domestic product (GDP) per capita: this represents Hong Kong's domestic economic activity. There is a strong mutual relationship between GDP per capita and the level of air passenger demand of an airport. More importantly, it is also considered to be the best variable to explain this particular relationship (Cline et al., 1998; Doganis, 2002; Hong Kong Census and Statistics Department, 2013; Matsumoto, 2004; 2007; Tsui et al., 2014).}\]
Table 2
Summary of variables used in the gravity model.

| Authors and date | Dependent variable | Explanatory variables |
|------------------|--------------------|-----------------------|
| Endo (2007)      | US imports and exports in passenger air service | GDP per capita, distance, language, size of domestic airline network, open skies agreement, language adjacency |
| Freund & Weinhold (2002) | US imports and exports | GDP, population, distance, common language, adjacency |
| Grosche et al. (2007) | City-pairs’ passenger volume | Distance, population, catchment, passenger volume |
| Grosso and Shepherd (2011) | Air cargo transport | Air liberalisation index (ALI), bilateral tariff, distance, border, common language, common coloniser, a coloniser relationship between two countries |
| Hazledine (2009) | Domestic and international air travel of Canadian passengers | Number of seats, business travellers, distance, population, incomes, language, intra-flight flights, flights to destinations within Canada, US, and elsewhere |
| Hwang and Shiao (2011) | Taiwan Taoyuan Airport’s air cargo demand | GDP per capita, population, distance, average freight cost of goods, scheduled cargo flight frequency, open skies agreements, colonial links |
| Khadaroo and Seetanah (2008) | Bilateral tourism flows (28 countries) | Tourist arrivals, income of origin, relative prices, distance, tourism infrastructure, population, command language, common border, proximity |
| Matsumoto (2004) | Air passenger and air cargo flows | GDP, population, distance, city-dummy variable |
| Matsumoto (2007) | Air traffic density of major cities | GDP, population, distance, city-dummy variable |
| Poole (2010) | International US trade flows | GDP per capita, distance, language, preferential trade agreements, trade sanction, travel visa policy, colonial links, common border |
| Pierrmartini and Rousova (2008) | Bilateral passenger traffic | Distance, border, colony, language, income, bilateral air service agreements, air service trade liberalisation |
| Strand (1999) | Norwegian air traffic volumes | Income, population, air travel time, surface travel time, flight frequency, fare |
| Yamaguchi (2008) | US trade flows | GDP per capita, population, distance, open skies agreements, airfares |
| Zhang and Findlay (2014) | Passenger traffic and tourist flows | GDP, distance, language, border, LCC, remoteness index, aviation policy index |
| Zhang and Zhen (2013) | Passenger traffic in the major Chinese cities | GDP, distance, fuel price, LCC |

- **GDP per capita of the destination**: this denotes GDP per capita of a city or destination connected to Hong Kong in which an airport is located.
- **Distance**: this represents the Great Circle distance between Hong Kong and a city or destination. In distance decay theory, the distance between two cities should have an inverse relationship with air passenger numbers between them (Matsumoto, 2004, 2007; McKercher and Lew, 2003; Pierrmartini and Rousova, 2008; Zhang and Findlay, 2014; Zhang and Zhen, 2013).
- **Fuel prices**: fuel prices affect air travel demand as air travellers appear to be very sensitive to increasing airfares. In general, fuel prices are negatively linked to air traffic flows, suggesting that higher aviation fuel prices would lead to higher airfare levels and have a negative impact on air traffic volumes (Tsui et al., 2014; Zhang and Zhen, 2013).
- **Airport hub status of the destination**: this dummy variable takes the value of 1 when an airport that connects to Hong Kong is an international hub airport, or it is a city that is a political centre or a major commercial city; 0 otherwise. An international hub airport can capture and transport larger amounts of airport traffic, as it possesses size and strategic location advantages; likewise, a political centre or a major commercial centre of an economy may also generate and concentrate a high level of air passenger travel with its strong political, economic and social status (Fung et al., 2008; Gillen and Lall, 1997; Williams, 2006; Zhang and Findlay, 2014).
- **Tourist city**: tourism has a close relationship with the aviation industry. This dummy variable takes the value of 1 when a city connected to Hong Kong is a tourist destination, which may attract a significant amount of leisure travellers, and 0 otherwise (Chi-Lok and Zhang, 2009).
- **Numbers of passenger airlines in service**: if there are more passenger airlines providing scheduled flight services at an airport, to a large extent, this may lead to higher airport passenger throughput due to the airport’s extensive flight network and connectivity to different destinations.
- **Low-cost carriers in operation**: Low-cost carriers (LCCs) can attract and transport a significant amount of leisure travellers (price-sensitive travellers) across borders, and they have been a major driver for the growth of airport demand in different countries worldwide (Barrett, 2004; Homombat et al., 2011; Zhang and Findlay, 2014; Zhang and Zhen, 2013). Therefore, the effect of LCCs upon passenger traffic flows between Hong Kong and its main destinations was considered in this study. This dummy variable takes the value of 1 when LCCs provide no-frills services to and from Hong Kong, and 0 otherwise.
- **Bilateral trade flows**: it is difficult to gather information on bilateral trade in goods between Hong Kong and its key trading markets by means of air transport. Therefore, air cargo volumes are used as the proxy to represent bilateral trade flows between Hong Kong and its trading partners. Larger bilateral trade flows between two cities or countries may directly relate to the increasing demand of business travel and international travel (Cristea, 2011; Kulendran and Wilson, 2000; Poole, 2010; Shan and Wilson, 2001; Tsui and Fung, 2015).
are expected to be positive (or positively associated with HKIA’s destinations for the period of 2001–2012).

The estimation results for the gravity model are reported in Table 3. Robust standard errors were calculated to take care of heteroskedasticity; t-values were generated accordingly. Pair-wise correlation between the explanatory variables is between −0.000 and 0.626 in the study, which suggested that the problem of multicollinearity did not exist. In addition, the Hausman Test suggested that the random-effect model is a more appropriate specification for analysing the panel data in this study (Baltagi, 2001). However the random-effect model with time effects was not estimated due to a lack of sufficient data.

The coefficients associated with all of the explanatory variables are expected to be positive (or positively associated with HKIA’s passenger traffic flow) during the estimation, except for distance, fuel prices, and travel visa. The variable ‘distance’ was found to have a significantly negative coefficient. This finding supports the notion of the distance decay theory in the gravity model (Grosso and Shepherd, 2011; Matsumoto, 2004, 2007; McKercher and Lew, 2003; Piermartini and Rousova, 2008; Zhang and Findlay, 2014), which claims that increasing bilateral travel distance between two destinations should have an inverse relationship with air passenger traffic and/or international travel flows. Unlike prior literature, the variable ‘fuel prices’ was not found to have a negative sign in the model and was statistically insignificant, which might suggest that fuel prices was not an important factor that adversely affected HKIA’s passenger traffic flows during the analysis period, while compared to the fuel price surge in 2008.7

Furthermore, the variable ‘travel visa’ was reported to have a negative but statistically insignificant coefficient in affecting HKIA’s passenger traffic flows. To a certain extent, this finding was in line with prior studies (Neumayer, 2010, 2011; Prideaux, 2005), which suggested that when governments impose travel visas and/or permits (acting as a travel barrier) for travelling by air for Hong Kong citizens and foreign nationals, this may jeopardise Hong Kong’s outbound and inbound tourism. Importantly, this particular situation pinpoints that continuous efforts are required from the Hong Kong government and policy makers to negotiate and increase numbers of visa-free entry agreements with foreign countries/territories.8 The ease or removal of visa control is believed to promote international tourism demand and flows between Hong Kong and its key tourist market sources (Han et al., 2011; Lee et al., 2010; Whyte, 2008). For example, the Individual Visit Scheme (IVS) between Hong Kong and cities in Guangdong (Mainland China) was initially signed in July 2003. This scheme seeks to simplify travel application for Chinese citizens visiting Hong Kong independently. Within the current 49 approved Chinese IVS cities, there are around 270 million Chinese residents who can apply for permission to travel to Hong Kong (Hong Kong Tourism Commission, 2014). Also, the total number of IVS visitors by air transport to Hong Kong increased from 0.92 million to 1.3 million between 2010 and 2012 (Hong Kong Tourism Board, 2012b).

The estimated values of the parameter of Hong Kong’s GDP per capita (one of the main variables of interest in the gravity model) was not found to have a negative sign in the model and was consistent with prior studies (Neumayer, 2010, 2011; Prideaux, 2005). In order to gain more insights about the significant relationship between Hong Kong’s GDP per capita and the share of Hong Kong residents by air transport (departures and arrivals) within HKIA’s passenger throughput, this situation was clearly shown by the increase in Hong Kong residents by air transport over the years – the total number of Hong Kong residents used air transport for their international trips grew from 5.01 million in 2001 to 6.22 million in 2012 (Hong Kong Tourism Board, 2012b). Also, GDP per capita of the destination (or a city) connected by Hong Kong was reported to have a positive and statistically significant coefficient in the model and was consistent with relevant data.

### Table 3: Estimation results for HKIA’s passenger traffic flows (2001–2012)

| Dependent variables – ln(air passenger numbers) | Coefficient | t-value |
|-----------------------------------------------|-------------|---------|
| Constant                                      | 0.537       | 0.156   |
| ln(HKIA’s GDP per capita)                     | 0.933***    | 2.758   |
| ln(GDP per capita of the destination)         | 0.108**     | 5.487   |
| ln(distance)                                  | −0.308***   | −9.548  |
| ln(fuel prices)                               | 0.040       | 0.456   |
| Airport hub status of the destination         | 0.716***    | 10.380  |
| Tourist city                                  | 0.197**     | 2.423   |
| Numbers of passenger airlines in service      | 0.209***    | 14.884  |
| Low-cost carriers in operation                | 0.015       | 0.188   |
| Bilateral trade flows                         | 0.174***    | 12.873  |
| Common language and cultural/colonial links   | 0.376***    | 4.853   |
| Travel visa                                  | −0.032      | −0.599  |
| Cathay Pacific presence                       | 0.332**     | 4.826   |
| Adj.-R²                                       | 0.741       | –       |
| Observations of routes                        | 672         | –       |

**Remarks:** *, **, and *** indicate that the explanatory variable is significant at the 0.10, 0.05, and 0.01 significance level, respectively.

7 The average annual crude oil prices was US$91.48 per barrel in 2008, compared with US$23 (2001), US$48.81 (2005), US$71.21 (2010), and US$84.46 (2012). Data relating to the average crude oil prices were obtained from the US Energy Information Administration and Illinois Oil & Gas Association.

8 In March 2013, Hong Kong government had signed visa-free access or visa-on-arrival agreements with 150 countries and/or territories worldwide (Hong Kong SAR Government, 2013).
particular airport or city. The coefficient suggested that if an airport connected by Hong Kong was an international aviation hub, or a political or commercial center, passenger numbers would be increased by 72% on average. Also, as expected, the variable ‘tourist city’ was found to be another significant factor in explaining HKIA’s passenger traffic flows, implying that more leisure travellers flew between Hong Kong and tourist destinations during the study period. For example, the popular tourist destinations of Denpasar, Phuket, and Taichung recorded 1.02%, 1.01%, and 1.50% of HKIA’s total passenger volumes in 2012, respectively. On average, the tourist destinations or cities served by Hong Kong would lead to an increase in HKIA’s passenger traffic volumes of 20%. It is worth noting that an increasing level of airport passenger demand or a rapid expansion of tourism (leisure travel) might be associated with both higher income levels and lower air transport costs (Chi-Lok and Zhang, 2009; Profiliidis, 2000; Tsui et al., 2014).

Considering airline operations at HKIA, the effect of ‘numbers of passenger airlines in service’ on HKIA’s passenger traffic flows is statistically significant at the 0.01 significance level, which suggested that more airlines provided scheduled passenger flight services to and from Hong Kong, as a consequence, helped increase air passenger traffic for that particular route. For example, the routes of Bangkok–Hong Kong and Singapore–Hong Kong had more than ten and six scheduled airlines in service, respectively, and both routes were often ranked among the top six of HKIA’s top 45 routes across the study years (see Table 1). In general, if more airlines serve a particular route, this may improve flight frequencies and offer more airline choices to air travellers and generate more seats, which may also reduce airfares and thus stimulate air travel demand for that city-pair. Additionally, the variable ‘low-cost carriers in operation’ was reported to be statistically insignificant, but was in line with Zhang and Findlay (2014), suggesting that LCCs did not have a significant impact on passenger traffic volumes between Hong Kong and its top 45 destinations during the study period. This is mainly due to LCC operations having only a small market share of HKIA’s top 45 routes.1 LCCs operating to and from Hong Kong just transported approximately 0.36 million (2002) and 3.51 million (2012) of air travellers between Hong Kong and its key Southeast Asian destinations such as Bangkok, Cebu, Kuala Lumpur, and Singapore. However, their potential impact on Hong Kong airport’s passenger traffic volumes and tourism sector (particularly that of price-sensitive tourists) should not be underestimated, particularly given the recent fast-paced growth of LCCs in the Hong Kong tourist market (in particular, Hong Kong Express Airways relaunched itself as a Hong Kong-based LCC in late 2013) and around the Asia-Pacific region, together with more Asian LCCs (e.g. AirAsia, Jeju Air, Jetstar Asia, Jin Air, Spring Airlines, and Tiger Airways) offering international services between Hong Kong and Asian destinations, as well as their ability to affect airfares charged by incumbent airlines (Fu et al., 2015; Zhang and Zhen, 2013). This could be important: the share of LCCs in HKIA’s passenger throughput has risen from 0.03% in 2001 to 6.31% in 2012 (Airport Authority Hong Kong, 2013). The variable ‘bilateral trade flows’ was also found to be statistically significant in the model with the 0.01 significance level. This indicated that bilateral trade flows (international trade) between Hong Kong and its key trading markets/partners had a significant impact on HKIA’s passenger traffic flows, given that Hong Kong was ranked as the world’s second busiest air cargo airport between 2001 and 2009, and further improved its performance to become the world’s busiest air cargo airport status afterwards.10 Given the notion that business travel is an output of international trade, and so having a significant amount of air cargo via HKIA might imply increasing international trade and a strong relationship between international business travel destined for Hong Kong (Cristea, 2011; Kulendran and Wilson, 2000; Poole, 2010; Shan and Wilson, 2001; Tsui and Fung, 2015).

The variable ‘language and cultural/colonial links’ was also found to be a statistically significant factor at the 0.01 significance level that affected HKIA’s passenger traffic flows. The coefficient implies that, on average, speaking a common language and having strong cultural and colonial links with Hong Kong (specifically Mainland China and the United Kingdom (UK))11 stimulated the growth in HKIA’s passenger numbers. Note that there are millions of Chinese and UK visitors flying to and from Hong Kong every year for visiting family and relatives (VFR) and for work and business purposes (Endo, 2007; Hwang and Shiao, 2011; Khadaroo and Seetanah, 2008; Piermartini and Roussova, 2008; Zhang and Findlay, 2014; Tsui and Fung, 2015). There were around 1.36 million in 2001 and 4.11 million in 2012 of Chinese and UK visitors, respectively, travelling to Hong Kong, equalling 21% and 36% of Hong Kong’s total visitor arrivals by air transport (Hong Kong Tourism Board, 2012a).

The variable ‘Cathay Pacific presence’ was also reported to be a statistically significant factor to explain HKIA’s passenger traffic flows in the model. The significance of Cathay Pacific presence at HKIA’s top 45 routes signalled its contribution towards the growth and change of passenger traffic flows between Hong Kong and its key overseas destinations. It should be noted that Cathay Pacific dominated 23 routes among HKIA’s top 45 routes in 2012 and took at least a 29% of HKIA’s passenger throughput between 2001 and 2012 (see Section 2.1).

4. Conclusion

This paper investigated HKIA’s passenger network and the key factors influencing its passenger traffic flows for the period of 2001–2012. HKIA’s top 45 routes took at least 85% of HKIA’s total passenger traffic, but showed a declining trend during the study period. The passenger flight network of HKIA has changed significantly, and has rapidly expanded to many new destinations worldwide. East Asia and Southeast Asia were the two most important regions for HKIA, having at least 31% and 22% of HKIA’s passenger throughput over the years. The top three busiest destinations of HKIA were Taipei/Taoyuan, Shanghai/Pudong, and Singapore during the study period. As of 2012, most destinations connected to HKIA showed growth, with the exceptions of Auckland, Delhi, Guangzhou, Johannesburg, London/Heathrow, Mumbai, Tokyo/Narita, Shanghai/Pudong, and Taipei/Taoyuan.

Hong Kong-based carriers improved their performance and successfully dominated most of HKIA’s top 45 routes, having dominated 32 routes in 2010 and 33 routes in 2012. This huk

9 The routes served by LCCs and the number of LCC operators providing scheduled passenger flight services to and from Hong Kong were: one route (one LCC) in 2001, four routes (four LCCs) in 2005, ten routes (nine LCCs) in 2010, and 15 routes (11 LCCs) in 2012.

10 HKIA overtook Memphis International Airport (US) in 2010 and become the world’s busiest air cargo airport handling 4.17 million tonnes of air cargo (Airport Council International, 2012).

11 Hong Kong was a British colony prior to 1997, and Hong Kong and the UK have still maintained a strong link of culture and economy after the changeover. Importantly, hundreds of thousands of UK citizens still work and live in Hong Kong and travel back to the UK to visit their family and relatives every year.
dominance by Hong Kong-based carriers is extremely important for HKIA in maintaining its status as one of the key aviation hubs in the Asia-Pacific region and the primary passenger gateway to Mainland China. However, four trunk routes (Bangkok, Dubai, Seoul/Incheon, and Singapore) have never been controlled by Hong Kong-based carriers. Among the four Hong Kong-based carriers, Cathay Pacific has played the most important role in supporting the growth of HKIA’s passenger throughput, with at least 30% of HKIA’s total passenger traffic the years, followed by Dragonair (8%). As of 2012, the importance of two smaller local airlines (Hong Kong Airlines and Hong Kong Express Airways) has been noticeable.

Nine significant factors were found to account for HKIA’s passenger traffic flows: (1) the increase in GDP per capita of Hong Kong had a positive impact; (2) GDP per capita of a destination connected to Hong Kong also had a positive impact; (3) longer travel distance between Hong Kong and a destination had a negative impact on HKIA’s passenger numbers; (4) an airport or a city connected by Hong Kong is an international hub airport or a major political/commercial centre is likely to generate more passenger traffic; (5) a tourist city or destination connected by Hong Kong is likely to generate more leisure travellers passing through HKIA; (6) more passenger airlines offering scheduled flight services at HKIA are likely to increase air passenger traffic via Hong Kong; (7) bilateral trade flows undertaken between Hong Kong and its key trading markets will generate more international business travel; (8) speaking a common language and having strong cultural/colonial links with Hong Kong (Mainland China and the UK) might strongly relate to a significant amount of vacation and VFR travellers passing through HKIA; and (9) the presence of Cathay Pacific among HKIA’s top 45 routes will have a significant impact on HKIA’s passenger traffic flows.

To our best knowledge, this is the first empirical study to investigate HKIA’s passenger traffic flows (using direct connectivity available at HKIA) based on detailed passenger numbers from HKIA’s top 45 routes. More importantly, this study also made two significant contributions to the literature on HKIA. Firstly, the findings of this study help shed some light on the commonly held belief that the hub dominance by Cathay Pacific (along with its subsidiary - Dragonair) has a significant impact on the growth of HKIA’s passenger throughput. The analysis and evaluation of Cathay Pacific’s contribution towards HKIA’s passenger throughput allow us to understand whether Hong Kong may maintain itself as one of the leading aviation hubs in the Asia-Pacific region and the primary gateway to Mainland China. In practice, it highlights that more vigilant efforts need to be undertaken by the Hong Kong government and policy makers to protect the economic benefits and financial viability of the Hong Kong-based carriers when negotiating aviation policies (e.g. bilateral air service agreements) and air access with foreign countries, particularly when dealing with more liberalised aviation regimes in the Asia-Pacific region. Secondly, the study highlighted the increasing presence of LCCs in the Hong Kong’s aviation market and, more importantly, suggested that their aggressive expansion plans will seriously affect the Hong Kong’s aviation market and, more importantly, suggested that their aggressive expansion plans will seriously affect the

passenger traffic flows with the dynamic panel data model. In addition, the changes in indirect connectivity (onward connections from HKIA’s direct destinations) and hub connectivity via HKIA have not been investigated in detail to show its entire flight network structure. A clear understanding of the growth rates of direct, indirect, and hub connectivity of HKIA may enhance our understanding of whether HKIA is still considered the main transfer airport in the Asia-Pacific region for international visitors (especially China’s international inbound and outbound travellers). For example, many Chinese outbound tourists will take advantage of HKIA’s extensive flight networks and choose Hong Kong as a stopover to travel to their overseas destinations (e.g. Phuket). With increasing amounts of outbound Chinese tourists, it is imperative to examine its impact on HKIA’s passenger throughput growth in future research.

Although the gravity model in this study had a statistically good fit, the estimation results did not explain some particular characteristics of passenger traffic flows of HKIA. The effects of global strategic airline alliance activities (e.g. Cathay Pacific is the member of Star Alliance) upon HKIA’s passenger network and traffic flows were not discussed in this study. This issue is meaningful for future investigations as global strategic airline alliance networks will bring different types of international passenger traffic via HKIA to their destinations. Furthermore, the reasons why passenger numbers for Dubai and London/Heathrow declined were not explained. In other words, the study has not considered the effect of airport competition upon HKIA’s passenger traffic volumes as HKIA always faces intense competition from other key international hubs in Asia and the Middle East to handle transfer traffic in the same catchment area. A route-based analysis for HKIA’s trunk routes would be meaningful to understand the causes of variations in passenger traffic volumes.

References

Airport Authority Hong Kong, 2013. Air Passenger Traffic. Retrieved 27 January, 2013 from http://www.hongkongairport.com.

Airport Council International, 2012. Annual Traffic Data. Retrieved 27 January, 2013 from http://www.aci.aero/Data-Centre/Annual-Traffic-Data/Cargo/2011-final.

Ballagi, L.A., 2001. Econometric Analysis of Panel Data, second ed. John Wiley & Sons, West Sussex.

Barrett, S., 2004. How do the demands for airport services differ between full-service carriers and low-cost carriers? J. Air Transp. Manag. 10 (1), 33–39.

Burgoughwout, C., de Wit, J., Veldhuis, J., Matsumoto, H., 2009. Air network performance and hub competitive position: evaluation of primary airports in East and South-East Asia. J. Airpt. Manag. 3 (4), 384–400.

Chang, Y.C., Hsu, C.J., Lin, J.R., 2011. A historic move – the opening of direct flights between Taiwan and China. J. Transp. Geogr. 19 (2), 234–244.

Cheng, K.M., 2012. Tourism demand in Hong Kong: incomes, prices, and visa restrictions. Curr. Issues Tour. 15 (3), 167–181.

Choi, L.K., Zhang, A., 2000. Effects of competition and policy changes on Chinese airport productivity: an empirical investigation. J. Air Transp. Manag. 15 (4), 166–174.

Cho, V.A., 2003. A comparison of three different approaches to tourist forecasting. Tour. Manag. 24 (3), 323–330.

Cline, R.C., Ruhl, T.A., Gosling, G.D., Gillen, D.W., 1998. Air transportation demand forecasts in emerging market economies: a case study of the Kyrgyz Republic in the former Soviet Union. J. Air Transp. Manag. 4 (1), 11–23.

Cristea, A.D., 2011. Buyer-seller relationships in international trade: evidence from U.S. States’ exports and business-class travel. J. Int. Econ. 84 (2), 207–220.

de Wit, J., Veldhuis, J., Burgoughwout, C., Matsumoto, H., 2009. Competitive position of primary airports in the Asia-Pacific Rim. Pac. Econ. Rev. 14 (5), 639–650.

Dogans, R., 2002. Flying off Course, third ed. Routledge, London.

Endo, N., 2007. International trade in air transport services: penetration of foreign airlines into Japan under the bilateral aviation policies. J. Air Transp. Manag. 13 (5), 285–292.

Ferreir, C., Wenshold, D., 2002. The internet and international trade in services. Am. Econ. Rev. 92 (2), 236–240.

Fu, X., Lei, Z., Wang, K., Yan, J., 2015. Low cost carriers competition and route entry in an emerging but regulated aviation market – the case of China. Transp. Res. Part A Policy Pract. 79, 3–16.

Fung, M.K.Y., Wan, K.K.H., Hui, Y.V., Law, J.S., 2008. Productivity changes in Chinese airports 1995–2004. Transp. Res. Part E 44 (3), 521–542.

Fung, M.K.Y., Law, J.S., Ng, L.W.K., 2006. Economic contribution to Hong Kong of the aviation sector: a value-added approach. Chin. Econ. 39 (6), 19–38.
Gillen, D., Lall, A., 1997. Developing measures of airport productivity and performance: an application of data envelopment analysis. Transp. Res. Part E 33 (4), 261–271.

Garcia-Herrero, A., 2011. Hong Kong as an international banking center: present and future. J. Asia Pac. Econ. 16 (3), 361–371.

Grosso, M.G., Shepherd, B., 2011. Air cargo transport in APEC. Regulation and effects on merchandise trade. J. Asian Econ. 22 (3), 203–212.

Große, T., Rothlauf, F., Heinzel, A., 2007. Gravity models for airline passenger volume estimation. J. Air Transp. Manag. 13 (4), 175–183.

Han, H., Lee, S., Lee, C.K., 2011. Extending the theory of planned behaviour: visa exemptions and the traveller decision-making process. Tour. Geogr. An Int. J. Tour. Space, Place Environ. 13 (1), 45–74.

Hazeldean, T., 2009. Border effects for domestic and international Canadian passengers. J. Air Transp. Manag. 15 (1), 7–13.

Homsombat, W., Lei, Z., Fu, X., 2011. Development status and prospects for aviation hubs – a comparative study of the major airports in South-East Asia. Singap. Econ. Rev. 56 (4), 573–591.

Hong Kong Census and Statistics Department, 2012. Gross Domestic Product (GDP), implicit price deflator of GDP, and per capita GDP. Retrieved 24 January, 2013 from http://www.censtatd.gov.hk/hkstat/sub/sp250.jsp?

ID=0&productType=4&tableID=0–300.

Hong Kong SAR Government, 2013. Visa-free Access for HK SAR Passports. Retrieved 15 June, 2014 from http://www.gov.hk/en/residents/immigration/traveldoc/hksarpassport/visafreeaccess.htm.

Hong Kong Tourism Board, 2012. Visitor Arrival Statistics. Retrieved 24 January, 2014 from http://www.parknet.hktb.com/apct/2014/visitor_statistics/download/2012_VISITORS_IND.html.

Hong Kong Tourism Board, 2012a. Visitor Arrival Statistics. Retrieved 24 January, 2014 from http://www.parknet.hktb.com/en/research_statistics/latest_statistics/index.html.

Hong Kong Tourism Board, 2012b. A Statistical Review of Hong Kong Tourism. Retrieved 24 January, 2014 from http://www.parknet.hktb.com/en/research_statistics/latest_statistics/index.html.

Hong Kong Tourism Board, 2013. Visitor Information: Individual Visitor Scheme. Retrieved 24 January, 2014 from http://www.tourism.gov.hk/english/visitors/visitors_ind.html.

Hwang, C.C., Shiao, G.C., 2011. Analyzing air cargo flows of international routes: an empirical study of Taiwan Taoyuan International Airport. J. Transp. Geogr. 19 (4), 738–744.

Kahn, A.E., 1993. The competitive consequences of hub dominance: a case study. Transp. Res. Part A 27 (6), 405–415.

Khalif, J., Seetanah, B., 2008. The role of transport infrastructure in international tourism development: a gravity model approach. Tour. Manag. 29 (5), 831–840.

Kulendran, N., Wilson, K., 2000. Is there a relationship between international trade and tourism? Appl. Econ. 32 (8), 1001–1009.

Kuo, Y.C., 2003. Testing the relationship between international air transport and tourist flows: some calculations. J. Air Transp. Manag. 10 (4), 239–247.

Lam, W.H.K., Lam, M.L., 2004. Air transport and tourist flows: some calculations. J. Air Transp. Manag. 10 (4), 239–247.

McKercher, B., Hui, E.L.L., 2004. Terrorism, economic uncertainty and outbound travel from Hong Kong. J. Travel & Tour. Mark. 15 (2–3), 99–115.

McKercher, B., Lew, A.A., 2003. Distance decay and the impact of effective tourism exclusion zones on international travel flows. J. Travel Res. 42 (2), 159–165.

Neumayer, E., 2010. Visa restrictions and bilateral travel. Prof. Geogr. 62 (2), 171–181.

Neumayer, E., 2011. On the detrimental impact of visa restrictions on bilateral trade and foreign direct investment. Appl. Geogr. 31 (3), 901–907.

Park, Y., 2003. An analysis for the competitive strength of Asian major airports. J. Air Transp. Manag. 9 (6), 353–360.

Poole, J., 2010. Business Travel as an Input to International Trade. The University of California Press, Santa Cruz.

Prideaux, B., 2005. Factors affecting bilateral tourism flows. Ann. Tour. Res. 32 (3), 780–801.

Profilelis, V.A., 2000. Econometric and fuzzy models for the forecast of demand in the airport of Rhodes. J. Air Transp. Manag. 6 (2), 92–100.

Piermartini, R., Rousová, L., 2008. Liberalisation of Air Transport Services and Passenger Traffic. WTO Staff Working Paper, ERSD-2008-06. WTO, Geneva.

Robinson, A., 2006. The Future of Hong Kong as a Global Aviation Hub. Retrieved 26 January, 2014 from http://www.simairline.net/bios/hong_kong.pdf.

Sadi, M.A., Henderson, J.C., 2000. The Asian economic crisis and the aviation industry: Impacts and response. Transp. Rev. A Transnatl. Transdiscipl. J. 20 (3), 347–367.

Shan, J., Wilson, E., 2001. Causality between trade and tourism: empirical evidence from China. Appl. Econ. Lett. 8 (4), 279–283.

Siu, A., Wong, Y.C.R., 2004. Economic impact of SARS: the case of Hong Kong. Asian Econ. Pap. 3 (1), 62–83.

Song, H., Wong, K.K.F., Chon, K.K.S., 2003. Modelling and forecasting the demand for Hong Kong tourism. Int. J. Hosp. Manag. 22 (4), 435–451.

Strand, S., 1999. Airport-specific transport forecasts: the resultant of local and non-local forces. J. Transp. Geogr. 7 (1), 17–30.

Tam, M.L., Lam, W.H.K., 2004. Determination of service levels for passenger orientation in Hong Kong International Airport. J. Air Transp. Manag. 10 (3), 181–189.

Tsui, W.H.K., Balli, H.O., Gilbery, A., Gow, H., 2014. Forecasting of Hong Kong airport’s passenger throughput. Tour. Manag. 42, 62–76.

Tsui, W.H.K., Fung, M.K.Y., 2015. Causality between business travel and trade volumes: empirical evidence from Hong Kong. Tour. Manag. 52, 395–404.

Wang, J.J., Cheng, M.C., 2011. From a hub port city to a global supply chain management centre: a case study of Hong Kong. J. Transp. Geogr. 18 (1), 104–115.

Whyte, B., 2008. Visa-free travel privileges: an explanatory geographical analysis. Tour. Geogr. An Int. J. Tour. Space, Place Environ. 10 (2), 127–149.

Williams, A., 2006. Developing Strategies for the Modern International Airport: East Asia and beyond. Ashgate Publisher Ltd, Farnham.

Yamaguchi, K., 2008. International trade and air cargo: analysis of US export and air transport policy. Transp. Res. Part F 44 (4), 653–663.

Yeung, J.H.Y., Cheung, W., Fung, M.K.Y., Zhao, X., Zhang, M., 2010. The air cargo and express industry in Hong Kong: economic contribution and competitiveness. Int. J. Shipp. Transp. Logist. 2 (3), 321–345.

Zhang, A., 2003. Analysis of an international air-cargo hub: the case of Hong Kong. J. Air Transp. Manag. 9 (2), 123–128.

Zhang, A., Hui, G.W.L., Cheung, L.C., Hui, Y.V., 2004. Air Cargo in Mainland China and Hong Kong. Ashgate Publishing Limited, Aldershot.