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Air Connectivity in APEC: Development and Challenges

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Contents

Abstract

This study aims at investigating the air connectivity among APEC economies and also in the context of the global aviation network. In the APEC Leaders' 2013 Declaration, APEC leaders affirmed their vision of reaching a seamlessly and comprehensively connected and integrated Asia-Pacific balanced on three pillars – physical connectivity, institutional connectivity and people-to-people connectivity. Further, in 2014, an APEC Connectivity Blueprint for 2015 – 2025 was developed to guide the region's efforts to better integrate the region. The study will use the NetScan model to measure the connectivity of major airports of APEC economies in the period between 2009 and 2017. The results will show the changes in the connectivity of the airports in the study period. Thus, the results may shed lights on the strategies and policies on how to establish a seamlessly and comprehensively connected aviation network among APEC economies.

CHAPTER 1

Introduction

Owing to the geography, the Asia Pacific region is separated by the vast Pacific Ocean. Air transport is an indispensable mode of transportation providing efficient and speedy flows of passengers and cargoes within the region. Under globalization and rapid technological progress in communication and transportation, international trade has been growing rapidly since the end of World War II. Air cargo transport has also been growing rapidly for the past three decades. However, air cargoes are commonly reported mainly in terms of volume or weight rather than value and it has substantially under-estimated the importance of air cargo transport in the international trade (Hummels, 2007). According to Arvis and B. (2016), although air cargo transport accounted for only 0.5 per cent of international trade by volume, it accounted for 35% of international trade by value. Goods moved by aeroplanes are typically of high value. They are supporting the just-in-time global supply chain system.

According to the APEC Connectivity Blueprint published in 2014, developing connectivity among APEC members is crucial for the long-term successful integration of trade, investment and related economic activities. It proposes to achieve three levels of connectivity: physical connectivity, institutional connectivity and people-to-people connectivity. In fact, improving the connectivity of economies in the Asia Pacific region is a major driving force for facilitating faster and speedier flows of goods, services and people. Air transport networks have been rapidly developed and linked up to various cities in the Asia Pacific region in the past decades.

In order to properly capture the performance of the quality of these networks, an air connectivity index could be developed to measure the importance of a country or a city as a node within the regional or global air transport system. An airport or a city is considered to be better connected if it has more direct flight links or shortens waiting time in transfer to other nodes of the air transport networks. In other words, a city's or a country's connectivity index score will be higher if the time cost of moving people or cargoes is lower. Hub-and-spoke networks have been an essential feature in most regional or global air transport networks since the deregulation of the domestic American air transport market in 1978. A spoke city, e.g., Wenzhou in China, Daegu in Korea, etc., with a good connection to only a few cities will not have a high connectivity score. However, a regional hub city, e.g, Guangzhou, Osaka, etc. with a good connection to a moderate number of cities will receive an intermediate connectivity score. A global hub city or country, e.g., Hong Kong or Singapore, with strong connections to a large number of cities or countries will receive high connectivity score. We aim at investigating the air connectivity among APEC economies in the context of the global aviation network.

In Chapter 2, we shall discuss the NetScan model used for measuring the air connectivity of APEC airports and regions. In Chapter 3, we will report development and pattern of air connectivity of APEC economies and with other regions. In Chapter 4, we will discuss strategies and policies on how to enhance a seamlessly and comprehensively air connectivity among APEC economies.

CHAPTER 2

The NetScan Model

The NetScan model was first developed by Veldhuis (1997) for the measurement of air connectivity, which was further developed and applied by Burghouwt and R. (2013) for the study of the trans-Atlantic market. Boonekamp and G. (2017) used the NetScan model to study air cargoes connectivity. The NetScan model considers both direct and indirect connections from origin airport A to destination airport B. The basic idea is to assign a quality-adjusted index, ranging from zero to one, to every flight connection. This quality-adjusted index measures the quality of relative travel time to every flight connection. If the flight is a non-stop direct flight from airport A to airport B, the index equals 1. If there are multiple stops and indirect flights from airport A to airport B, the index will be less than 1. This is the case as a multi-stop flight takes more time to arrive at airport B from airport A compared with a non-stop flight. If the additional travel time of an indirect connection exceeds a certain threshold, the index of connection equals zero. In general, the threshold of a certain indirect connection between two airports depends on the travel time of a theoretical direction between these two airports. Therefore, if the theoretical direct travel time between two airports is longer, the maximum indirect travel time will also be longer as well. For example, the maximum indirect travel time is three hours for a direct flight of an hour. On the other hand, the maximum indirect travel time is 24 hours for a direct flight of 12 hours. As a result, the total number of connections or connectivity units (CNUs) is derived from the product of the index and the frequency of the connection per time unit e.g., day, week and year. The NetScan model consists of the following equations:

$$MAXT = (3 - 0.075 * NST) * NST \tag{2.1}$$

$$PTT = FLY + (3 * TRF) \tag{2.2}$$

$$QUAL = 1 - \left(\frac{PTT - NST}{MAXT - NST} \right) \tag{2.3}$$

$$CNU = QUAL * FREQ \tag{2.4}$$

where MAXT is the maximum perceived travel time, NST is the non-stop travel time, PTT is perceived travel time, FLY is the flying time, TRF is transfer time, QUAL is the index of an individual connection, FREQ is the flight frequency, let say, per week and CNU is the number of connectivity units. In case of a direct connection between airport A and B, PTT = NST as TRF = 0 and QUAL = 1 in equation (2.3). If the PTT reaches the maximum perceived travel time, MAXT, QUAL=0 in equation (2.3). For any given airport, we sum up all individual routes operating in that airport,

$$CNU_j = \sum_{i=1}^{N} QUAL_{ij} * FREQ_{ij} \tag{2.5}$$

CNUs can also be interpreted as the number of quality-adjusted direct flights from one airport to a specific destination. For a given country, we sum up the CNUs of all airports to all destinations within that country to obtain the CNU for that particular country.

For our analysis below, we could employ the OAG database which consists of flight information on March at a route level from 2008 to 2017. OAG is an air travel intelligence company based in the United Kingdom. It provides digital information and applications to the world's airlines, airports, government agencies and travel-related service companies. OAG is best known for its airline schedules database which holds future and historical flight details for more than 900 airlines and over 4,000 airports. OAG maintains an extensive flight status and day-of-travel database in the aviation market and provides analytical tools to assess air travel trends.

CHAPTER 3

Analysis of Air Connectivity of APEC

3.1 Connectivity of APEC Airports to APEC Destinations

Let us consider the computed CNUs of airports, which is equivalent to the number of quality-adjusted direct flights from an airport to a destination. Fig. 3.1 reports Top 50 APEC airports to APEC destinations (excluding domestic flights) in March 2017. Hong Kong International Airport (HKIA) has the highest score, 13,212, followed by Singapore with a score of 12,245 and Incheon Airport in Seoul, Korea, with a score of 11,234. The rest of top ten airports are Taoyuan Airport in Taipei (8,431), Kuala Lumpur Airport (8,201), Lester Pearson Airport in Toronto (8,101), Shanghai Pudong Airport (6,821), Bangkok International Airport (6,655), Tokyo Narita Airport (6,219) and Osaka Kansai Airport (4,680). Interestingly, among these top ten airports, six of them are located in the North Asia region (among them three are in the Greater China region (China, Hong Kong and Taiwan)) and another three are located in the ASEAN region. Hong Kong and Singapore are the top performers as they fly to a large number of international airports and recorded very high scores.

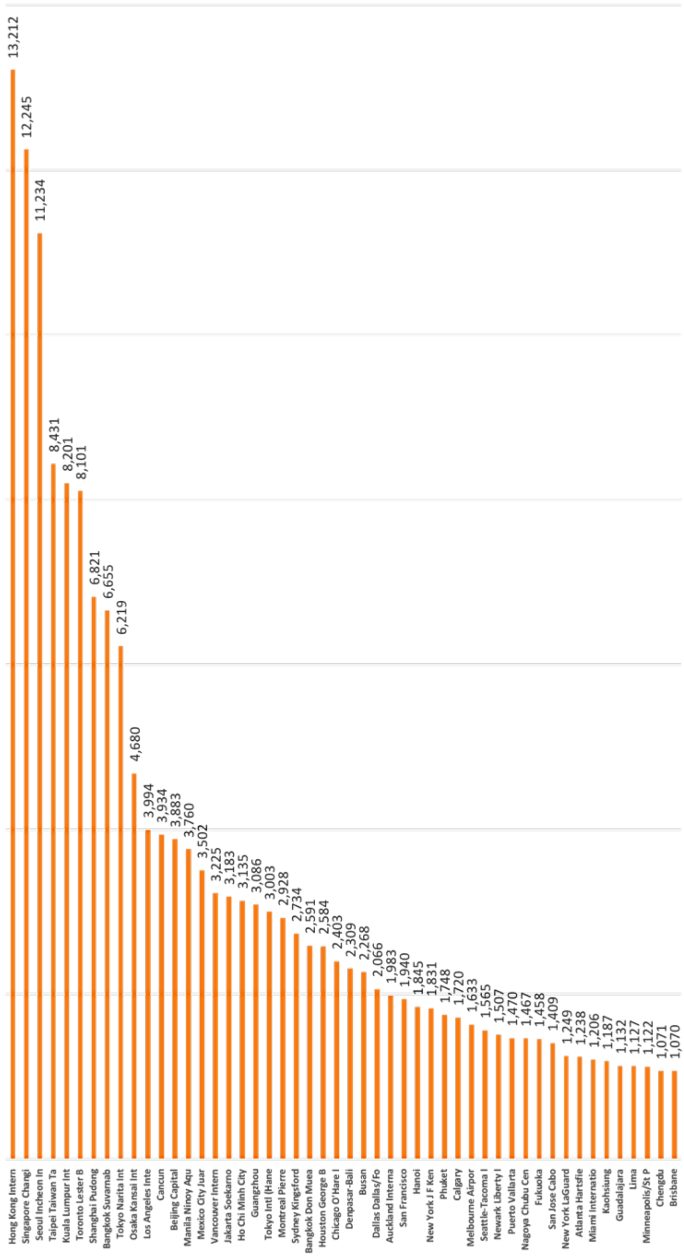


Figure 3.1 Top 50 APEC Airports to APEC Destinations (excluding domestic flights) in March 2017

Figure 3.2 Top 20 Selected APEC Airports (with positive growth rate) to APEC Destinations (excluding domestic flights) from 2010 to 2017

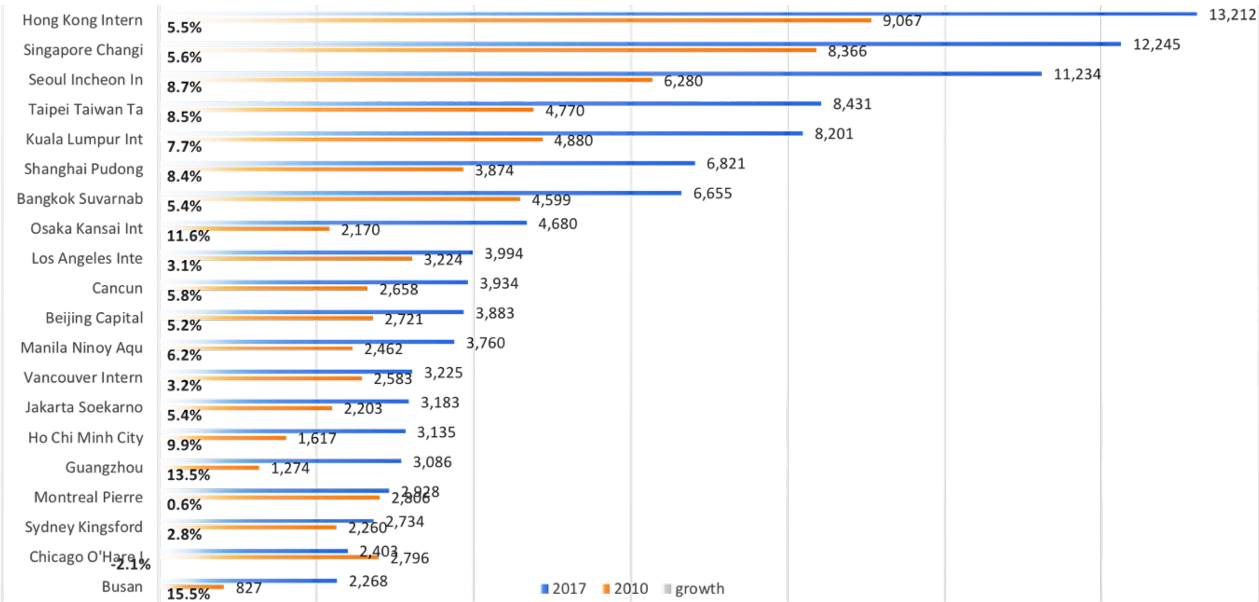


Fig. 3.2 reports the top 20 selected APEC airports (with positive growth) to APEC destinations (excluding domestic flights) from 2010 to 2017. The top 5 airports all command relatively strong growth in their air connectivity scores, especially for Singapore Airport and Incheon Airport whose scores ranked the second and the third respectively. Kuala Lumpur Airport also performed well as its score was more than doubled from 2010 to 2017. Similarly, the scores of Osaka Kansai Airport in Japan, Ho Chi Minh City Airport in Vietnam and Guangzhou Airport in China were also more than doubled from 2008 to 2017. On the other hand, airports in North America had the lowest increases as the aviation market in North America was saturating. Indeed, Chicago O'Hare Airport experienced a decline during the same period. Among these top 20 airports, six of them are in the ASEAN region, five of them are in the Greater China region and another five are in the North American Free Trade Area (NAFTA) region (two in Canada, two in Mexico and one in the US).

Figure 3.3 APEC Airports to APEC Destinations (excluding domestic flights) by Departure Regions

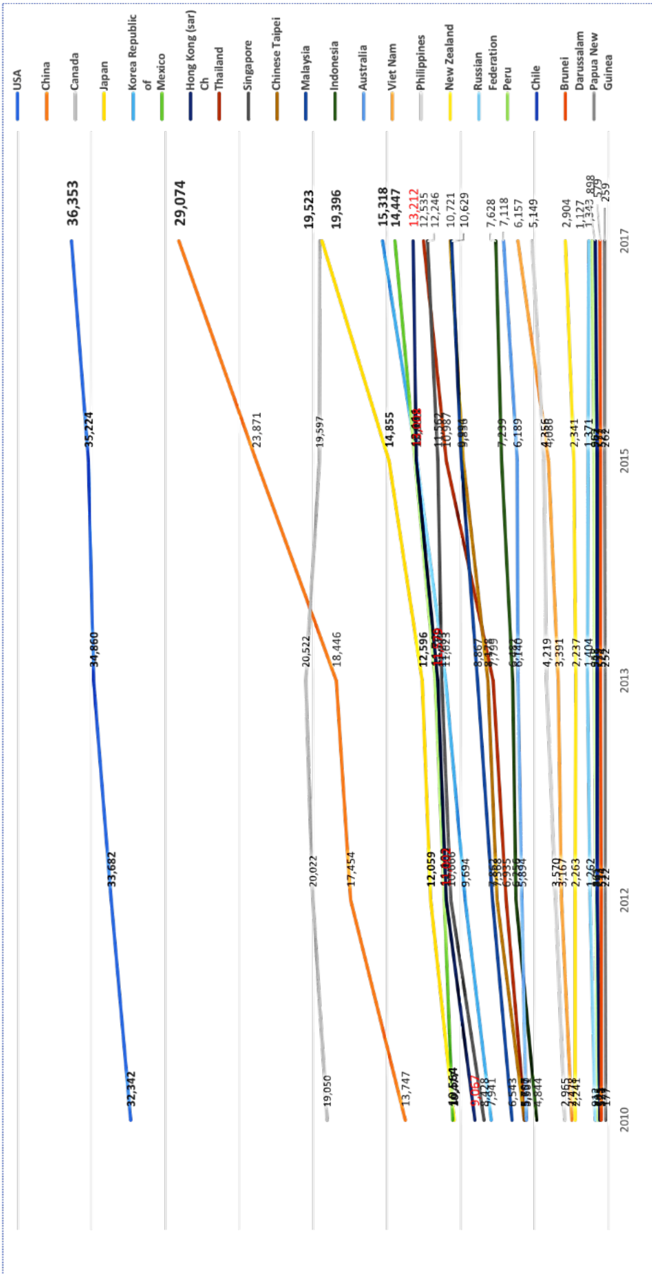


Figure 3.4 Top 20 APEC Airports (with positive growth) to APEC Destinations (including domestic flights) from 2010 to 2017

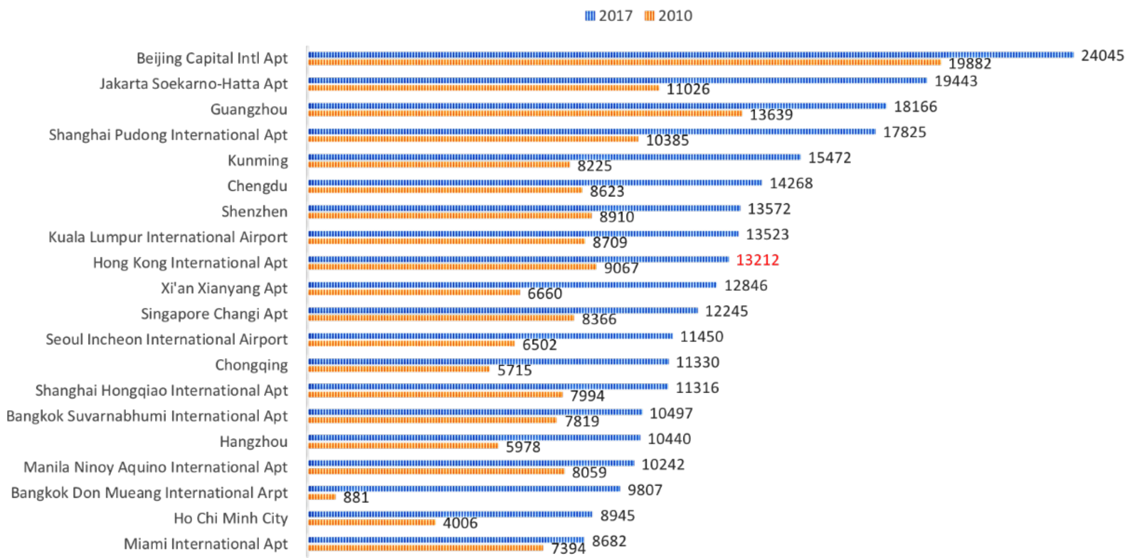


Fig. 3.3 reports the APEC airports to APEC destinations (excluding domestic flights) by departure regions. The US ranked the first and followed by China, Canada and Japan. Most countries' scores were increasing. China expanded at the fastest rate, while the US increased at a slower rate. Canada experienced no growth during the period. In addition, Japan expanded at a relatively high rate as well.

Fig. 3.4 reports the top 20 APEC airports (with positive growth rate) to APEC destinations (including domestic flights) from 2010 to 2017. Among the top 20 APEC airports, 11 are from China and Hong Kong, and 7 are from the ASEAN region. Fig. 3.5 reports the annual growth rate of CNUs from the Top 20 APEC airports to APEC destinations (including domestic flights) from 2008 to 2017. In terms of the growth rate, Bangkok Don Mueang Airport had the highest rate (41.1%) and followed by Ho Chi Minh City (12.2%), Chongqing Airport (10.3%), Xian Airport (9.8%) and Kunming Airport (9.4%). Miami Airport had the lowest growth rate.

Fig. 3.4 and 3.5 also highlighted the outstanding performance of airports in the ASEAN region. This may be due to the implementation of an Open Sky Agreement among the ASEAN members and the rapid growth of low-cost carriers in this region. The first stage of the ASEAN Open Sky Agreement was implemented at the end of 2008, with full implementation since 1 Jan 2016.

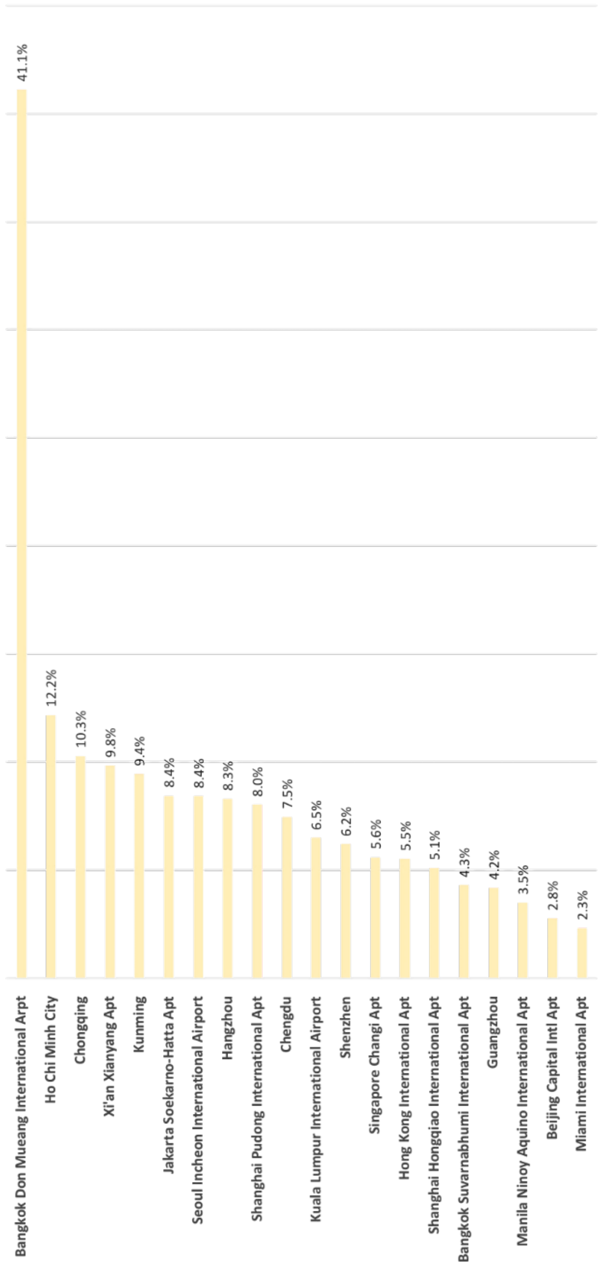


Figure 3.5 Annual Growth Rate of CNUs from the Top 20 APEC Airports to APEC Destinations (including domestic flights) from 2008 to 2017

3.2 Connectivity of APEC Economies to APEC Destinations

Fig. 3.6 reports the CNUs of APEC economies to APEC destinations based on the country level air connectivity index for the whole period. The US and China ranked the first and second respectively and followed by Canada and Japan. These countries ranked high because they are having a large number of airports connecting to various destination airports in the APEC region. Thus, small countries such as Brunei and Papua New Guinea ranked at the bottom.

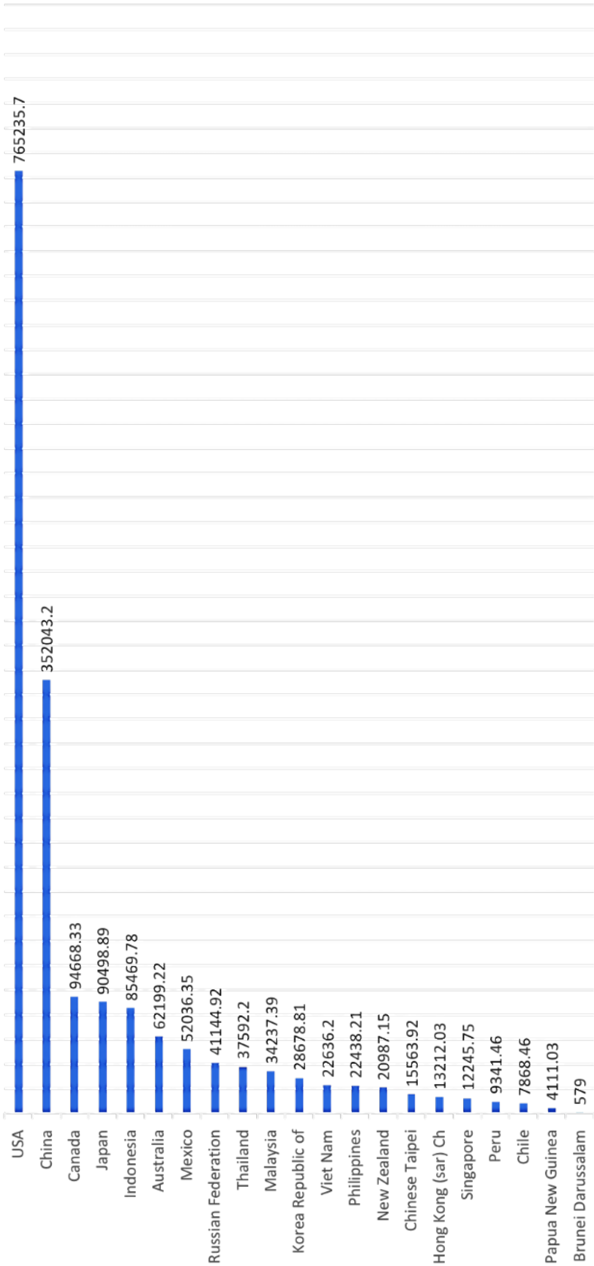


Figure 3.6 APEC Departure Economies to APEC Destinations (including domestic flights) in March 2017

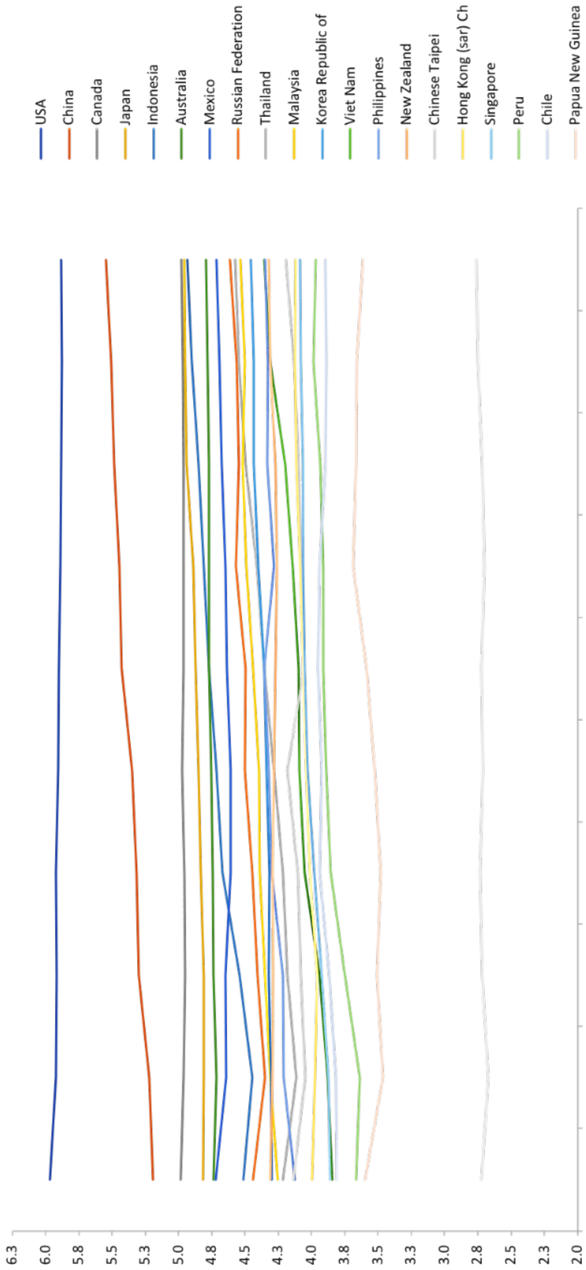


Figure 3.7 APEC Departure Economies to APEC Destinations (including domestic flights) from 2008 to 2017

Fig. 3.7 reports APEC departure economies to APEC destinations (including domestic flights) from 2008 to 2017. Both the US and Canada were declining over time while China and Japan were increasing. Most countries' CNUs were increasing and China's was increasing the fastest compared with other countries. Both Fig. 3.6 and 3.7 showed that there had been an increasing trend of air connectivity within the APEC region, especially within the East Asian region.

Fig. 3.8 reports the CNUs of APEC economies to non-APEC destinations in March 2017. Again, the US ranked the first and now Russia ranked the second, followed by China, Thailand and Canada. The US is well connected to European and South American destinations. Russia is also very well connected to European destinations. However, New Zealand, Brunei and Papua New Guinea ranked at the bottom. Fig. 3.9 reports APEC departure economies to non-APEC destinations from 2008 to 2017. There was no growth for the US, Russia and Canada, while China and Thailand were increasing at a much faster rate. Other East Asian and ASEAN countries experienced growth as well.

Figure 3.8 APEC Departure Economies to Non-APEC Destinations in March 2017

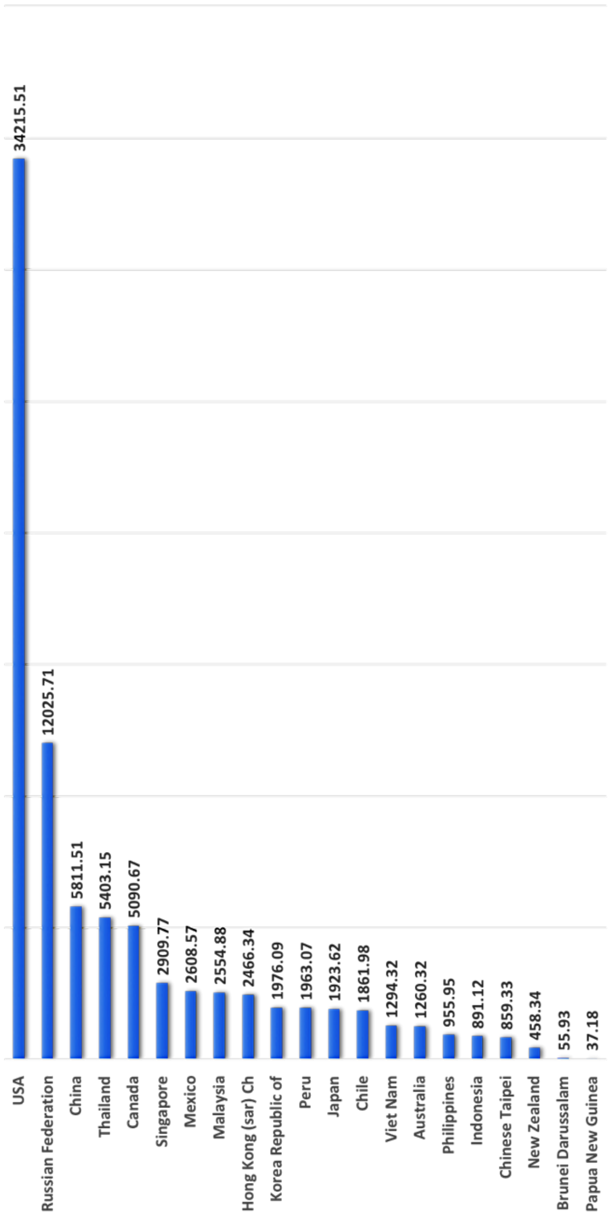
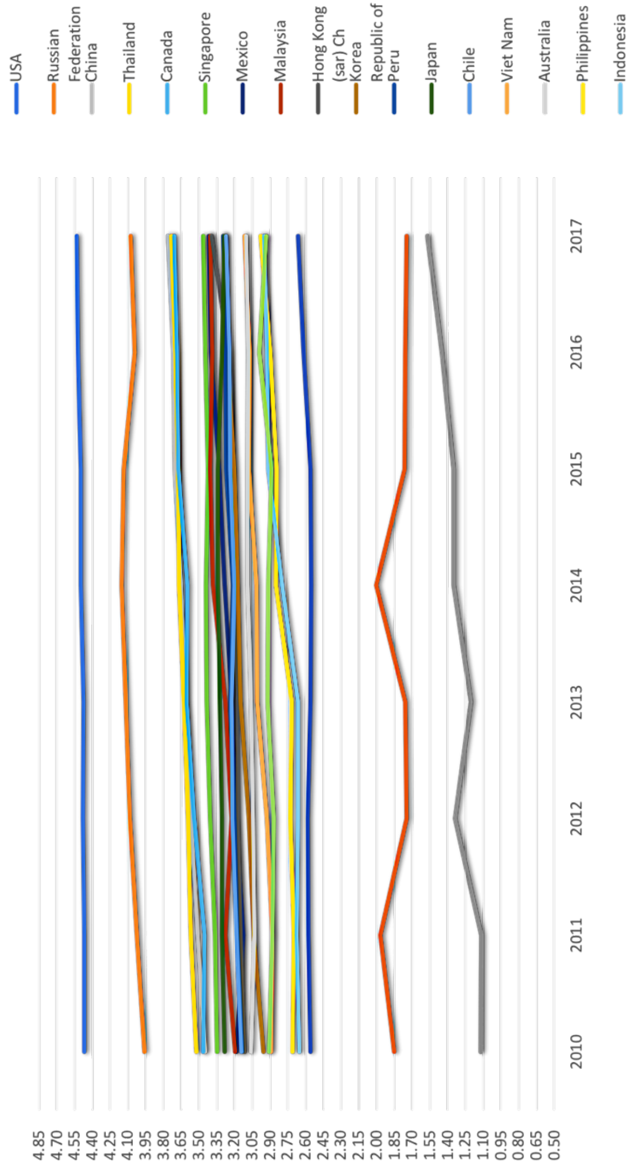


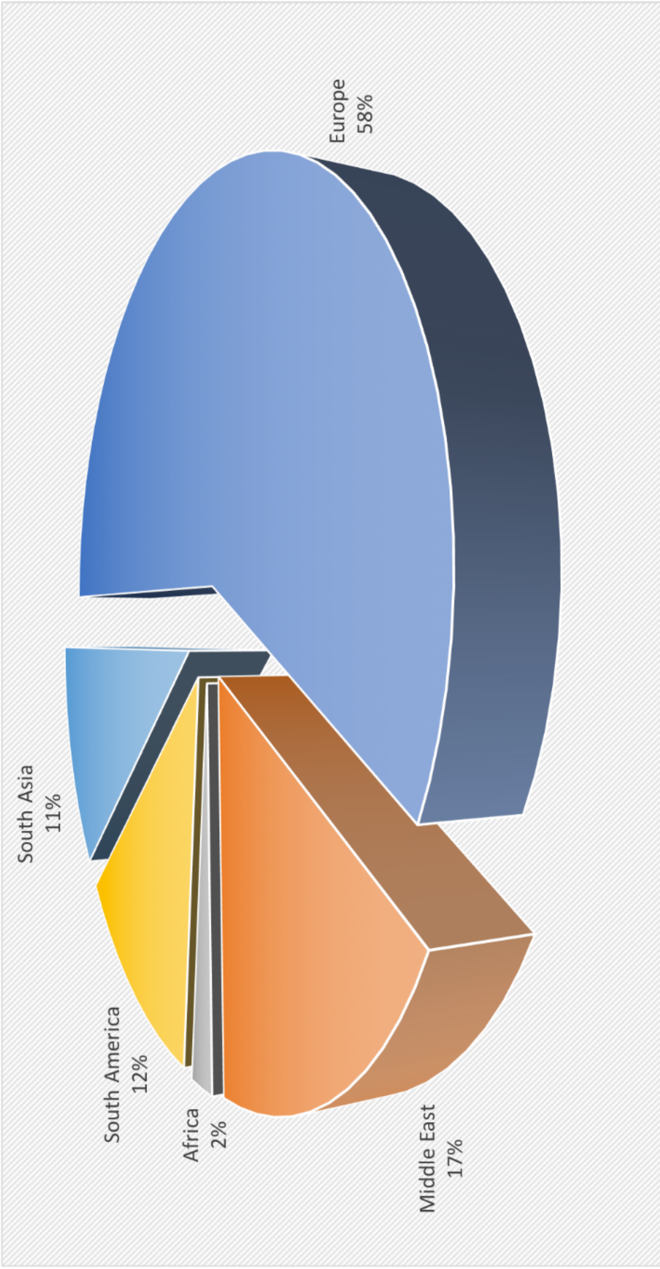
Figure 3.9 APEC Departure Economies to Non-APEC Destinations from 2008 to 2017



3.3 Connectivity of APEC Economies to Selected Continents

Fig. 3.10 reports the CNUs from APEC economies to selected continents, including South Asia, South America, Africa, the Middle East and Europe. About 58% of the destinations leaving from APEC were located in Europe. 17% of destinations were in the Middle East, 12% in South America and 11% in South Asia.

Figure 3.10 Non-APEC Destinations from APEC Economies in March 2017



3.4 Connectivity of Hong Kong

Fig. 3.11 reports the distribution of destinations of CNUs from the Hong Kong International Airport, among which 89% were within the APEC economies.

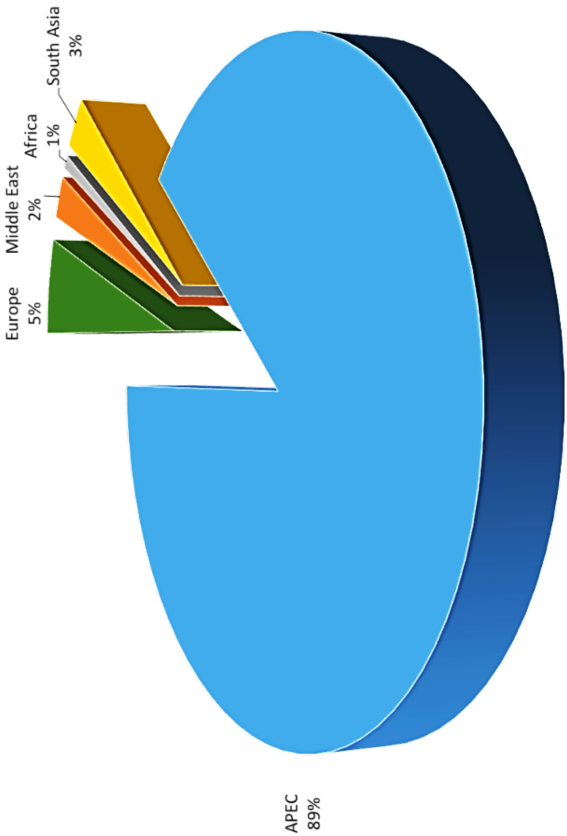


Figure 3.11 Distribution of Destinations of CNUs from HKIA

Fig. 3.12 reports APEC destinations from HKIA from 2008 to 2017. China ranked the top and followed by Chinese Taipei, Japan, Thailand, Korea and the Philippines. The air connectivity to China first declined in 2008 then increased again in 2010. There were some declines in recent years. However, the air connectivity to Thailand was increasing rapidly in recent years.

Figure 3.12 APEC Destinations from HKIA from 2008 to 2017

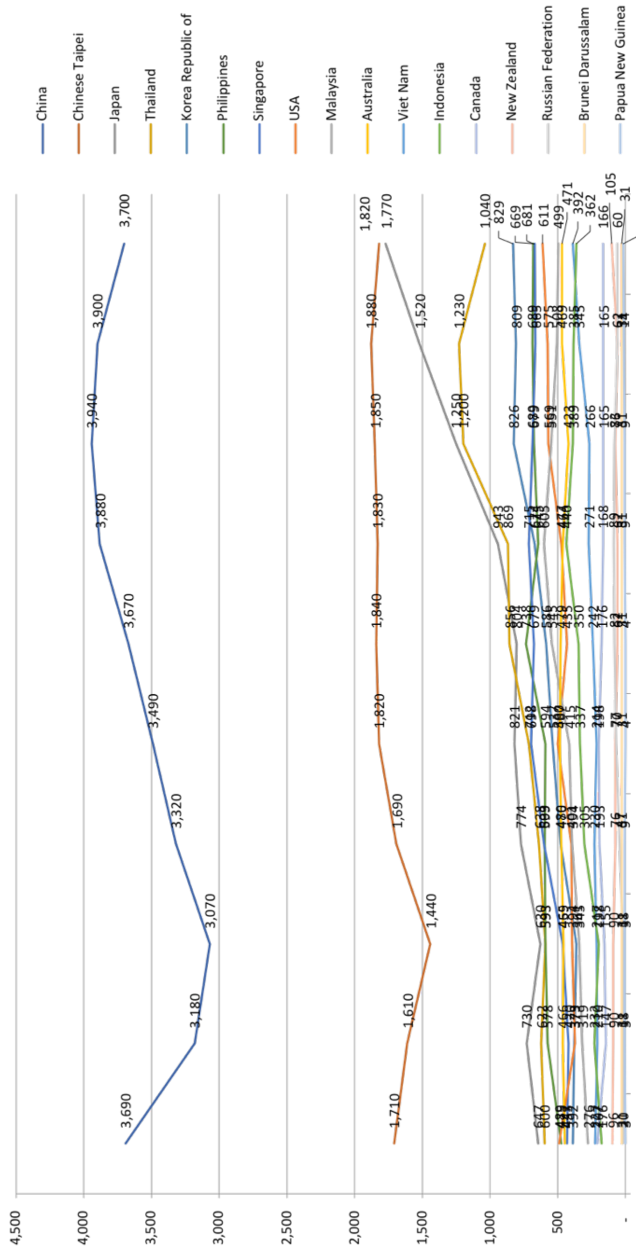


Fig. 3.13 reports the top 50 destination airports from Hong Kong International Airport. Taipei Taoyuan Airport, Shanghai Pudong Airport and Seoul Incheon Airport were the top three destinations. They followed by Singapore Changi Airport, Bangkok Airport and Beijing International Airport.

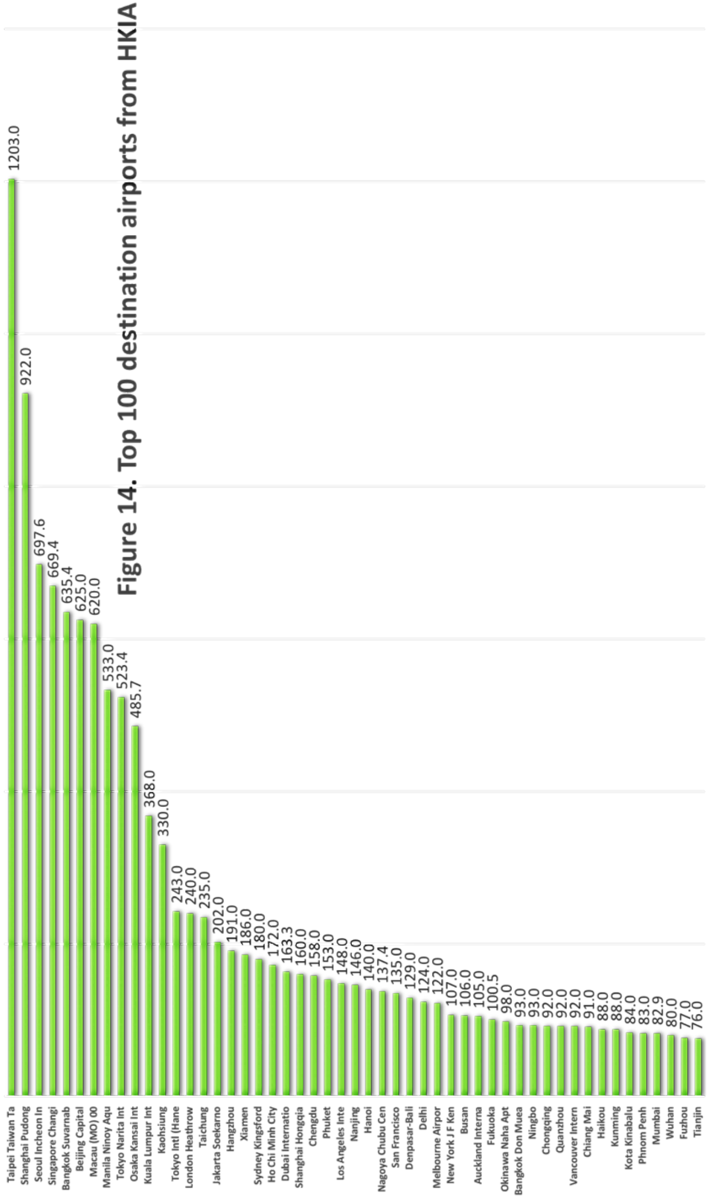


Figure 3.13 Top 50 Destination Airports from HKIA

3.5 Econometric Analysis—Connectivity and Economic Indicators

By analysis the country level CNU in conjunction with data from the World Bank from 2008 to 2016, we are able to investigate the possible correlation of connectivity of a country with its economic indicators, such as GDP per capita and its growth rate, foreign direct investment, trade as a percentage of GDP and in particular high tech export as a percentage of manufactured goods. Also, other development indicators could include the penetration of mobile phone usage per 1,000 persons, and the number of tourist arrivals. The OAG dataset, along with the World Development Indicators (WDI) penal data, would consist of more than 1,600 observations for our analysis.

The regression analyses reported in both Table 3.1 and 3.2 show the following results:

i. Income is a significant determinant of the world CNUs, particularly for the middle income and low-income countries, as well as APEC.
ii. FDI is a significant determinant of the world CNUs, particularly for the middle income and low-income countries, as well as APEC.
iii. Mobile connectivity plays a significant role in the air connectivity in APEC.
iv. Population size is a significant determinant of the world CNUs, particularly for the high and middle-income countries, as well as OECD.
v. Investment (capital formation) is a significant determinant of the air connectivity.
vi. Tourism always has a significant correlation with the air connectivity.

Table 3.1 Correlation between CNU with Selected Development Indicators

	GDP per Captia	GDP growth rate	FDI	Import per GDP	Export per GDP	High Tech export per manufacture goods	Mobile subscriptions per 1000 persons	Number of tourist arrivals	CNU
World									
CNU	0.1066***	-0.0217	0.4736***	0.1337***	0.0377	0.1018	0.1673***	0.2360***	
GDP per Capita (t-1)									0.2884***
No.of Obs.	1706	1417	1618	1632	1632	1217	1758	1640	1708
R square	0.266	0.006	0.023	0.018	0.012	0.007	0.373	0.302	0.221
High Income group									
CNU	0.0990**	-0.3331	-0.1446	0.038	-0.0767	-0.036	0.0731*	0.3591***	
GDP per Capita (t-1)									0.2382***
No.of Obs.	431	312	424	431	431	417	509	475	575
R square	0.062	0.007	0.004	0.003	0.026	0.01	0.14	0.587	0.191
Middle income group									
CNU	0.0237	-0.1836	0.5502**	0.0665**	-0.1459***	0.5594*	0.2103***	0.1532*	
GDP per Capita (t-1)									0.3075**
No.of Obs.	433	346	395	424	424	277	421	402	392
R square	0.177	0.025	0.033	0.037	0.072	0.021	0.368	0.21	0.183
Low income group									
CNU	0.0959***	0.0402	0.4643***	0.2009***	0.1409**	0.138	0.0599	0.2586***	
GDP per Capita (t-1)									0.2205**
No.of Obs.	842	759	799	777	777	523	828	763	741
R square	0.419	0.011	0.045	0.029	0.022	0.005	0.527	0.309	0.249
APEC									
CNU	0.7172***	-0.5078	1.1783	-0.2286**	0.0301	-0.2658	0.4424***	0.5306***	
GDP per Capita (t-1)									0.3697***
No.of Obs.	171	149	161	162	162	149	171	170	171
R square	0.655	0.061	0.064	0.086	0.159	0.021	0.652	0.706	0.82
OECD									
CNU	0.3157***	0.3671	0.6464	-0.029	-0.1220**	0.092	0.1277***	0.2919***	
GDP per Capita (t-1)									0.4205***
No.of Obs.	279	211	248	279	279	245	279	279	279
R square	0.218	0.022	0.04	0.124	0.24	0.017	0.313	0.641	0.314

* p<0.05, ** p<0.01, *** p<0.001
All variables are log-linear, except time variables. All regssions are time variable controlled.
Data source: GOA, World Bank, WDI panel data from 2008 to 2017
High income = log of GDP per capita equal to or exceed log of GDP per capita at 10 percentile
Low income = GDP per capita less than 50 percentile
Middle income = log of GDP between log of GDP per capita at 10 percentile and 50 percentile

Table 3.2 The Determinants of Air Connectivity

	World	High Incom group	Middle Income group	Low Income group	OECD	APEC
GDP per Capita (t-1)	0.2493***	0.1694**	0.2984***	0.2130**	0.1087	0.3731***
FDI	0.0456***	0.0048	0.0373**	0.0894***	0.0026	0.0176
Mobile per1000 persons	0.041	-0.0366	-0.0214	0.0335	0.2787	0.2453**
Tourist arrivals	0.1447***	0.4113***	0.0789**	0.1619***	0.2504**	0.2715***
Population	0.8996***	1.2531***	0.9823**	0.1398	2.1615***	-0.5517
Gross capital formation p	0.1946***	0.1394*	0.2046*	0.1534**	0.2120*	-0.1236
No.of Obs.	1130	285	289	556	242	147
R square	0.371	0.524	0.447	0.38	0.323	0.871

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

All variables are log-linear, except time variables. Results are obtained by fixed effect regressions.

Data source: GOA and WDI panel data from 2008 to 2017

High income = log of GDP per capita equal to or exceed log of GDP per capita at 10 percentile

Low income = GDP per capita less than 50 percentile

Middle income = log of GDP between log of GDP per capita at 10 percentile and 50 percentile

Number of tourists arrival data from World Bank

CHAPTER 4

Policy Recommendations for APEC

i. Expanding airport capacity and related-infrastructures—For many of the APEC cities, the provision of aviation infrastructure (e.g., runways, passengers and freight terminals, road linkages, railways linking to greater catchment areas, etc.) has been very much behind the demand for aviation services. This is true for developing economies, as well as for developed economies. Better planning, coordination and exchange of experiences would be essential for the enhancement of connectivity within APEC and between APEC and non-APEC economies.

ii. Achieving financing sustainability for aviation development—Improving air connectivity would require substantial financial resources. There are many funding sources to support the investment in aviation infrastructure, including non-aeronautical revenue, passenger tax, foreign direct investment, bond financing, loan financing, etc. APEC is the appropriate platform for providing the expertise and sources for such funding support. For every APEC economy, a sustainable financing arrangement would be necessary for the healthy development of the aviation industry. A designated special fund could be established under APEC for the purpose as well.

iii. Striving open skies liberalization—ASAs between respective APEC members are still restrictive to various extents, for different reasons. 5th Freedom Rights have rarely been granted. In order to enhance air connectivity, APEC should focus more on open skies liberalization among APEC members.

iv. Deregulating the aviation industry—There have been many monopolistic and anti-competitive elements in the aviation industry, including the domination of one major airline, unfair competition with foreign airlines, unnecessary regulations against LCCs, direct and hidden subsidies, a single supplier of certain airport services, etc. It is important for every APEC member to review and de-regulate the aviation industry, permitting a level playing field for new entrants and international participants.

v. Assessing and providing aviation manpower—Based on ICAO's assessment on "NextGen Aviation Professionals", there will be a severe shortage of skilled personnel in the aviation industry in the next 20 years. The rapid development of aviation technology and the trend of retirement are two of the major reasons. Developing countries, in particular, would be in a disadvantageous position because of lacking resources and expertise. This should be the responsibility of advanced economies to provide the leadership for training and supplying the aviation manpower within the APEC family.

vi. Enhancing airspace management—With rapid aviation development within APEC, more airspace congestions and flight delays would result. It is important to consider establishing a multinational institution, similar to Eurocontrol in the EU, to rationalize the airspace management within APEC.

vii. Introducing slot trading—There are many Level-3 airports in APEC, with capacity constraints could not be mitigated, even in the long–term. Slot trading could improve the operational efficiency of congested airports. APEC, probably with the assistance of IATA, could provide a platform for facilitating the introduction of slot trading in APEC.

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Air Connectivity in APEC: Development and Challenges

This study aims at investigating the air connectivity among APEC economies and also in the context of the global aviation network. In the APEC Leaders' 2013 Declaration, APEC leaders affirmed their vision of reaching a seamlessly and comprehensively connected and integrated Asia-Pacific balanced on three pillars — physical connectivity, institutional connectivity and people-to-people connectivity. Further, in 2014, an APEC Connectivity Blueprint for 2015-2025 was developed to guide the region's efforts to better integrate the region. The study will use the NetScan model to measure the connectivity of major airports of APEC economies in the period between 2009 and 2017. The results will show the changes in connectivity of the airports in the study period. Thus, the results may shed lights on the strategies and policies on how to establish a seamlessly and comprehensively connected aviation network among APEC economies.

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