Is it time for an integrated aviation market in Northeast Asia? An airline performance perspective

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Abstract: This research first examines the link connectivity of major Northeast Asian carriers at country levels, and then uses a dynamic network DEA model to assess these carriers' efficiency performance. The connectivity measure suggests that although China, Japan and Korea differ in the size of domestic markets, the major carriers of the three countries do not differ much in terms of their connectivity performance in their key international markets. Chinese and Japanese carriers are quite similar in technical efficiency while Korea's two carriers take the lead in this measure. We thus present an argument that most of the carriers in this region are operating at a near-level playing field and it is time to push forward the aviation market integration agenda in Northeast Asia.

Keywords: Aviation market integration; Northeast Asia; Connectivity; Airline efficiency

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1. Introduction

The success of European Union (EU) integration has inspired other regions around the world to consider and pursue various forms of integration and common market arrangement. The Association of Southeast Asian Nations (ASEAN) Economic Community is an example, which has been relatively successful in enabling the free flow of goods, services, capital, skilled workers, and investment. The development of the ASEAN Single Aviation Market (SAM) is particularly impressive: the number of international passengers in this region increased from 141.9 million in 2010 to 288.8 million in 2017 (ASEAN, 2019). Amid the China-United States (US) trade war and protectionism threat in recent years, China has had a greater incentive to seek a free trade agreement (FTA) with other countries, and achieving an FTA deal with its Northeast Asian (NEA) partners, namely, Japan and Korea,[1] is on the top agenda. NEA is a region of global significance: China, Japan and Korea are the world's second, third and 11th largest economies, respectively, and together they make up more than a quarter of the world's GDP and one-fifth of the world's international trade, greater than the size of the economy of the EU. However, the degree of economic integration in NEA has lagged behind other regions such as the EU, ASEAN, and North America.

NEA countries have realised the need to complete an FTA as soon as possible, which will benefit all parties. However, the progress of free trade in airline services among China, Japan and Korea has been slow and the NEA sky remains largely regulated, although air traffic in this region has recorded a dramatic increase over the last several decades. In the last 15 rounds of NEA FTA negotiations, aviation market integration was not touched. More broadly, air transport services between two countries have been governed by bilateral agreements for many decades. A typical air service agreement (ASA) grants airlines designated by the signatories the rights to fly between the two countries. Designation usually applies only to the airlines owned and controlled by residents of the economy making the designation. Many bilateral agreements also restrict the capacity and frequency of the services that the designated airlines provide (Zhang and Findlay, 2011; Zhang et al., 2011). Consequently, these arrangements are expected to raise costs and prices, hampering the movement of goods and people and inhibiting the extent of international integration.

[1] The word "Korea" in this article refers to "South Korea".

There have been regular meetings among the aviation authorities of the three NEA economies. Korea is keen to pursue an 'open skies' deal in this region, given its relatively small domestic market and its close cultural and economic links with China and Japan. The signing of an open-skies agreement between Japan and Korea from 2007 has lifted restrictions on frequency, capacity and destinations, with the exception of the two congested Tokyo airports, covering both passenger and cargo services (Lee, 2011). China opened the 5th freedom rights to all foreign airlines in Hainan Province in 2004. The effect of this unilateral open-skies policy on the tourism industry has been tremendous (Zhang and Findlay, 2011). Open-skies arrangements have also been implemented between China's Shandong province and Korea since 1996. China and Japan reached an open-skies deal in 2012 but this deal excludes flights to/from Beijing, Shanghai, Tokyo Haneda, and Tokyo Narita (Lee, 2016). In 2019, China and Korea signed an expanded bilateral air services memorandum of understanding to add 14 weekly flights between Beijing and Seoul to support Beijing Daxing International Airport that was opened in September 2019 (CAPA, 2019).

From 2008 to 2017, NEA's air passenger volume more than doubled - from 370 million to 760 million - representing 15% and 20% of the world's total traffic, respectively. China was the main contributor to this growth. This can be clearly seen from Figure 1. In 1990, China and Korea had roughly the same size in the air passenger sector with Japan being number one of the three. However, in the last three decades, the air passenger growth rate in China was remarkable. It surpassed Japan in 2004 and maintained a two-digit annual growth in the following 15 years. China has been the world's second largest aviation market in terms of the volumes of passengers and air cargo moved in its domestic market since 2007. IATA forecasts that China will overtake the US as the largest air passenger market in the mid-2020s measured by traffic to, from, and within a country. Growth in China and other Asian economies including India, Indonesia and Thailand may shift the centre of gravity of the air transport industry from the west hemisphere to Asia in the next two decades.

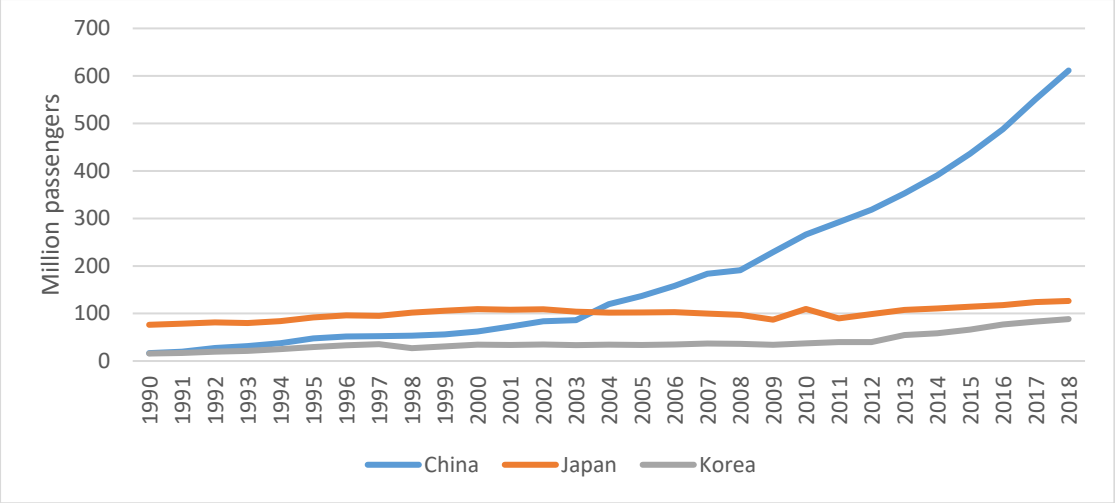

Figure 1. Number of passengers carried in China, Japan and Korea, 1990-2018 (Source: World Bank)

Despite the huge benefits of the liberalisation and open-skies arrangement that have been confirmed in numerous studies (e.g., Fu et al., 2010; Zhang and Findlay, 2014; Laplace et al., 2019), the movement to free trade in air services is slow and has been hampered by many obstacles. Forsyth (2013, p.403) pointed out that 'the traditional approach to air services negotiations has been one steeped in mercantilist notions' and that 'the negotiations were excessively airline centric' with little attention being given to the interests of consumers. Furthermore, the air negotiators did not give sufficient consideration to the economic interests of the nation. This research will examine the performance of the major carriers in NEA in terms of their network connectivity at country levels and technical efficiency, and present an argument that most of these carriers are operating at a near-level playing field and thus it is time to push forward the NEA single aviation agenda.

2. Relevant Studies

Given the close economic and cultural ties, the possibility of adopting an open-skies regime or establishing an integrated single aviation market in NEA has been explored by a few transport researchers. Oum and Lee (2002) and Zhang (2001) discussed the possibility of creating open skies in NEA and identified many obstacles. The reluctance of the state-owned carriers was one. Forsyth (2013) also pointed out that national carriers constitute the largest barrier to international air transport liberalisation. China, Japan and Korea have a long tradition of protecting their flag carriers (Zhang, 2001; Oum and Lee, 2002). It is no secret

that Air China is a favourite child of the Chinese government and has long received special treatment (Lee, 2016). Wang et al. (2018) note that China's state-owned airlines could exercise a significant influence on the decisions made by the Civil Aviation Administration of China (CAAC), the aviation regulator, and any aviation reforms and new aviation policies would put the interests of the state-owned airlines first. This has led to a slow and chequered deregulation process in China.

Zhang (2005, 2008) proposed a roadmap towards an integrated aviation market in NEA. Strategies were proposed to remove the barriers to liberalisation including regulatory and institutional barriers, administrative and customs barriers, infrastructure and financial barriers, and technical barriers. An integrated NEA air transport market is expected to go through a lengthy process because of inherent economic, political and social obstacles. Nevertheless, this does not imply that NEA should passively wait for the right conditions to emerge by themselves, considering that the region already lags behind other major regions in terms of air transport services integration. In fact, in the past decade, most of the obstacles have changed or disappeared. The benefits of open skies and the single aviation market examples have been observed and accepted by many governments and consumers, which makes the conclusion of an open-skies zone in NEA more possible than in the early 2000s. Lei et al. (2016) claim that one fundamental change in China's international aviation policy in recent years is that the interests of the state-owned carriers is no longer the sole consideration when the government negotiates traffic rights with foreign countries. Liu and Oum (2018) contend that the rapid growth of China's big three has conferred them with the opportunity to play a leadership role in the world air transport sector. Adler et al. (2014) modelled the likely impacts of liberalisation of the transport market in NEA and suggested that more liberal arrangement can benefit both consumers and the airline sector. For example, granting cabotage will increase competition and frequency, and reduce fares. However, the benefits may not be distributed evenly across the market players.

Law et al. (2018) noticed that in recent years, the US major carriers asked the US government to end open-skies agreements with Qatar and United Arab with the excuse that the gulf carriers received subsidies from their governments, which put their US counterparts at an unlevelled playing field. In 2017, Air France-KLM and Lufthansa Group requested the European Commission to ensure fair competition in the aviation industry with the same claim that the Gulf carriers obtained illegal subsidies from their governments. de Wit (2014)

argued, however, that the unlevelled playing field mainly comes from the fact that some airlines such as the Gulf carriers are based in a favourable location, which gives them a competitive advantage. This should not be a reason to turn to protectionism. Regarding the subsidy claim, open-skies agreements never spell out the definition of a subsidy and many national airlines, including the US carriers, have received various forms of financial support from their government. For example, the big-three carriers in the US received more than $70 billion from 2000 to 2015 including a benefit of $30.96 billion from bankruptcy debt relief (Cline, 2016).

Although transport researchers have developed fine arguments against air transport protectionism in the excuse of unfair competition, in reality and in the government's decision, the current performance of its national carriers and the potential impact of the proposed liberalised arrangement are still a significant consideration. Therefore, this research aims to analyse the performance of the major NEA carriers in network development and technical efficiency, which will contribute to the negotiation and formulation of an integrated aviation market in NEA. Specifically, we will look at how the NEA carriers have developed their link connectivity between countries and what patterns have been exhibited in the period from 2006 to 2018. We will also explore their technical efficiency performance in recent years and see if they are ready to embrace greater challenges and more intense competition. The measures and relevant literature are presented in Section 3, followed by the results and analysis in Section 4. The last section concludes.

3. Methodology

3.1 Measuring airline link connectivity

The basic connectivity measure has been described in Zhang et al. (2017), in which the connectivity of 69 Chinese airports was calculated.[2] Following the same spirit, we only slightly modify this measure to calculate the link connectivity of the major airlines in NEA at the country level. This connectivity measure considers quantity and quality factors such as the availability of seats (capacity) and travel time (velocity). We let k represent a unique flight between origin airport i and destination airport j. The connectivity ($\text{Connectivity}_{ijk}$)

[2] As extension of this approach to measure multi-modal connectivity can be found in Zhu et al. (2019).

that flight *k* from airport *i* to airport *j* contributes is calculated by multiplying the velocity discount and capacity discount (Eq. 1),

$$\text{Connectivity}_{ijk} = D_{Cap_{ijk}} \times D_{Vel_{ijk}} \quad (1)$$

where $D_{Cap_{ijk}}$ represents the capacity discount for connection *k* between airports *i* and *j*. $D_{Vel_{ijk}}$ represents the velocity discount.

To calculate the capacity discount, we need to choose a benchmark capacity. For convenience, a seat number of 434 was chosen as the benchmark for this study as it is the number of seats of Boeing 747 used in China in 2006. Similarly, we need to select a velocity benchmark. As most jets cruise at an average speed of 900km/h, this value is set as the velocity benchmark.[3]

If we denote the capacity of flight k from airport i to airport j as $Seat_{ijk}$, the capacity discount $D_{Cap_{ijk}}$ can be expressed as,

$$D_{Cap_{ijk}} = \sqrt{\frac{Seat_{ijk}}{434}} \quad (2)$$

The velocity discount is calculated based on the following system of equations:

$$Duration_{Adjusted_{ijk}} = T_{landing_{ijk}} - T_{takeoff_{ijk}} + t_{airport_{ijk}} \quad (3)$$

$$\text{Velocity}_{ijk} = \frac{Distance_{ij}}{Duration_{Adjusted_{ijk}}} \quad (4)$$

$$\text{D}_{Vel_{ijk}} = \sqrt{\frac{\text{Velocity}_{ijk}}{900}} \quad (5)$$

where $Duration_{Adjusted_{ijk}}$ is the adjusted time length (duration) of flight *k* from airport *i* to airport *j*. The scheduled in-flight time between two airports is the difference between the

[3] The choice of the benchmark values only affects the scale of the capacity discount and does not hamper the purpose of comparing the connectivity scores between airlines or over time.

scheduled arrival time and scheduled departure time, $T_{arrive_{ijk}} - T_{depart_{ijk}}$. Extra time at the airports is denoted by $t_{airport_{ijk}}$. For simplicity, 100 minutes for domestic flights and 180 minutes for international flights are assumed to be the extra times required to fulfil the necessary formalities such as security check at the departure airport and baggage re-claim at the arrival airport.

The link connectivity between airport *i* to airport *j* of an airline is the sum of the connectivity of all the flights of this airline between airport *i* and airport *j* in both directions, which can be expressed as:

$$\text{connectivity}_{ij} = \sum_{m} \text{connectivity}_{ijm} + \sum_{n} \text{connectivity}_{jin} \qquad (6)$$

It is easy to obtain the link connectivity of an airline between two countries by considering all the flights operated by this airline between these two countries.

The flight schedule and aircraft type data are extracted from IATA AirportIS covering a period from 2006 to 2018. We consider all the direct flights running between two countries and so the connectivity measure reflects the annual connectivity between two countries.

3.2 Measuring airline efficiency performance

Data envelopment analysis (DEA) has been a popular approach in measuring the efficiency. However, in the last decade or so, researchers have formed the view that traditional DEA models tend to ignore the internal structure of Decision-Making Units (DMUs) and the intertemporal efficiency changes over time (Yu et al., 2019). For example, the operation of a typical airline company involves two stages: the production stage and the consumption or service stage (Yu and Chen, 2017). In the first stage, capacity is produced and in the second stage, the capacity is used as an input to generate service outputs (Zhu, 2011). Following Omrani and Soltanzadeh (2016), we label these two interconnected stages as 'production' and 'consumption', respectively. Researchers have also realised that a firm's efficiency performance is based on the resource allocation and production decisions over time and thus the interdependence between different periods needs to be acknowledged. That is, the connecting activities or transition elements between periods need to be accounted for. Therefore, different versions of network and dynamic DEA models have been developed.

This research follows a dynamic network DEA (DNDEA) framework proposed by Tone and Tsutsui (2014), which is illustrated in Figure 2.

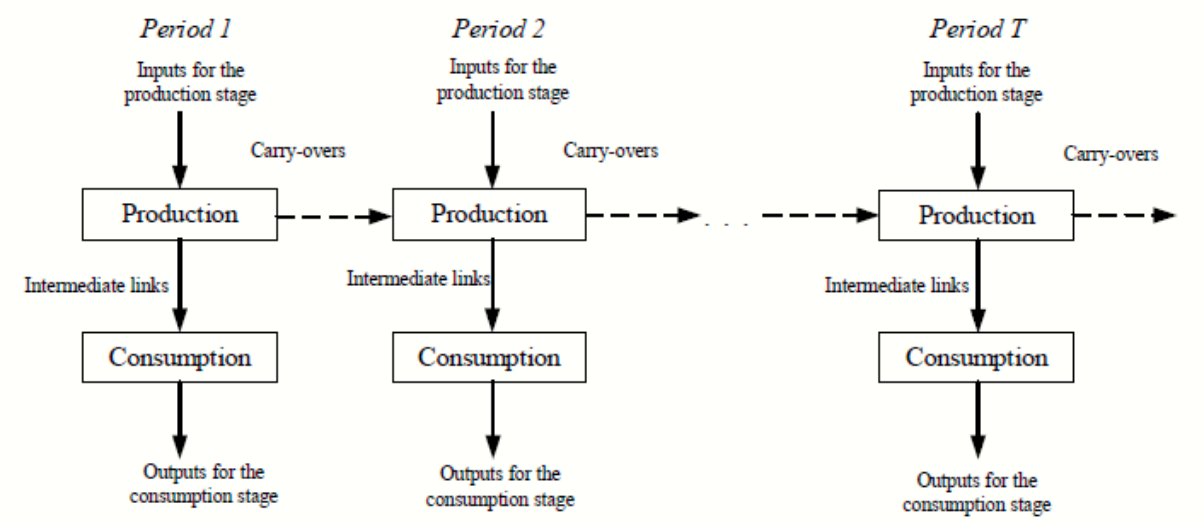

Figure 2. Two-stage structure of an airline

As the airline industry is a labour and capital intensive industry, many DEA studies examining airline efficiency have used the number of employees and fleet size as two main input variables (e.g., Duygun et al., 2016). Revenue passenger-kilometres (RPK) and revenue tonne-kilometres (RTK) are commonly used outputs (Yu, 2016), which are also used in this research.

Following Omrani and Soltanzadeh (2016) and Li and Cui (2017), available seat kilometres (ASK) is used as an intermediate output linking the production and consumption stages. Tone and Tsutsui (2010) and Cui et al. (2016) contend that capital stock is not only an output of the current year, but also an input of the next year. Following this argument, total assets is taken as a carry-over variable or a dynamic factor. All the data used for DNDEA are obtained from relevant airlines' annual financial reports. We build our DNDEA model under the constant returns-to-scale (CRS) assumption and within the slacks-based measure (SBM) framework developed in Tone and Tsutsui (2014). This is because although an airline may operate under variable returns to scale (VRS) in the short run, in the long run, it could adjust its capacity to move to CRS (Cummins and Xie, 2013).

The indicators selected for input, output, intermediate product and carry-over and the descriptive statistics are explained in Table 1. The DEA-Solver Pro software was used to produce the efficiency scores.

Table 1. Descriptive statistics of the input, output, intermediate product and the carry-over variables

Variable	Mean	Std. dev.	Min.	Max.
Inputs				
Number of employees	44,037	26,962	9,594	96,234
Fleet size	330	205	80	754
Outputs				
RPK (million-km)	105,745	52,740	35,017	230,697
RTK (million-km)	5,768	2,490	1,738	230,697
Intermediate output				
ASK(Million-km)	134,162	63,486	31,206	280,646
Carry-over				
Total asset (Million USD)	21,897	8,317	5,715	230,697

4. Results

4.1 Link connectivity

We calculate the air link connectivity of the major carriers in NEA including China's 'big three', namely, Air China, China Eastern, China Southern, Japan's Japan Airlines (JAL) and All Nippon Airways (ANA), and Korea's Korean Air and Asiana Airlines. It is understood that these major carriers have substantial power of influence over their home country's aviation policy. Analysing their link connectivity between countries and their efficiency performance can generate important information that is essential to the airline managers and aviation policy makers. The link connectivity of each carrier is presented in Tables A1-A7 in Appendix A. Each table contains the airline's domestic market link connectivity and the links with the top nine economies measured with the 2018 data.

Tables A1-A3 show that China is a growth market and the connectivity of the big three more than doubled from 2006 to 2018 in the domestic market. In contrast, the connectivity of the two Korean carriers shrank during this period in their domestic market as shown in Tables A4-A5. Tables A6-A7 suggest that Japan Airlines also recorded a decrease in link connectivity in its domestic market and ANA only saw a very slight increase in connectivity

in the period 2006-2018. To Korean Air, the US is the most important market, followed by Japan and China. However, the increase in connectivity to China was much higher than the increases to the US and Japan markets during the study period. Similarly, to Asiana, the connectivity with China is much higher than with Japan. For all the Japanese and Korean carriers, their links between Korea and Japan decreased or stagnated from 2006 to 2018 while their connections with China experienced a substantial increase except Japan Airlines whose link with China declined over time.

China's big three have some common important markets such as the US, Japan, Korea, Australia and Thailand. However, they each have different focuses. Japan is the most important market to China Eastern whose link connectivity between China and Japan reached 7,378 in 2018. In contrast, China Southern's connectivity in the China-Japan market was only 3,265 in 2018 and this figure was 5,488 for Air China. The top international market was the China-US market for Air China, and China Eastern's connectivity was also very high in this market. In 2018, China Southern had the highest connectivity from China to Thailand, recording a connectivity of 5,136, followed by China Eastern's 4,728 and Air China's 3,652.

Air China had a heavy presence in the markets between China and European countries such as Germany, France and Italy. However, none of these European markets appears in the China Eastern and China Southern's top list. This is largely a historical legacy as Air China is the flag carrier and was the only designated one in early ASAs. The China-Australia market is important to all the big three carriers, particularly China Southern. China Southern Airlines has been the largest carrier in the Australia-China market since 2011. It has launched non-stop services to all major Australian capital cities from China, including Adelaide, Brisbane and Perth. In 2016, China Southern carried about one-third of all arrivals into Australia from China.

China Eastern and Air China recorded great increases in connectivity in almost all of their international markets except the mainland China-Hong Kong market which saw decreases from 2006 to 2018. The decrease for China Eastern is particularly obvious. At the same time, the link connectivity between China and Taiwan exhibits steady growth from almost nothing. This is because regular scheduled flights were not available between the two before the end of 2018. Only limited chartered flights were available between 2003 and 2008. Since 2008, the vast majority of the passengers travelling between China and Taiwan chose direct flights. Before that, most of them had to take a connecting flight at Hong Kong or Macau.

Vietnam has become an important market to Japanese and Korean carriers, and their links with Vietnam grew substantially from 2006 to 2018, reflecting their trade and investment ties with this young and growing economy. Vietnam is also a key destination market for China Southern. In fact, all the carriers considered in this study share some key common markets: the markets within the NEA region might be their top priority, followed by the US, ASEAN and Australia markets.

4.2 Efficiency performance

The overall and period efficiency scores for the major carriers in the three NEA economies are reported in Table 12. Cathay Pacific is included as a benchmark. The rank column shows the ranking of the airlines based on the overall efficiency score.

Table 2. Overall and period efficiency

Airline	Overall Score	Rank	2012	2013	2014	2015	2016	2017
Japan Airlines	0.265	6	0.211	0.231	0.310	0.236	0.300	0.358
ANA	0.426	4	0.399	0.454	0.452	0.360	0.464	0.454
Korean Air	0.887	1	0.787	0.780	1	0.825	1	1
Asiana	0.750	3	0.613	0.65	0.821	0.726	0.890	0.899
Air China	0.316	5	0.263	0.271	0.361	0.298	0.375	0.372
China Eastern	0.260	7	0.235	0.244	0.371	0.253	0.311	0.204
China Southern	0.257	8	0.212	0.216	0.287	0.242	0.306	0.320
Cathay Pacific	0.860	2	0.720	0.738	1	0.812	1	1

Table 2 suggests that all the airlines were more efficient in 2017 than in 2012,[4] except China Eastern. Korean Air and Cathay Pacific ranked consistently in the first two places from 2012 to 2017, closely followed by Asiana. The efficiency scores of Chinese and Japanese carriers do not differ much with ANA's performance being slightly better. Therefore, it appears that Korea's two carriers fall within the first-tier group while Chinese and Japanese airlines can be classified as second-tier carriers.

Figures 3 and 4 show the airline efficiency in the production and consumption processes, respectively. Interestingly, airlines exhibited relatively stable efficiency performance in the production stage while in the consumption stage, the performance was subject to a wider

[4] We are constrained by the data availability and cannot present a longer period efficiency analysis as the connectivity analysis.

fluctuation, probably indicating that airlines had a better control over the level of their capacity, but whether they could fill the capacity was also affected by external conditions. Again Korea's two carriers had higher efficiency in both stages while China's big three and Japan Airlines remained in the bottom in the two processes. However, Japan Airlines' efficiency exhibited a steady increase in recent years in the consumption stage, which is consistent with the findings reported in Yamaguchi (2019).

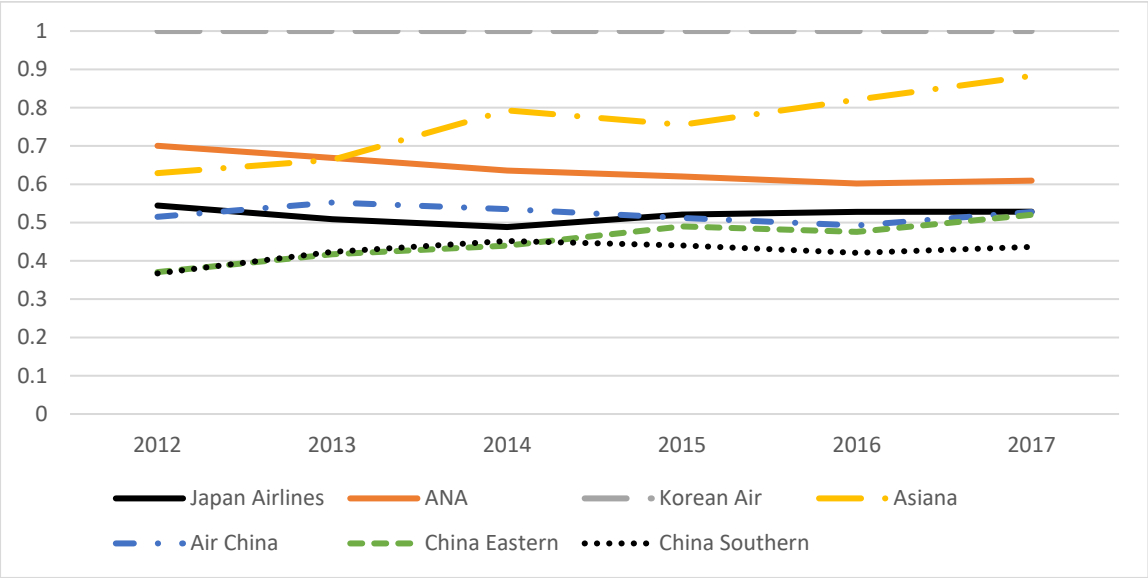

Figure 3. Efficiency performance in the production stage

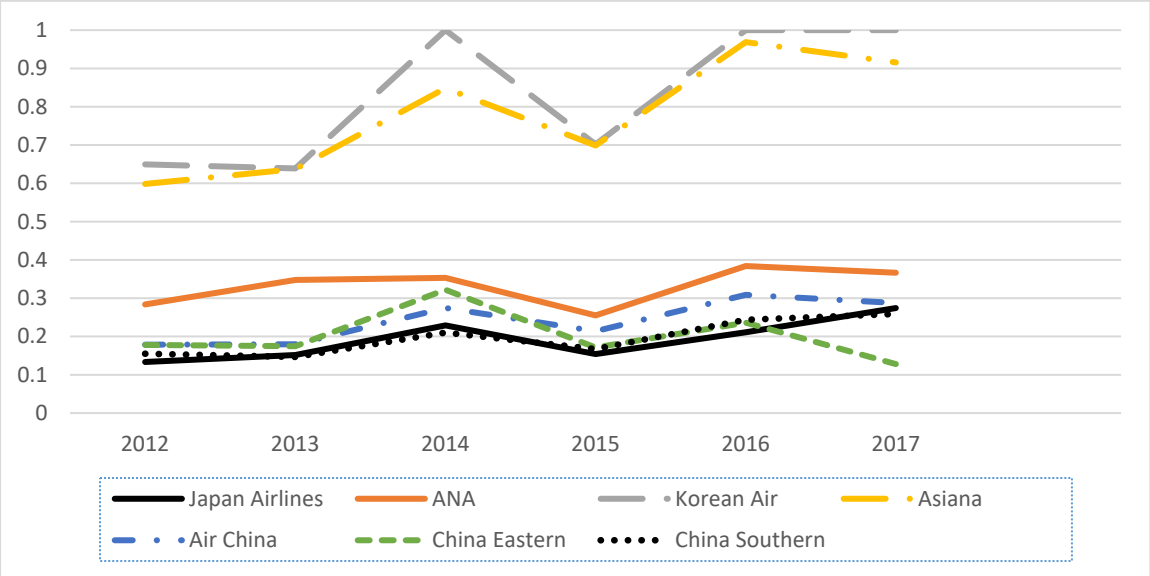

Figure 4. Efficiency performance in the consumption stage

5. Achieving an Integrated Air Transport Market in NEA

Zhang (2005) proposed step-by-step liberalisation/integration strategies in NEA. In the first phase, the NEA countries should focus on deregulating their domestic markets and liberalising existing bilateral ASAs. In the second phase, the NEA countries should focus on the unification of air trade rules and reduce regulatory barriers to cross investment and alliance formation by airlines. In the third phase, a multilateral open skies agreement should be negotiated to establish an integrated aviation market for NEA. This proposal came at a time when the bilateral ASAs in NEA were quite restrictive. 20 years ago, China was a relative newcomer to the global market and the country's airlines were in a state of development and far from mature (Zhang, 2005). Chinese airlines could not maintain the level of service quality of their foreign counterparts. In contrast, Japan and Korea had well-established carriers with extensive international networks by the early 2000s. The bilateral ASAs between China, Korea and Japan were more restrictive than the standard Bermuda I agreements (Button, 2003). This was even so for China's international air transport policy. For instance, the reciprocity principle in third/fourth freedom negotiations was based on the actual market shares between the Chinese and foreign carriers, rather than on the capacity provisions. China even proposed that a carrier be compensated, if it did not make the revenue equivalent to its share of bilateral operations (Zhang, 2005). To restrict competition in the long-haul markets to the US and Europe, CAAC adopted a "one route, one carrier" policy, and the rights to serve these markets were largely reserved to the state-owned carriers.

Park (2002) identified 30 factors constraining the air services liberalization between China and Korea, including: the egoistic attitude of China's international route allocation policy, China's conservative attitude towards open skies, China's strong control over visa issuing and international traveling of its citizens, lack of implementation of China's air cargo agreement, conflicts between Korean carriers with respect to liberalisation, lack of professional manpower in both countries, and poor management and service levels of Chinese carriers. Park also identified 30 major barriers impeding liberalization of the Korea-Japan market, including the historical conflicts, Japan's protectionist tendencies in international air transport services, gaps in market size between the two countries, saturation of all routes between Korea and Japan, insufficient airport capacity in Tokyo area, and Japan's restrictive visa control against Korean travellers.

However, 20 years on, most of the fundamental factors impeding an integrated aviation market in NEA no longer exist or at least have been mitigated. Visa arrangements between the NEA countries have been much easier and simpler. The three countries have been negotiating an FTA. All of the three NEA countries have embraced the concept of open skies and have completed quite a few open skies agreements with some key aviation markets. At the same time, the bilateral ASAs between NEA countries have been gradually liberalised. For example, Duval (2016) reports that Korea and Japan concluded an open skies agreement in 2007 but with a limit on the capacity to Tokyo's Narita Airport. This limit was gradually removed after 2010 when the second runway was constructed. A limited number of fifth freedom to the US via Japan was granted to Korean carriers. The seventh freedom right was further added to this open skies agreement in 2013. As noted earlier. China and Japan reached an open skies agreement in 2012 with flights to/from Beijing, Shanghai, Tokyo Haneda and Tokyo Narita being excluded, but air services between Beijing, Shanghai and Tokyo have gradually increased in the last few years. China and South Korea's bilateral ASAs grouped the routes between the two countries into four zones. Zone 1 includes the routes between Incheon and Beijing and Shanghai. Zone 2 consists of the routes between other Korean airports and Beijing and Shanghai. Zone 3 contains the routes from Incheon to Chinese airports other than Beijing and Shanghai, while Zone 4 includes the routes between the two nation's airports outside Beijing, Shanghai, and Incheon. This partition has provided a good practice in establishing an integrated aviation market in NEA when it is difficult to reach agreements involving all metropolitan cities. With the launch of Beijing Daxing Airport, the weekly frequencies of all the four zones have increased with a total of 608 flights between the two countries.

It should be acknowledged that quite often, strong opposition to open skies comes from the airline industry. For example, the Australian government proposed an open-skies policy to be applied in Northern Australia, permitting domestic passengers flying to destinations such as Broome, Townsville, Cairns and Darwin to be serviced by overseas airlines. This policy intended to stimulate economic development and tourism in these regional areas. However, Australia's two carriers, Qantas and Virgin vehemently opposed this proposal and argued that they had invested heavily in these regions, and that this plan would put Australian aviation jobs at risk and force Qantas and Virgin to suspend routes to smaller towns and cities. As a result, this proposal did not go ahead. Zhang (2005) mentioned that the airline industries of the NEA three countries were tightly regulated for a long time, which resulted in their

national flag carriers exhibiting large differences in their competitiveness. This served as one of the key obstacles to the liberalisation of air transport in NEA.

This research's findings can assist us to evaluate Zhang's (2005) road map towards the NEA integrated aviation market and reassess the role of national carriers as an obstacle towards an open-skies arrangement. The above analysis has shown that the first-stage objectives have been largely realised, and today, a liberal ASA is the norm and all the three countries have accepted the concept of open skies. We thus argue that it is time for the NEA countries to consider the construction of an integrated aviation market without the need to use the step-by-step approach for the following reasons.

First, our research shows that the major carriers in NEA do not differ much in terms of presence in the major international markets. For all carriers under study, the NEA countries are their key destination markets. Outside this region, the US and ASEAN markets are the most important markets to most of the NEA carriers. For example, the total connectivity of China's big three to the US was 15,791 in 2018. This figure was 16,259 for Korean' big-two carriers and 19,941 for Japan's big-two carriers. These numbers are quite comparable. Both Korea and Japan have had open-skies agreements in place with the US. The China-US ASA has also been liberalised, which affects not only the China-US bilateral market but also the Korea-China and Japan-China country-pair markets, since both Korea and Japan offer alternative routings for the China-US traffic with one-stop connections. In a similar fashion, the fifth-freedom rights that US carriers enjoy out of Tokyo and Incheon would affect the US-China bilateral market and traffic in/out of major Chinese hubs. Zhang (2008) argues that when NEA is viewed as a unit, the fragmented approach by each NEA country towards the US in negotiating ASAs might be suboptimal as compared to a unified, concerted approach. Without an integrated aviation market and coordinated arrangements, the three NEA economies tend to be engaged in fierce competition to encourage convergence of air transport business onto their own home hubs (Yoshida, 2004). That is, if each country's strategic aim is to channel traffic originating in the others' hinterland regions into their own hubs for onward carriage to Europe or the US, then the policy implication is that air services negotiators of each country may be over-generous – relative to a unified, concerted approach when the interests of the *whole region* are considered. In addition, a unified, concerted approach may be a more strategic and effective way to deal with the US 'divide and conquer' strategy (Oum, 1998).

Second, obviously carriers of Korea and Japan may benefit more from the move towards an integrated market, considering their relatively small domestic market. However, this does not necessarily mean a loss to China and Chinese carriers. China's gateways cities such as Beijing, Shanghai and Guangzhou do not lack direct international air services. However, other Chinese cities desperately want to attract new and keep the existing international services. The local government has to inject a large amount of money each year to keep their international flights running. Unfortunately, many airlines are opportunistic and frequently suspend the services when more profitable markets become available or another city gives a higher subsidy for operating international flights. An integrated aviation market will benefit China's second- and third- tiers cities as more foreign carriers can expand their networks into China. China has been the largest source market of international tourists to many countries. Chinese airlines can use its marketing advantages to attract more passengers than their NEA counterparts. Our link connectivity results show that Chinese airlines have recorded impressive growth in both domestic and international markets. They have outperformed or posed serious threat to many of the legacy carriers servicing the China market. For example, in the China-US market, the allocated quota has been used up by Chinese carriers that are now pushing for an increase of the capacity between the two countries, while 10 years ago it was the US carriers that called for the capacity increase. This is also the case for the China-Germany market where it was the Germany side that was reluctant to increase the flight frequency and capacity.

Third, our efficiency results suggest that China and Japan's major carriers are quite comparable in terms of their technical performance. In fact, the relatively cheap labour may have led Chinese carriers to use more workers in their operations, which may have resulted in lower efficiency shown in this research. There is nothing wrong with this, particularly in the context of the Chinese government encouraging the creation of jobs. The relatively higher efficiency of Korea's two carriers might be due to the fact that they have smaller domestic markets and had greater incentives to cut costs to make themselves more competitive in the international markets. There is no doubt that fiercer competition in an integrated aviation market will make Chinese carriers even stronger.

6. Conclusion

This research examines the link connectivity of major carriers in Northeast Asia as well as their efficiency performance. The connectivity measure shows that China is a growth market,

and the connectivity of its big-three airlines more than doubled from 2006 to 2018 in the domestic market. In contrast, the connectivity of the big-two Korean carriers shrank during this period in their domestic market. Japan Airlines also recorded a decrease in link connectivity in its domestic market, and ANA only saw a very slight increase in connectivity during the period 2006-2018. To Korean Air, the US is the most important market, followed by Japan and China, but the increase in connectivity to China was much higher than the increases to the US and Japan. Similarly, to Asiana, the connectivity with China was much higher than that with Japan. For all the Japanese and Korean carriers, their links between Korea and Japan have decreased or stagnated, while their links with China experienced a substantial increase from 2006 to 2018, except for Japan Airlines whose link with China decreased over time. We have also shown that Chinese and Japanese carriers are quite similar in technical efficiency while Korea's two carriers performed much better. In fact, Chinese carriers are more competitive now than they were 20 years ago thanks to the deregulation in the domestic and international markets. They have emerged as strong competitors to Korean and Japanese carriers in Northeast Asia as indicated by the link connectivity measure.

We thus argue that the national carriers in NEA should no longer act as the single largest barrier to international air transport liberalisation when they do not differ significantly in competitiveness. It is time to move forward the aviation market integration agenda in this region. This is actually in their best interest as an integrated market will give them a larger market to play in and a better position to compete with the carriers outside this region. It is also expected that this move will result in a deeper integration of the economies of the NEA countries.

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Appendix A

Table A1. Link connectivity of China Eastern

Origin country	Destination country	2006	2008	2010	2012	2014	2016	2018
China	China	73,724	87,035	112,107	130,209	149,518	165,668	190,927
China	Japan	3,617	4,125	4,558	4,898	4,799	7,435	7,378
China	US	945	1,117	1,428	1,797	3,138	5,237	5,655
China	Thailand	1,009	922	1,149	1,802	2,733	3,931	4,728
China	Korea	3,264	3,793	2,637	2,776	3,726	4,541	3,473
China	Australia	681	661	923	1,333	1,805	2,349	3,307
China	Hong Kong	6,425	5,321	3,798	3,106	3,276	2,898	2,982
China	Taiwan	-	56	941	1,786	2,149	2,216	2,229
China	Canada	484	325	530	686	1,065	1,821	2,014
China	Singapore	1,278	1,319	1,522	2,117	1,692	1,872	1,931

Table A2. Link connectivity of Air China

Origin country	Destination country	2006	2008	2010	2012	2014	2016	2018
China	China	67,494	76,312	94,778	100,815	109,989	118,678	133,816
China	US	1,918	2,224	2,128	2,729	4,819	5,839	6,693
China	Japan	3,305	3,693	4,322	4,208	4,418	5,236	5,489
China	Germany	2,061	2,224	2,194	2,613	3,161	3,482	3,729
China	Thailand	569	603	530	732	1,185	2,504	3,652
China	Hong Kong	2,718	2,438	2,441	2,541	3,005	2,670	2,569
China	Australia	659	976	1,265	1,548	1,496	1,806	2,144

China	Korea	1,974	1,921	1,587	1,791	2,348	2,901	2,002
China	France	883	772	625	990	1,094	1,674	1,956
China	Italy	802	1,079	1,082	1,407	1,568	1,694	1,875

Table A3. Link connectivity of China Southern

Origin country	Destination country	2006	2008	2010	2012	2014	2016	2018
China	China	109,315	118,764	154,503	162,372	190,754	190,260	213,278
China	Thailand	642	687	896	1,416	2,908	4,903	5,137
China	Australia	546	565	1,279	2,938	3,094	4,068	4,652
China	US	665	638	514	846	1,233	3,411	3,443
China	Korea	2,198	2,334	2,486	2,752	3,922	4,413	3,281
China	Japan	2,871	2,773	2,380	2,626	2,031	3,281	3,265
China	Vietnam	626	608	630	709	893	1,460	3,122
China	Taiwan	-	24	802	1,508	2,188	2,033	2,142
China	Malaysia	368	458	527	804	683	1,462	2,137
China	New Zealand	-	-	-	636	992	1,635	1,491

Table A4. Link connectivity of Korean Air

Origin country	Destination country	2006	2008	2010	2012	2014	2016	2018
Korea	US	8,100	8,375	8,986	10,154	10,489	10,564	10,623
Korea	Korea	16,097	15,597	13,881	12,412	11,084	11,492	10,604
Korea	Japan	6,137	6,038	7,074	7,497	6,632	6,923	6,733
Korea	China	3,397	4,573	4,398	5,091	5,745	6,531	6,532
Korea	Vietnam	705	861	893	1,231	1,669	2,309	3,236
Korea	Thailand	1,762	2,081	1,993	2,727	2,524	2,582	2,820

Korea	Hong Kong	822	1,017	1,236	1,514	1,580	1,532	1,550
Korea	Singapore	507	630	630	810	1,020	1,285	1,285
Korea	Canada	656	642	1,286	1,022	991	1,293	1,282
Korea	Indonesia	817	880	1,228	1,335	1,396	1,402	1,246

Table A5. Link connectivity of Asiana

Origin country	Destination country	2006	2008	2010	2012	2014	2016	2018
Korea	Korea	9,966	9,785	7,529	7,152	8,108	7,976	7,666
Korea	China	3,843	4,848	5,035	5,489	6,337	7,009	6,206
Korea	US	3,111	3,841	4,442	5,208	5,536	5,672	5,636
Korea	Japan	4,431	4,599	5,289	5,427	4,982	5,101	4,723
Korea	Vietnam	711	781	832	1,795	1,576	1,880	2,332
Korea	Philippines	1,082	1,435	1,641	1,563	1,589	1,601	1,554
Korea	Thailand	1,056	1,219	1,078	1,246	1,108	1,291	1,202
Korea	Germany	381	713	711	748	696	748	886
Korea	Australia	720	722	680	650	629	643	778
Korea	Singapore	544	569	686	649	651	663	766

Table A6. Link connectivity of Japan Airlines

Origin country	Destination country	2006	2008	2010	2012	2014	2016	2018
Japan	Japan	73,770	70,625	63,264	57,375	59,193	59,253	62,064
Japan	US	4,970	3,912	3,349	7,102	8,493	9,696	10,444
Japan	China	5,186	6,240	3,839	3,190	3,392	3,483	3,377
Japan	Thailand	-	-	148	1,779	1,709	1,953	2,282
Japan	Taiwan	-	1,838	1,934	2,121	2,083	2,111	2,017

Japan	Singapore	1,731	1,770	1,266	1,072	1,491	1,416	1,460
Japan	Korea	2,711	2,828	1,998	1,900	1,637	1,212	1,055
Japan	Vietnam	637	412	683	902	1,158	1,013	1,015
Japan	Australia	2,069	-	144	776	748	631	893
Japan	Hong Kong	1,530	1,306	1,188	713	709	647	606

Table A7. Link connectivity of ANA

Origin country	Destination country	2006	2008	2010	2012	2014	2016	2018
Japan	Japan	91,859	91,045	93,681	98,639	104,461	103,824	103,769
Japan	US	4,020	4,594	4,344	5,616	7,942	8,896	9,497
Japan	China	4,037	5,491	4,383	4,940	5,074	6,157	6,197
Japan	Germany	757	749	1,036	1,910	2,335	2,544	2,599
Japan	Singapore	656	977	958	1,330	1,394	1,727	1,732
Japan	Thailand	1,032	924	878	1,255	1,173	1,492	1,688
Japan	Hong Kong	1,029	1,324	1,340	1,453	1,456	1,526	1,589
Japan	Indonesia	-	-	-	510	758	866	1,329
Japan	Taiwan	-	575	599	836	820	814	812
Japan	Korea	1,070	1,094	1,212	1,347	760	725	669