



Hong Kong's aviation and tourism growth - An empirical investigation

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ABSTRACT

This study investigates the critical link between aviation and tourism growth in Hong Kong, with a focus on the identification of causal relationships between scheduled airline seat capacity and visitor arrivals. This is achieved through the cointegration analysis and Granger-causality test, using monthly data collected from Hong Kong's top 17 tourist source markets during 2008–2018. Our analysis finds clear evidence of an overall two-way causal relationship between airline scheduled capacity and tourist arrivals. The positive externalities between the two crucial sectors to the Hong Kong economy call for coordinated planning and policy design in the tourism and aviation sectors, and justify continued government support. On the other hand, market-specific features are evident in selected markets. Such heterogeneity is likely due to airline network effect and regulation in the international market. Therefore, direct subsidy is not always an efficient support measure. A combination of liberalization policy and industry supports are preferred in views of the benefits to be achieved for the two sectors and the Hong Kong economy.

1. Introduction

The relationship between air transport and tourism has been an important topic in both air transport and tourism literatures. Many studies found supporting evidence that air transport and tourism are mutually dependent (Duval, 2013, 2020; Ivanova, 2017; Spasojevic et al., 2018). Tourism growth stimulates aviation operations, whereas transport services, notably aviation services, are clearly essential elements in the delivery of tourism (Lumsdon and Page, 2007). Hong Kong has many roles at the same time: an “international aviation hub”, a “regional and international gateway”, “the planet’s most popular city destination”, a “tourism destination”, and a “shopping paradise” (Lew and McKercher, 2002; McKercher, 2008; Homsombat et al., 2011; Tsui et al., 2018). Tourism is one of the pillar industries of Hong Kong¹ (Jin, 2011; Airport Authority Hong Kong, 2020; Tourism Commission, 2019). The city has broad tourist appeal, attracting more than 58.47 million and 65.15 million of overseas tourists in 2017 and 2018, respectively (Hong Kong Tourism Board, 2017, 2018).² In 2017, Hong Kong's tourism sector employed around 257,100 persons, accounting for about 7% of the city's total employment (Tourism Commission, 2019). Total

expenditure associated with inbound tourism (TEAIT) in 2017 and 2018 were approximately HK\$296.70 million and HK\$328.19 million, respectively (Hong Kong Tourism, 2017, 2018). The main arrival mode of Hong Kong's tourists is by land transport, which is the dominant transport mode for tourists from mainland China. However, regional and inter-continental travellers mostly arrive by air (Fung et al., 2006; International Air Transport Association, 2014). Visitor arrivals by air to Hong Kong in 2017 and 2018 were approximately 23.4% and 22.08% of its total visitor arrivals (Hong Kong Tourism Board, 2017, 2018).

Despite the great success in the past decades, Hong Kong is facing many challenges in the years to come, notably high infrastructure and input costs in both the aviation and tourism sectors, limited potential of further capacity expansion in the long term, competition from the established network airlines and aggressive low-cost carriers (LCCs) in increasingly liberalized international market (Fu et al., 2010, 2015; Wang et al., 2017, 2020). It is important for stakeholders to have a good understanding of the key demand drivers for aviation and tourism, and how these two sectors influence each other. Hong Kong's aviation and tourism have to be aligned on the basis of sustainable development, thus that their interdependence are exploited for the benefits of the city's

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¹ Hong Kong's four pillars are financial services, trading and logistics, tourism, and producer and professional services (Airport Authority Hong Kong, 2020).

² Visitor arrivals included visitors from mainland China.

economy. This calls for well-defined empirical investigation to identify and quantify such interactions.

As discussed in more details in the literature review section, many studies have examined the relationship between aviation and tourism, which offer rich insight and practical findings across many markets. However, some research gaps remain. Importantly, Pacheco and Fernandes (2017) concluded that prior studies showed that there is no uniform relationship between air transport and tourism, or air transport and economic development. The causal relationships behave differently across countries and regions, and empirical estimation results can vary depending on the indicators and variable used. Therefore, the interactive relationship between aviation and tourism in Hong Kong shall not be taken for granted. Indeed, one would expect significant heterogeneity across the aviation markets linking Hong Kong to the rest of the world. Therefore, it is important to conduct empirical investigation using real market data. This study aims to complement previous studies by examining whether there is a significant long-term and causal relationship between airline seat capacity and inbound visitor arrivals in Hong Kong. By using data collected from Hong Kong's top 17 tourist source markets during the period of 2008–2018, robust inference can be made with a representative extensive dataset. More importantly, in the literature there has been a trade-off in sample size vs. market heterogeneity. To increase sample size, it is customary to pool the data from many markets to increase estimation efficiency. On the other hand, this could introduce significant heterogeneity in the sample. Our study restricts to the key tourist source markets to one single city (i.e. Hong Kong), so that destination market characteristics remained the same for all observations. On the other hand, a dataset over extended period means there are sufficient variation in the data which improves estimation accuracy. Our study is also among the first to use airline scheduled capacity in causality analysis. Previous studies have used indicators such as dummy variables of direct service availability (Duval and Schiff, 2011), flight frequency (Koo et al., 2017), actual passenger volume (Álvarez-Díaz et al., 2019), manager's score of airport performance (Castillo-Manzano et al., 2011). Because airlines schedules are mostly planned and released for booking in advance, they are more directly determined by airlines, and less dynamic compared to actual traffic volume that is jointly determined by supply and demand. Therefore, our approach enhances the robustness of estimation with very recent data, allowing us to provide reliable and timely findings to stakeholders in Hong Kong. Our analysis finds clear evidence of an overall two-way causal relationship between airline scheduled capacity and tourist arrivals. The positive externalities between the two crucial sectors to the Hong Kong economy call for coordinated planning and policy design in the tourism and aviation sectors, and justify continued government support. On the other hand, market-specific features are evident in selected markets. Such heterogeneity is likely due to airline network effect and regulation in the international market. Therefore, direct subsidy is not always an efficient support measure. A combination of liberalization policy and industry supports are preferred in views of the benefits to be achieved for the two sectors and the Hong Kong economy. Because leisure tourists tend to be more price sensitive than business travellers, promoting the growth of the LCC sector may facilitate the growth and recovery of the tourism sector in Hong Kong, which has been badly hit amid the COVID-19 pandemic.

This paper is structured as follows: Section 2 reviews the key findings and research methods in the relevant literature. Section 3 provides an overview of scheduled airline seat capacity and visitor arrivals to Hong Kong from the sampled markets. Section 4 describes the methodology and reports estimation results. Section 5 discusses key findings and policy implications of this study. The last section summarises and explores possible future research opportunities.

2. Literature review

The relationship between aviation and tourism has been an

important topic in the aviation and tourism literature, and a few prior studies investigated Hong Kong's tourism demand in different aspects (e.g. Hanqin and Lam, 1999; Law, 2001; Hiemstra and Wong, 2002; Song et al., 2003; McKercher, 2008; Song et al., 2010; Lee, 2011a; 2011b; Ho and McKercher, 2014; Ahn and McKercher, 2015; Liu and McKercher, 2016; Tsui and Fung, 2016; Min Poon and McKercher, 2016; Tsui et al., 2018). It is generally acknowledged that the availability of air services is necessary for tourism activity, and the quality of aviation services stimulate tourism demand (e.g. Duval, 2013; 2020; Duval and Schiff, 2011; Ivanova, 2017; Koo et al., 2017; Spasojevic et al., 2018). These prior studies suggested the theoretical rationales of the causal connection between air transport and tourism. That is, aviation provides the essential accessibility to tourism market and services, and thus the availability and quality of aviation services contribute significantly to the development in the tourism sector. Such a relationship is evident in geographically isolated markets such as New Zealand and Australia, where aviation is effectively the only viable transport mode for overseas visitors. In particular, Duval and Schiff (2011) is one of the few empirical studies on the impact of direct air services on tourist arrivals. The recent study of Koo et al. (2017) also examined the causal relationship between direct air services and tourism demand.

Granger-causality test has been extensively used for the identification of causality (Wooldridge, 2016), and has been adopted in the tourism investigations. Kulendran and Wilson (2000) found a positive relationship between international travel flows and international trade volume using the cointegration and Granger causality approaches. Pulina and Cortés-Jiménez (2010) examined the relationship of LCCs and tourism activity in Alghero (Italy) using Granger-causality test, and concluded that LCC services influenced both domestic and international tourism demand, albeit to differing degrees. Tsui and Fung (2016) analysed relationship between business travel and trade volumes between Hong Kong and its three key trading partners (i.e. Mainland China, Taiwan, and the US), and identified different patterns of casual relationships. Küçükönel and Sedefoğlu (2017) used panel Granger test to examine the causal relationships between air transport, tourism, employment rate and economic development for OECD countries. Results indicated that an uni-directional short-run causal relationship between economic growth, tourism, employment and air transport, and the aforementioned factors played important roles in the growth of air transport. More recently, Pisa (2018) investigated the causal relationship between air transport, tourism and economic growth in South Africa using cointegration, Granger-causality test and the vector auto-regressive model (VAR). No evidence of causality and long-run relationships could be identified between air transport and gross domestic product (GDP), or between GDP and tourism. Álvarez-Díaz et al. (2019) studied the causal relationship between LCC and international tourism demand for North Portugal and Galicia-Spain. They found that LCC passengers have a positive influence on the number of hotel nights spent by international guests.

In addition to studies on the causal relationship between air transport and tourism, many have used the Granger-causality test to examine the relationship between air transport and economic development in different markets such as Australia (Baker et al., 2015), Brazil (Fernandes and Pacheco, 2010; Pacheco and Fernandes, 2017), mainland China (Hu et al., 2015), India (Mishra et al., 2011), Korea (Seo et al., 2010), Nigeria (Saheed and Iluno, 2015), Pakistan (Mehmood and Kiani, 2013), Taiwan (Chang and Chang, 2009), the US (Chi, 2014), the Asia-Pacific region (Van De Vijver, Derudder & Witlox, 2014), and South Asia (Hakim and Merkert, 2016).³

Although these studies offered rich insight and practical findings in

³ It should be noted that methods other than Granger causality have been used in the literature too, such as production function (Yao et al., 2012), augmented gravity models (Brugnoli et al., 2018) and dynamic common correlated effects estimator (Fu et al., 2021).

selected markets, it is unclear to what extent the conclusions can be directly applied to Hong Kong. On the one hand, Hong Kong is one of well-established tourist destinations in the region. On the other hand, many tourists are from mainland China who have relied on ground transport. Business travel has always accounted for a very significant share of the city's aviation sector, with its local LCC development lagged behind compared to both developed and developing economies in the region (i.e. Singapore, Australia, Japan, Korea, Malaysia, and Philippines). In addition, since Hong Kong is well connected to many destinations, there must be significant heterogeneity across the routes. Therefore, it is important to conduct empirical investigation using real market data. This study also complements previous studies by using data collected from Hong Kong's top 17 tourist source markets, so that destination market characteristics remained the same for all observations. The following section outlines the data sources and the background of the aviation market in Hong Kong.

3. Overview of Hong Kong's airline seat capacity and visitor arrivals by air

We compiled data for Hong Kong's key 17 tourist source markets during the period of January 2008–June 2018 from the Hong Kong Tourism Board and the OAG database (Official Airline Guide, 2020).⁴ Available seat kilometre (ASK) represents the seat capacity scheduled by airlines, catering for air travel of different purposes. Visitor arrivals (tourist) represent the total number of visitor arrivals by air from a country (tourist source market) visiting Hong Kong, irrespective of purposes of visit (including business, vacation, visiting friends and relatives, en route and others). Table 1 and Fig. 1 provide descriptive statistics and time plots of available seat kilometres and visitor arrivals by air in logarithm form (i.e. $\ln(\text{ASKs})$ and $\ln(\text{Tourist})$, respectively). As shown in the charts in Fig. 1, both ASK and visitor arrivals for all markets were generally increasing during the sample period, although visitor arrivals from the UK and France presented a declining tendency and Germany presented a steady trend, respectively. ASK numbers experienced higher volatility, likely due to network effects. Scheduled seat capacities are used not only for passengers destined for Hong Kong, but also connecting passengers. For example, passengers may fly from Australia to London via Hong Kong. The consistent capacity increase between Hong Kong and Australia reflects such a network effect. On the other hand, increased capacity and flight frequency often lead to higher service quality to consumers in terms of reduced schedule delay, which further stimulate traffic demand and extending network effects (Brueckner and Flores-Fillol, 2007; Pai, 2010; Pitfield et al., 2010; Wang et al., 2014; Fu et al., 2019). It is also clear that despite the traffic reduction caused by the global financial crisis (GFC) in 2008/09, Hong Kong has not suffered major or long-lasting losses during our sample period prior to the COVID-19 pandemic (Tsui and Fung, 2016).

The total visitor arrivals to Hong Kong reached the record level of 1.29 million tourists in October 2017, and shortly after total ASK to Hong Kong reached a peak of 30.4 billion in January 2018. The markets included in our sample are Hong Kong's top tourism destinations, with their combined ASK and visitor arrivals accounted for 87.6% and 85.51% of Hong Kong's total volumes during the sample period, respectively. In most markets and also aggregation of all markets, the time series of $\ln(\text{ASK})$ appear to follow those of $\ln(\text{Tourist})$, which leads to a *priori* expectation that there is likely some causal relationship between air transport and tourism, although the cases for Australia, Japan, Philippines, Taiwan, and the UK do not seem to provide strong support.

Regarding monthly average $\ln(\text{ASK})$ of the sampled markets, the top

two markets were the US and Australia, both are long-haul markets. They accounted for 17.97% and 11.15% of Hong Kong's total scheduled ASKs during the study period. Mainland China and Japan are Hong Kong's top aviation markets. Despite their geographic proximity, the related ASKs were also quite high. They are followed by another three long-haul markets (in descending order, Canada, the UK and New Zealand), which accounted for between 5.25% and 4.35% of Hong Kong's total ASK. The five proximate and short-haul Asian markets' shares were between 4.04% and 2.48%, which were Singapore, Indonesia, Malaysia, Taiwan and South Korea. The three markets with least scheduled airline seat capacity were South Africa, France, and Philippines, with shares ranging from 2.30% to 1.17%.

In terms of average monthly visitor arrivals by air, the two largest markets were mainland China and Taiwan, due to geographic proximity and close economic and cultural ties. They accounted for 33.69% and 10.42% of the total volume, respectively. This is followed by a mix of both long distance and regional markets, including the US, Japan, South Korea, Philippines, Australia, the UK, and Singapore in descending order, with shares between 3.29% and 6.09%. Similar patterns had been identified earlier (see also McKercher, 2008), which remained stable for extended period of time. The following tourism markets for Hong Kong were Malaysia, Indonesia, Canada, and France, which contributed between 2.84% and 1.32% of the total visitor arrivals by air. Despite their sizable markets in terms of scheduled ASKs, the two long distance markets, New Zealand and South Africa, accounted for less than 1% of visitor arrivals by air.

Overall, the markets included in our sample accounted for more than 80% of Hong Kong's total scheduled airline seat capacity and visitor arrivals by air. Therefore, empirical results in our study will be representative and characterize the overall market conditions. On the other hand, we need to pay attention to possible heterogeneity across ASK and visitor arrival numbers. Decision makers of the Hong Kong government, airline management, airport authority, as well as tourism authority and operators need to develop a good understanding route-specific characteristics for the design of appropriate air transport and tourism policies.

4. Methodology and findings

This study uses a three-stage procedure to test the long-run relationship and causality between the time series of $\ln(\text{ASK})$ and $\ln(\text{Tourist})$ as follows: Stage 1: test the order of integration of $\ln(\text{ASK})$ and $\ln(\text{Tourist})$ with the Augmented Dicky-Fuller (ADF) and Phillips-Perron (PP) unit root tests. Stage 2: test the existence of cointegration (a long-run relationship) between $\ln(\text{ASK})$ and $\ln(\text{Tourist})$. Stage 3: construct Granger causality tests where $\ln(\text{ASK})$ and $\ln(\text{Tourist})$ were cointegrated. The detailed analysis results are summarized as follows.

• Stage 1: Unit root tests

Cointegration between the two time series variables implies a long-run relationship (Granger, 1981; Kulendran and Wilson, 2000; Khan et al., 2005; Oh, 2005). To estimate the cointegration of $\ln(\text{ASK})$ and $\ln(\text{Tourist})$ in this study, these two time series variables need to be stationary so as to avoid the problem of spurious correlation (Tsui and Fung, 2016). The ADF and PP unit root tests were used to test the stationarity of $\ln(\text{ASK})$ and $\ln(\text{Tourist})$ being investigated (Dickey and Fuller, 1976; Phillips and Perron, 1988; Wooldridge, 2016) (see Equation (1)). Table 2 shows the unit root test results of $\ln(\text{ASK})$ and $\ln(\text{Tourist})$, and the results indicated that these two time series variables of all the sampled markets are stationary, which is at the 0.05 significance level and can be regarded as cointegration of order I(1).

$$\Delta x_t = \alpha + \beta x_{t-1} + \sum_{i=1}^k \delta \Delta x_{t-i} + \mu_t \quad (1)$$

where x denotes the level of the variables of interest ($\ln(\text{ASK})$ or \ln

⁴ The sampled 17 key tourist source markets are Hong Kong's key inbound tourist source markets that have already established stable direct flight services for tourists and passengers travelling to Hong Kong. The tourism data are reported by the Hong Kong Tourism Board and publicly available.

Table 1
Descriptive statistics for Hong Kong's key tourist source markets (January 2008–June 2018).

	ASK (million)	Visitor arrivals by air (number)	ASK (million)	Visitor arrivals by air (number)	ASK (million)	Visitor arrivals by air (number)	ASK (million)	Visitor arrivals by air (number)	ASK (million)	Visitor arrivals by air (number)	ASK (million)	Visitor arrivals by air (number)
	The US		Canada		The UK		Germany		France		South Africa	
Maximum	4886.87	82,305	1615.53	27,664	1245.69	54,360	868.24	19,063	634.50	17,818	596.02	6395
Minimum	2242.12	39,031	769.28	13,096	621.97	21,716	389.33	8791	258.96	9527	334.45	1645
Mean	3652.23	59,480	1067.50	18,486	898.22	32,188	674.00	12,728	438.78	12,922	470.95	3936
Standard deviation	661.54	8548.7	210.99	3252.4	143.80	6340.3	92.42	2628.4	92.44	2074.8	76.56	1046.4
No. of months	126	126	126	126	126	126	126	126	126	126	126	126
	Australia		New Zealand		Japan		South Korea		Indonesia		Malaysia	
Maximum	4713.82	46,639	2210.56	33,589	2445.33	100,314	855.05	97,345	868.97	40,528	787.10	55,647
Minimum	1082.46	18,168	468.90	2935	657.45	37,462	306.05	20,312	338.25	7877	392.46	12,191
Mean	2267.18	34,907	884.72	6418	1368.44	58,843	503.83	52,566	582.01	21,629	559.11	27,729
Standard deviation	954.18	5711.8	340.24	2751.6	573.10	10,387.3	156.86	14864.6	147.78	7523.9	88.47	9245.0
No. of months	126	126	126	126	126	126	126	126	126	126	126	126
	Philippines		Singapore		Thailand		Taiwan		Mainland China		All markets	
Maximum	375.32	71,225	1103.33	67,444	1218.04	55,802	694.69	125,458	2503.34	619,029	30,431.73	1,288,583
Minimum	162.33	21,148	483.82	15,628	399.38	9622	317.17	77,762	1238.20	106,159	13,124.77	567,040
Mean	237.47	40,826	821.57	32,173	741.46	27,734	527.57	101,835	2003.66	329,083	20,324.52	976,873
Standard deviation	63.09	11,099.2	182.42	11,125.8	270.55	9501.2	138.19	10,871.7	290.06	114,457.1	4690.61	161,259.2
No. of months	126	126	126	126	126	126	126	126	126	126	126	126

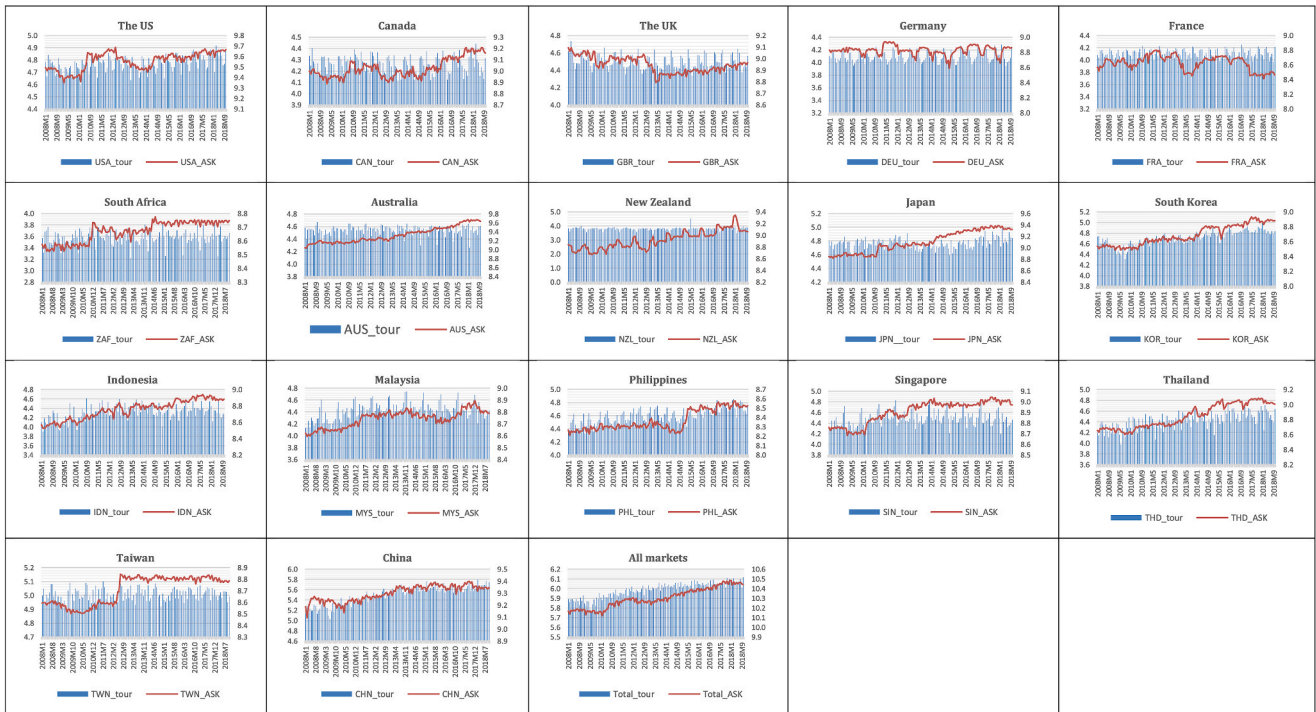


Fig. 1. Time plots of ln(ASK) and ln(Tourist) by air of Hong Kong's key tourist source markets (January 2008–June 2018).

(Tourist)), t denotes time period, α is a constant, β is the coefficient and μ_i is the error term, respectively.

• Stage 2: Cointegration test

This stage tests the existence of cointegration (a long-run relationship) between ln(ASK) and ln(Tourist). Following the approach of Engle and Granger (1987), for ln(ASK) and ln(Tourist) to be cointegrated, both time series variables need to be integrated of the same order, e.g. I(1). The order of cointegration is determined by the ADF and PP unit root tests as discussed above. Investigating cointegration between ln(ASK) and ln(Tourist) in this study, the ordinary least square (OLS) model was estimated for both time series variables of all the sampled markets, and their residuals were tested for stationarity based on the ADF and PP tests (see Equations (2) and (3)). Tables 3–5 present three different scenarios (without constant, with constant only, and with constant and trend), which suggest a long-run relationship between ln(ASK) and ln(Tourist) for most of the sampled markets at the 0.10 significance level or above, except for Australia and Taiwan. Table 6 summarises the identified long-run relationship between ln(ASK) and ln(Tourist) for Hong Kong's key 17 tourist source markets. Overall, the cointegration tests in this study lent support for the proposition that there is a long-run relationship between air transport and tourism in Hong Kong.

$$\ln(\text{ASK})_t = \alpha_0 + \alpha_1 \ln(\text{Tourist})_{t-1} + \mu_t \tag{2}$$

$$\ln(\text{Tourist})_t = \beta_0 + \beta_1 \ln(\text{ASK})_{t-1} + \varepsilon_t \tag{3}$$

where α and β are the coefficients, t denotes time period, μ_t and ε_t are the error terms, respectively.

• Stage 3: Granger causality test

Granger (1988) suggested that if two time series variables are cointegrated, then there must be Granger causation in at least one direction. Cointegration between ln(ASK) and ln(Tourist) in Stage 2 implies long-term relationship but does not indicate the direction(s) of the causal relationship (Kulendran and Wilson, 2000). Following Granger

(1988), Kulendran and Wilson (2000), Khan et al. (2005), and Tsui and Fung (2016), the Granger-causality test are used to investigate whether uni-directional (one-way) or bi-directional (two-way) Granger causation can be identified between ln(ASK) and ln(Tourist) in this study. The logic in conducting the Granger-causality test is that prior literature provided evidence of different Granger causality directions between aviation and tourism/economic development. For example, empirical findings have suggested inter-linkage between air transport and tourism (Duval, 2013; Spasojevic et al., 2018), a bi-directional Granger causality between international travel and international trade (Shan and Wilson, 2001; Tsui and Fung, 2016), and an uni-directional Granger causality from tourism and economic growth to air transport (Fernandes and Pacheco, 2010; Küçükönel and Sedefoğlu, 2017). During the Granger-causality test, the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) were used to select for the optimal lag lengths for both ln(ASK) and ln(Tourist). The optimum lag used for the Granger-causality test were verified and checked by lags 12, 18 and 24, respectively. In examining the evidence of the direction(s) of Granger causation between ln(ASK) and ln(Tourist), the following hypotheses were established and tested with significance level chosen at 0.10 (see Equations (4) and (5)). For example, a rejection of the null hypothesis in Equation (4), suggests that ln(ASK) (scheduled airline seat capacity) does not Granger-cause ln(Tourist) (visitor arrivals by air) for a market.

H_0 : testing ln(ASK) does not Granger-cause ln(Tourist) for a market:

$$H_0 : \alpha_{21} = \alpha_{22} \dots = \alpha_n = 0 \tag{4}$$

H_0 : testing ln(Tourist) does not Granger-cause ln(ASK) for a market:

$$H_0 : \beta_{21} = \beta_{22} \dots = \beta_n = 0 \tag{5}$$

Table 7 reports the results of Granger-causality test for all of the sampled markets being studied, and Table 8 summarises the directions of Granger-causation relationship, respectively. The results indicated that the rejection of the null hypothesis for eight markets (the US, the UK, Germany, South Korea, Indonesia, Philippines, Singapore, and mainland China), suggesting that scheduled airline seat capacity did Granger-cause (or increase) the number of tourists flying to Hong Kong

Table 2
ADF and PP unit root tests for the time series variables.

Countries	Unit root tests	ln(ASK)			ln(Tourist)		
		ln(ASK)	Δ ln(ASK)	Integration order	ln(Tourist)	Δ ln(Tourist)	Integration order
The US	ADF	0.881	-2.9935**	I(1)	1.651	-3.691***	I(1)
	PP	0.526	-17.798***		0.386	-30.068***	
Canada	ADF	1.181	-3.184***	I(1)	0.584	-3.780***	I(1)
	PP	0.959	-17.696***		-0.845	-47.354***	
The UK	ADF	-0.451	-3.273***	I(1)	-1.700*	-5.198***	I(1)
	PP	-0.790	-17.527***		-0.965	-28.480***	
Germany	ADF	-0.269	-2.768***	I(1)	0.180	-4.654***	I(1)
	PP	0.127	-17.100***		-0.443	-16.703***	
France	ADF	-0.247	2.840***	I(1)	0.013	-13.145***	I(1)
	PP	-0.262	-14.273***		-0.578	-34.061***	
South Africa	ADF	1.160	-2.863***	I(1)	0.266	-3.911***	I(1)
	PP	2.539	-23.556***		-0.066	-51.194***	
Australia	ADF	2.232	-2.172**	I(1)	-0.222	-4.589***	I(1)
	PP	3.171	-15.019***		-0.282	-56.219***	
New Zealand	ADF	1.584	-2.259**	I(1)	-0.148	-11.923***	I(1)
	PP	1.450	-14.661***		0.256	-42.015***	
Japan	ADF	-1.657	-2.254**	I(1)	0.635	-3.855***	I(1)
	PP	3.033	-13.940***		-0.105	-43.428***	
South Korea	ADF	1.631	-3.236***	I(1)	1.300	-3.094***	I(1)
	PP	2.219	-15.371***		0.095	-21.155***	
Indonesia	ADF	2.136	-3.950***	I(1)	1.513	-3.418***	I(1)
	PP	2.044	-10.092***		0.948	-42.682***	
Malaysia	ADF	0.750	-2.664***	I(1)	1.151	-3.406***	I(1)
	PP	0.958	-18.574***		0.751	-30.714***	
Philippines	ADF	0.711	-2.378**	I(1)	2.588	-3.100**	I(1)
	PP	1.138	-16.292***		1.209	-21.079***	
Singapore	ADF	1.253	-2.836***	I(1)	0.419	-3.413***	I(1)
	PP	1.354	-18.174***		0.371	-35.945***	
Thailand	ADF	1.897	-3.198***	I(1)	2.154	-4.017***	I(1)
	PP	1.694	-14.704***		0.708	-47.582***	
Taiwan	ADF	0.618	-2.514**	I(1)	0.078	-9.443***	I(1)
	PP	0.712	-16.387***		0.069	-65.065***	
Mainland China	ADF	0.933	-3.143***	I(1)	2.613	-2.532**	I(1)
	PP	1.541	-19.964***		2.340	-29.405***	
All markets	ADF	1.262	1.716*	I(1)	1.823	-2.478**	I(1)
	PP	3.049	-21.603***		0.564	-33.526***	

Remarks: *, **, and *** indicate that the time series variable is significant at the 0.10, 0.05, and 0.01 significance level, respectively. The ADF and PP unit root test results are without constant. The ADF and PP unit root results with constant only as well as series and trend are unreported for the sake of brevity and contact the corresponding author for additional results. Δ represents first-order differencing of the time series variables.

Table 3
ADF and PP tests for hypothesis of cointegration of ln(ASK) and ln(Tourist) (without constant).

Countries	ln(ASK) & ln(Tourist)			Countries	ln(ASK) & ln(Tourist)		
	ADF test (AIC/SIC)	PP test	Cointegration		ADF test (AIC/SIC)	PP test	Cointegration
The US	-2.445**	3.669***	Yes	South Korea	-1.185	-5126***	Yes
	-2.445**				-5.312***		
Canada	-0.597	-1.590	Yes	Indonesia	-1.431	-2.084**	Yes
	-1.799*				-1.392		
The UK	-2.097**	-2.683***	Yes	Malaysia	-1.344	-3189***	Yes
	-2.097**				-1.344		
Germany	-3.957***	-4.646***	Yes	Philippines	-1.514	-4.836***	Yes
	-3.957***				-1.514		
France	-2.414**	-2.360**	Yes	Singapore	-0.925	-2.411**	Yes
	-1.807*				-0.925		
South Africa	-1.653*	-1.951**	Yes	Thailand	-0.257	-5060***	Yes
	-1.715*				-0.041		
Australia	0.958	-0.305	No	Taiwan	-1.219	-1.444	No
	0.958				-1.049		
New Zealand	-0.583	1.965	No	Mainland China	-1.915*	-7.377***	Yes
	-0.583				-1.915*		
Japan	-0.824	-1.196	No	All markets	-1.531	-6.123***	Yes
	-0.862				-1.531		

Remarks: The ADF and PP without constant tests the null hypothesis (H_0) of the non-stationary of the resulting residual time series of the regression of ln(ASK) and ln(Tourist). AIC and SIC results are based on lag 12. *, ** and *** indicate the rejection of the null hypothesis (H_0) at the 0.10, 0.05 and 0.01 significance level, respectively.

Table 4
ADF and PP tests for hypothesis of cointegration of ln(ASK) and ln(Tourist) (with constant).

Countries	ln(ASK) & ln(Tourist)			Countries	ln(ASK) & ln(Tourist)		
	ADF test (AIC/SIC)	PP test	Cointegration		ADF test (AIC/SIC)	PP test	Cointegration
The US	-2.447	-3.661***	Yes	South Korea	-1.215	-5.090***	Yes
Canada	-2.447			Indonesia	-5.288***		
	-0.316	-1.556	No		-1.366	-2.072	No
The UK	-1.784			Malaysia	-1.378		
	-2.152	-2.670*	Yes		-1.252	-3.165**	Yes
Germany	-2.152			Philippines	-1.252		
	-3.928***	-4.629***	Yes		-1.495	-4.822***	Yes
France	-3.928***			Singapore	-1.495		
	-2.400	-2.348	No		-0.951	-2.389	No
South Africa	-1.797			Thailand	-0.951		
	-1.670	-1.925	No		-0.154	-4.893***	Yes
Australia	-1.706			Taiwan	0.057		
	2.478	-0.126	No		-1.219	-1.420	No
New Zealand	2.478			Mainland China	-1.045		
	-0.280	-1.900	No		-1.905	-7.350***	Yes
Japan	-0.280			All markets	-1.905		
	-0.851	-1.145	No		1.495	-6.1055***	Yes
	-0.875				-1.495		

Remarks: The ADF and PP with constant and trend tests the null hypothesis (H₀) of the non-stationary of the resulting residual time series of the regression of ln(ASK) and ln(Tourist). AIC and SIC results are based on lag 12. *, ** and *** indicate the rejection of the null hypothesis (H₀) at the 0.10, 0.05 and 0.01 significance level, respectively.

Table 5
ADF and PP tests for hypothesis of cointegration of ln(ASK) and ln(Tourist) (with constant and trend).

Countries	ln(ASK) & ln(Tourist)			Countries	ln(ASK) & ln(Tourist)		
	ADF test (AIC/SIC)	PP test	Cointegration		ADF test (AIC/SIC)	PP test	Cointegration
The US	-2.680	-4.309**	Yes	South Korea	-2.242	-60.78***	Yes
Canada	-2.680			Indonesia	-6.263***		
	-1.398	-2.993	No		-2.507	-4.525***	Yes
The UK	-3.107			Malaysia	-3.360*		
	-2.067	-3.032	No		-2.106	-5.216***	Yes
Germany	-2.067			Philippines	-2.106		
	-3.953**	-4.620***	Yes		-2.358	-5.631***	Yes
France	-3.953**			Singapore	-2.358		
	-2.718	-2.646	No		-1.961	-5.520***	Yes
South Africa	-2.236			Thailand	-1.961		
	-2.456	-4.951***	Yes		-2.291	-8.008***	Yes
Australia	-3.700**			Taiwan	-7.676***		
	-1.998	-2.519	No		-1.913	-2.781	No
New Zealand	-1.998			Mainland China	-1.257		
	-3.272*	-4.845***	Yes		-2.383	-7.585***	Yes
Japan	-3.272*			All markets	-2.383		
	-3.048	5.355***	Yes		-2.056	-6.758***	Yes
	-3.048				-2.056		

Remarks: The ADF and PP with constant and trend tests the null hypothesis (H₀) of the non-stationary of the resulting residual time series of the regression of ln(ASK) and ln(Tourist). AIC and SIC results are based on lag 12. *, ** and *** indicate the rejection of the null hypothesis (H₀) at the 0.10, 0.05 and 0.01 significance level, respectively.

Table 6
Long-run equilibrium relationship between ln(ASK) and ln(Tourist).

Identified long-run relationship based on ADP and PP unit root tests	Tourist source markets or countries
ln(ASK) ↔ ln(Tourist) (A long-run relationship existed)	The US, Canada, The UK, Germany, France, South Africa, New Zealand Japan, South Korea, Indonesia, Malaysia, Philippines, Singapore, Thailand, Mainland China, All markets
ln(Tourist) — ln(ASK) (a long-run relationship did not exist)	Australia, Taiwan

for holidays and vacations or other purposes. The null hypothesis that ln(Tourist) does not Granger-cause ln(ASK) was also rejected for most of the sampled markets, except for three markets (Australia, South Korea, and Taiwan). That is, visitor arrivals by air from these three markets do not Granger-cause (or increase) seat capacity scheduled by airlines.

Importantly, overall, (i.e. when all markets are considered), bi-directional Granger-causation between ln(ASK) and ln(Tourist) are statistically significant at 1%.

5. Discussion and conclusions

Whereas the economic benefits of aviation has been one critical issue in the air transport literature, not many studies have examined the causal relationship between aviation and tourism. Most empirical findings support a positive relationship in place, albeit not always consistent and there is significant diversity across different markets. It has been concluded that there is no uniform relationship between air transport and tourism, or air transport and economic development. Despite Hong Kong’s success in both the tourism and aviation sectors, the city faces significant challenges in terms of rising costs, capacity constraints and increased competition. It is important for stakeholders to have a good understanding of the key drivers for aviation and tourism, and how these

Table 7
Granger causality between ln(ASK) and ln(Tourist).

Countries	Granger causality		Countries	Granger causality	
	H ₀ : ln(ASK) do not Granger-cause ln(Tourist)	H ₀ : ln(Tourist) do not Granger-cause ln(ASK)		H ₀ : ln(ASK) do not Granger-cause ln(Tourist)	H ₀ : ln(Tourist) do not Granger-cause ln(ASK)
The US	Rejected (0.0008)***	Rejected (9.E-07)***	South Korea	Rejected (0.0295)***	Fail to reject (0.0591)
Canada	Failed to reject (0.3548)	Rejected (0.0003)***	Indonesia	Rejected (0.0128)***	Rejected (7.E-08)***
The UK	Rejected (0.0017)***	Rejected (2.E-09)***	Malaysia	Fail to reject (0.0725)	Rejected (0.0025)***
Germany	Fail to reject (0.1555)	Rejected (6.E-16)***	Philippines	Rejected (0.0003)***	Rejected (0.0001)***
France	Fail to reject (0.4250)	Rejected (0.0002)***	Singapore	Rejected (8.E-05)***	Fail to reject (0.0189)
South Africa	Fail to reject (0.9763)	Rejected (0.0008)***	Thailand	Fail to reject (0.4610)	Rejected (0.0003)***
Australia	Fail to reject (0.0966)	Fail to reject (0.0535)	Taiwan	Fail to reject (0.1411)	Fail to reject (0.1598)
New Zealand	Fail to reject (0.0879)	Rejected (0.0099)***	Mainland China	Rejected (0.0007)***	Rejected (0.0004)***
Japan	Fail to reject (0.4702)	Rejected (8.E-07)***	All markets	Rejected (2.E-05)***	Rejected (6.E-06)***

Remarks: The parentheses indicate the *p*-values. *** indicate that the rejection of the null hypothesis (H₀) at the 0.01 significance level, respectively.

Table 8
Summary of Granger-causality test.

Countries	Identified Granger-causation relationship	Significance level	Countries	Identified Granger-causation relationship	Significance level
The US	ln(ASK)⇌ln(Tourist)	1%	South Korea	ln(ASK)→ln(Tourist)	1%
Canada	ln(Tourist)→ln(ASK)	1%	Indonesia	ln(ASK)⇌ln(Tourist)	1%
The UK	ln(ASK)⇌ln(Tourist)	1%	Malaysia	ln(Tourist)→ln(ASK)	1%
Germany	ln(Tourist)→ln(ASK)	1%	Philippines	ln(ASK)⇌ln(Tourist)	1%
France	ln(Tourist)→ln(ASK)	1%	Singapore	ln(ASK)→ln(Tourist)	1%
South Africa	ln(Tourist)→ln(ASK)	1%	Thailand	ln(Tourist)→ln(ASK)	1%
Australia	No Granger-causation relationship found		Taiwan	No Granger-causation relationship found	
New Zealand	ln(Tourist)→ln(ASK)	1%	Mainland China	ln(ASK)⇌ln(Tourist)	1%
Japan	ln(Tourist)→ln(ASK)	1%	All markets	ln(ASK)⇌ln(Tourist)	1%

Remarks: Arrows indicate direction of Granger causation between ln(ASK) and ln(Tourist).

two sectors influence each other. This study aims to provide timely analysis on this important topic, thus Hong Kong’s aviation and tourism can be aligned on the basis of sustainable development. This is achieved by empirically analysing whether there is a long-run relationship between scheduled airline seat capacity and visitors by air, using monthly data from 2008 to 2018 for the city’s key tourist source markets. Our cointegration and Granger-causality tests suggest the following: First, the cointegration tests found clear evidence of a long-run relationship between scheduled airline seat capacity and visitor arrivals in most markets (except Australia and Taiwan). Such a pattern is consistent and significant, but market-specific features should also be recognized. Second, the analysis of co-movement in air transport and international inbound tourism using the Granger-causality tests concludes that overall there is bi-directional (two-way) Granger causality between scheduled airline seat capacity and visitor arrivals by air. Consistent pattern has been individually verified for the markets of the US, the UK, Indonesia, Philippines, Singapore, and mainland China. Uni-directional (one-way) Granger causality from scheduled airline seat capacity to visitor arrivals by air, or from visitor arrivals by air to scheduled airline seat capacity, can also be identified for some markets with statistical significance.

Despite the overall consistency of the key findings, variations in Granger-causality test results reflect the heterogeneity across different markets. Among others, this could be ascribed to airlines’ network configurations, especially that Hong Kong is a major international aviation hub. For example, both Hong Kong and Australian airlines have been using the Hong Kong International Airport to offer connection services from Oceania to Europe (i.e. the so-called Kangaroo routes). Furthermore, air transport regulations and policies may also play important roles. The bilateral air service agreements (ASA) between Hong Kong and Australia remain fairly restrictive, with capacity limits on the Hong Kong-Australia routes (Australia Aviation, 2016). Higher restrictiveness in aviation policy leads to lower levels of movement of people between international cities, and tourism flows are highly

sensitive to changes in bilateral aviation policy (Zhang and Findlay, 2014). In the Hong Kong–Australia market, it is important to remove various constraints on international airlines (Dresner and Oum, 1998; Clougherty et al., 2001; Intervistas, 2006; Li et al., 2010; Adler et al., 2014). For the case of Taiwan, no evidence of Granger-causality between scheduled airline seat capacity and visitor arrivals by air to Hong Kong could be identified. Historically, routes linking Hong Kong to Taiwan (especially the city of Taipei), were among the world’s busiest routes. In 2008, Taiwan and mainland China signed cross-strait agreement which allows non-stop or direct flights, which effectively shifted Hong Kong’s role of a transit hub in the related markets (Lau et al., 2012; Tsui et al., 2018; Wu et al., 2018). On the other hand, such cross-strait agreement between mainland China and Taiwan was accompanied by a time of increased economic integration, and increased tourist flows due to political good will established following the agreement. These effects are likely to be more significant than the casual relationships between aviation and tourism in Hong Kong, making it difficult to be identified statistically. In addition, it should be noted that our analysis used aggregated data at route level, which do not capture the important effects of airline networks and connecting passenger traffic. For example, airlines based in Singapore, such as Singapore Airlines and its subsidiaries, and Australian LCC (Jetstar) could have played important roles in the Hong Kong–Australia market. Such network effects are, however, not captured in our analysis on route (city/country-pair) based data. If passenger itinerary data can be obtained, it would be useful to extend our analysis by including all connecting passengers in the estimation. Such an analysis, together with a better control of other social and political factors, should more clearly model the transport markets.

Our study offers valuable findings and recommendations to stakeholders (e.g. the Hong Kong government, the Hong Kong Tourism Board, airline management and tourism operators). On the one hand, Hong Kong’s policy makers must appreciate the inter-dependence between the tourism and aviation sectors, as evidenced by the bi-directional causality

empirically identified in our analysis. This calls for coordinated planning and policy design in the tourism and aviation sectors. Thanks to positive causality, any measure promoting the growth of one sector is expected to generate positive feedback effects, and thus justify government support measures. This implies that stakeholders in the tourism sector, or government economic agencies in general, may play more active roles in the formulation of aviation policies, such as those related to aviation infrastructure and air liberalization. In addition, since tourists tend to be price sensitive, the Hong Kong government and aviation policymakers may facilitate increased operations by LCCs, which provide no-frill services at low costs, often stimulating air traffic and tourism growth (Dresner et al., 1996; Windle and Dresner, 1999; Fu et al., 2011). This will lead to increased market share of Hong Kong's tourism market (Lee et al., 2018; Wang et al., 2017), promoted by local carriers or overseas entrant airlines. On the other hand, our study found significant heterogeneity across different markets. For example, no significant causal relationship were found for Australia. This implies direct government support such as aviation subsidy will provide limited help to the aviation and tourism sectors. Instead, removing existing constraints via liberalization is probably more effective and of higher priority. The Hong Kong government should also consider fifth freedom negotiation with foreign governments, which would encourage Hong Kong-based carriers to expand their international networks, and prompt more international carriers to develop Hong Kong as their transit hub. The latter was a challenging plan due to airport capacity constraint. With the third runway to be added at the Hong Kong International Airport (HKIA) soon, it may become a feasible option in the future. The current LCC movements at HKIA are largely restricted by its capacity shortage and constraint (Wang et al., 2017). After the opening of third runway at HKIA in 2024, as expected, increased airport slots and capacities can allow more leading Asian LCCs to boost seat capacities serving the Hong Kong market (Hong Kong Airport Authority, 2019; Wang et al., 2017). Although the COVID-19 pandemic has brought catastrophic damage to the global and regional markets (Czerny et al., 2021), strong rebounds are expected post the crisis, when LCCs could play an even more important roles with their low cost and high capacity utilization rates. In general, stakeholders in Hong Kong should consider individual markets' characteristics, and the possible network effects in airlines' operation and competition strategy. Finally, our study of the overall markets of Hong Kong found strong two-directional causal relationship between scheduled airline services and tourist arrivals. This implies that there are significant positive externalities between the two crucial sectors to the Hong Kong economy. Unless this externality is formally recognized, the benefits of government supporting policy will be under-estimated. In plain words, air transport and tourism are mutually dependent, and stakeholders in the two sectors should work together to leverage on the synergies.

As discussed in details in previous sections, the data and empirical model in this study allow us to improve the estimation efficiency and robustness. Still, some potential limitations may call for further improvements. For example, additional tourism-demand factors such as airfares, exchange rates, tourism prices for inbound tourists to visit and stay at Hong Kong, the impact of LCCs, were not formally controlled. As a meaningful extension of this study, it would be valuable to investigate the air transport-tourism nexus in Hong Kong in consideration of additional tourism-related variables. Importantly, given the mutual relationship between air transport and tourism, it would very valuable to develop a more comprehensive theoretical framework to further explore the air transport-tourism relationship. This is a research agenda clearly worthy of further attention, given the rapid growth in international air transport and tourism in Hong Kong and the region.

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