A Structure-Conduct-Performance Analysis of Passenger Aircraft Manufacturers in China Aviation Market

By

Kai-Xiang Lin

林楷翔

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This senior paper was presented

by

Kai-Xiang Lin
林楷翔

It was defended on

Nov 30, 2019

and approved by

Reviewer 1: Shao-Tzu Wu, Assistant Professor, Department of International Affairs

Signature: _____ Date: _____

Reviewer 2: Yu-Hsuan Lee, Assistant Professor, Department of International Affairs

Signature: _____Date: _____

Advisor: Ren-Her Hsieh, Associate Professor, Department of International Affairs

Signature: _____ Date: _____

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Kai-Xiang, Lin, B.A.

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Abstract

The Commercial Aircraft Corporation of China (COMAC) is a passenger aircraft manufacturer and was set up in 2008. Comparing with Boeing and Airbus which have dominated global aviation market, COMAC is a new entrant and would be a threat to Airbus and Boeing in global aviation market, especially in China aviation market. The purpose of this paper is to analyze the traits of China passenger aircraft market and the aircraft manufacturing providers with the structure-conduct-performance paradigm. First, the paper discusses the number of buyers and suppliers in China passenger aircraft market. Then, in aspect of conduct and performance, the paper elaborates the competition of Airbus and Boeing responding to the global demands, the government assistance to Airbus and Boeing, the investment of Airbus and Boeing in China market, and the market value of Airbus and Boeing in China. Finally, some issues are explained, such as COMAC orders from China buyers, B737 MAX incidents, the application of flying certificate, and substitution effect from high-speed rail, to indicates the chances and challenges of COMAC in the future. The result shows COMAC is not ready yet to compete and share the aviation market with Airbus and Boeing in domestic and even global market, at least COMCA needs to get the flying certificates from CAAC, FAA, and EASA which are the huge barriers for it to entry the markets in the advanced economies.

Keywords: China passenger aircraft market, Airbus, Boeing, COMAC, SCP paradigm

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LIST OF ABBREVIATION

Abbreviation	Stand for
COMAC	Commercial Aircraft Corporation of China
FAA	Federal Aviation Administration
EASA	European Aviation Safety Agency
ICAO	Civil Aviation Organization
LCC	Low cost carried airlines
CAAC	Civil Aviation Administration of China
CR4	Four-firm Concentration Rate
VTOL	Vertical takeoff and landing
DoD	Department of Defense
HSR	High- speed rail
USTR	Office of the United States Trade Representative
ICBC Leasing	Industrial and Commercial Bank of China Leasing
BOC Aviation	Bank of China Aviation
CDB Leasing	China Development Bank Leasing
BoCom Leasing	Bank of Communications Financial Leasing
CALC Leasing	China Aircraft Leasing Group

INTRODUCTION

Background

Nowadays, there are many aircraft manufactural companies producing various types of aircrafts. In the aviation market, there are also many companies that manufacture passenger aircrafts. Airbus and Boeing have dominated the passenger aircraft market for many years. Most airlines companies in the world purchase Airbus and Boeing passenger aircrafts, resulting in Airbus and Boeing becoming a duopoly in the market. To face the increasing demand of passenger aircrafts in the future, Airbus and Boeing forecast that the market will focus on Asia in the future, especially in China. Airbus and Boeing have been actively seeking business opportunities in China and maintaining good relations with China. However according to the news, two Boeing 737 MAX- 8 aircrafts have crashed within six months: One was the Lion Air Flight 610 that crashed on October 29th, 2018 in which all 189 people on board died. The other one was the Ethiopian Airlines Flight 302 that crashed on March 10, 2019, where all 157 people on board died. Consequently, many airlines halted the 737 Max aircrafts' service in the air, asking for compensation for economic losses, and even canceling orders of 737Max. Simultaneously, these events made aircraft buyers and tourists lose confidence in Boeing. After the B737 MAX-8 events, Airbus 380 aircraft (A380), one of larger passenger aircraft and most popular to airlines, was determined to end its production in 2021 because airlines around world considered the cost of A380 to be high, with the major buyer Emirates airline, reducing their orders of A380 aircrafts over these years.

Subsequently to the Boeing 737 MAX-8 aircraft crash, many news and social medias discussed whether Commercial Aircraft Corporation of China (COMAC), a

stated-own company set up in 2008, would have the opportunity to be involved in the passenger aircraft market. When C919, launched by COMAC, began trial flying, it had been considered a potential competitor to Boeing 737 and Airbus 320. Moreover, aviation manufacturers have always accepted the support of the government, and they have also been affected by political factors in which have led to positive and negative interference. For instance, government subsidies involving excessive money to aviation manufacturers to reduce the cost and expand the market, and government policies focused on buying aircrafts might lead to increase the cost of airlines and influence fair market competition among aircraft manufacturers.
There are few research papers discussing the passenger aircraft sale market. Therefore, this paper is much focused on the passenger aircrafts sale market in China and increase the understanding of passenger aircraft manufacturers, such as Airbus, Boeing, and COMAC among people.

Motivation

The aviation industry is used by many and hence loved by many people. However, there are more people that discuss how airlines undertake market study and make comparison with other airlines; while there are few discussions on the manufacturing of passenger aircrafts. Airbus and Boeing have been the two main aircrafts suppliers in the airlines market for many years and many papers on them discuss their technology development but few on their sale market. Besides, due to of China's huge demand market, China has also established its own aviation manufacturer in which currently its aircraft has been sold to China domestic airline, not to airlines around the world yet.

Thus, this research paper is designed to not only help the understanding of Airbus and Boeing, and COMAC in the sale market but also to enhance the recognition of the development of China's passenger aircraft market in the future.

Research Purpose

Aviation is popular and profitable. With the improvement of technology, there are many aircraft manufactures set up in different countries to produce different aircrafts. Nowadays, people recognize the two famous aircrafts, Airbus and Boeing. Recently, another potential manufacturer from China, COMAC placed efforts to enter the market. However, COMAC is still not known widely in the world but is developing in the domestic market.

Therefore, the first purpose is to analyze the structure, conduct, and performance of these three companies in China's sale market via the integration of the literature review and second data. The second purpose of this paper is to realize the chances and challenges to COMAC in China's passenger aircraft market. The final purpose is to increase the recognition of passenger aircrafts in the sale market, especially the market in China.

Research Questions

1. What is the structure of air passenger market in China?
2. What are the conduct and the performance of Airbus and Boeing in China?
3. What are chances and challenges to COMAC?

Contribution

The researcher analyzed the aircraft manufacturing providers with the structure-conduct-performance paradigm. This research may help people recognize the traits of China's passenger aircraft market and reduce misleading news about COMAC being ready to enter the market. Besides, some issued explained in this research indicates some factors of COMAC to successfully entering the passenger aircraft market in the future, especially China's passenger aircraft market.

Limits

This research paper used the qualitative research method to analyze China's passenger aircraft market. However, there are many research papers focused on the aircraft technology, instead of aircraft sale market. Thus, this research might face some limits. Also, there are no aircraft manufacturing in Taiwan hence the researcher made attempts to collect secondary data to make up some limits.

Delimits

Aircraft manufactural industry is a big and complicated industry. Thus, the research will focus on the passenger aircraft sale market, which does not involve defense aircrafts, private aircrafts, cargo aircrafts, and components. Due to the development of COMAC, the researcher mainly focused in China. Also, the research focused on the main companies Airbus and Boeing and did not focus on other companies which are not involved in subsidiaries of Airbus and Boeing. As above, the paper discusses the passenger aircraft of sale market of Airbus, Boeing, and COMAC in China passenger aircraft market.

LITERATURE REVIEW

Global Air Passenger Market

The Type of Passenger Aircraft

The market for aircraft is typically divided into two product categories: narrow-body and wide-body aircraft. According to International Civil Aviation Organization(ICAO), aircrafts can be characterized by their sizes. Wide-body aircraft is a large transport aircraft with internal cabin sufficient for normal passenger seating to be divided into three axial groups by two aisles. The other, narrow-body aircraft is an aircraft having only one aisle in the cabin with passenger seating divided into two axial groups.[1] These two types of aircraft are widely serving among countries and major cities. Regional jet is one type of smaller narrow- body aircraft, which is used for short- term trip to smaller city or domestic city.

Table 1 Passenger Aircraft Family Sort

Wide-Body Aircraft	Narrow-Body Aircraft	
B777, A350, B787, A330, B777, A380, B767, B747	A320, B737, A220, C919 A321,	Regional Jet ERJ 145 (Embraer) CRJ900 (Bombardier) ARJ21 (COMAC)

All aircraft sorted by the researcher

Future Forecast of Global Passenger Demand

There are more than a half world population living in Asia-Pacific. From 2015 to 2017, the international tourism grew year by year in Asia-Pacific, which involved China, India and Southeast Asian countries, as these economies expand with increased travelling.[2] With more people traveling, airlines became more competitive ,

[1] "Manual on the Regulation of International Air Transport," International Civil Aviation Organization, 2016, https://www.icao.int/Meetings/a39/Documents/Provisional_Doc_9626.pdf.
[2] Boeing, "Commercial Market Outlook 2018–2037," (2018). 11.

which was the key to make aviation market blossom, and low cost carried airlines (LCC) become more and more established in Asia-Pacific.[3] The entrance of LCCs have brought more competition to tradition airlines. However, on the bright side to Airbus and Boeing, more passenger aircraft are required to fulfill the increasing amount people travelling. The demand forecast of passenger aircraft to be delivered from 2018 to 2038 by Airbus and Boeing to Asia Pacific region is about 16,540 [4] and 16,930 [5] respectively. Furthermore, the narrow-body aircraft of Airbus and Boeing delivered to Asia-Pacific respectively count for 78 and 71 percent, while wide- body of Airbus and Boeing would both count for 20 percent. [6] Thus, the economic development growing in Asia-Pacific will increase the demand for passenger aircraft. With more people going aboard and more competition between traditional airlines and LCCs. Airlines buy many narrow-body aircraft so that aircraft manufacturers will actively compete in narrow-body aircraft market.

Passenger Aircraft Competition Factors

There are many passenger aircraft manufacturers in the world which are in developing and developed countries, such as, Airbus in EU, Boeing in the US, Bombardier in Canada, and Embraer in Brazil, etc. However, Airbus and Boeing have dominated passenger global aircraft market. From the research paper *Take Off and Crash*, we could find the market failure in developing. As to aviation market, developing countries find it is harder to compete with developed countries due to the government assistance and well-developed technology. Moreover, passenger aircraft

[3] Ibid 39.
[4] "Global Market Forecast Cities, Airports & Aircraft -2019-2038 ", Airbus 2018, accessed 07/08, 2019, file:///C:/Users/user/Downloads/GMF-2019-2038-Airbus-Commercial-Aircraft-book.pdf.
[5] Boeing, "Commercial Market Outlook 2018–2037." 39.
[6] Ibid.

manufacturers compete with the various factors, such as constant technological development, sufficient finance, speed aircraft, and fuel economy. [7] Thus, if aircraft manufacturers wish dominate the market, they must be well developed in aviation technology, well managed in finance, and well assisted by government. The competitive factors are challenges to aircraft manufacturers and cause new competitors to enter passenger aircraft market with more difficulty.

Airbus Entering Passenger Aircraft Market

After WWII, Boeing was the main passenger aircraft supplier which dominated the market. Airbus aimed to enter the passenger aircraft market to become another aircraft supplier in the world. The European government gathered aviation manufacturers in the Europe to research and develop aviation devices. During that period, Airbus was not looking forward to entering passenger aircraft market. However, Airbus succeeded to produce A300, its first wide-body passenger aircraft, in 1972. Airbus tried to expanded business to other countries. Airbus sold aircraft to Asia and the US, in which the aviation market in the US is one of the biggest markets. In 1978, Airbus firstly sold A300 to Eastern Airlines in the US, which ceased air business in 1991. The first aircraft delivered to the US was very important for Airbus, which was a sign on whether Airbus aircraft would successfully enter the US market. After successfully entering the US aviation market, Airbus counted global passenger aircraft from 15 to 20 percent in 1980s. Moreover, Airbus had opportunities to enter global passenger market. Boeing had some problems in aircraft production, such delivery delay, inefficient production, and old aircraft technology system, etc.

[7] A. Hira, & de Oliveira, L. G., "Take Off and Crash: Lessons from the Diverging Fates of the Brazilian and Argentine Aircraft Industries," *COMPETITION & CHANGE* 11, no. 4 (2007). https://doi.org/10.1179/102452906X239501.

Boeing lost extensive profit and aircraft buyers fell down, allowing Airbus to succeed to enter the global passenger market. In 1991 to 1995, the world passenger aircraft counted for 45 percent from Airbus.[8] Thus, Airbus was getting stronger and hence succeeded to enter the global passenger aircraft whilst Boeing encountered problems of aircraft production.

The Government Subsidy Agreement in 1992

Boeing awared that Airbus became Boeing's competitor when Airbus sold aircraft, A300, to Eastern Airlines in the US in 1978. The United Stated government found that the EU government subsidized much money to Airbus. In order to protest the competitiveness of Boeing in the world, the United Stated placed a tariff designed to decrease the impact on Boeing in the domestic market and also to prevent Airbus from increasing its trade in the US market. However, the EU found that the USA have been subsidized Boeing since WWII. The subsidies from the US government to Boeing were more than the EU to Airbus. The United States and Europe government had previously discussed and regulated rules of government support to aircraft manufacturers in 1979 but they both concerned and fear that their customers would be stolen by each so that they did not formulate the regulations of government support. In the late1980s, the US and the EU started bilateral negotiations. Until 1992, the US government and EU government signed the agreement of limited government subsidy.[9] The agreement brought more cost to Airbus and Boeing and increased aircraft price. Moreover, the reasons the US and the EU signed the agreement:

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[8] William Alexander Burns, "How Airbus Surpassed Boeing: A Tale of Two Competitors," (2007).
吳佳玲。「歐洲的挑戰，美國的回應－空中巴士的崛起」。碩士論文，淡江大學歐洲研究所，2000。https://hdl.handle.net/11296/gup2ab，p 99。

[9] 吳佳玲。「歐洲的挑戰，美國的回應－空中巴士的崛起」。碩士論文，淡江大學歐洲研究所，2000。https://hdl.handle.net/11296/gup2ab，p123-125。

the US was afraid of Airbus in EU to be stronger than Boeing, while the EU was aimed to stop new competitors to enter the passenger aircraft market. Although the 1992 agreement was a big step of negotiation, the agreement mainly regulated government subsidy, which were not covered of the technology, aircraft price, and any kind of business.[10] The agreement must bring conflicts between Airbus and Boeing in the passenger aircraft market. Finally, the agreement was terminated in 2004 since the US dropped out the agreement and all the rules of agreement were not used to limited government subsidize to aircraft manufacturers in the future. Thus, the US government and the EU government could not end up their subsidies and also Airbus, Boeing, and other new competitors could not compete with each other without government support, hence, government and companies have mutual connection.

Globalization Division in 1990s

In 1990s, the world economy was in depression. Globalization made the economy recover in which different industrial manufacturing companies corporated with foreign companies in other countries to produce some parts of their goods. Airbus and Boing has cooperated with manufacturers in Asia, especially China and Japan. Of course, government had subsidized to Airbus and Boeing to expand the parts produce to other countries. Besides, China and Japan have attempted to take advantage of technology learned from progress manufacturers, and research to develop its own aircraft. The globalization corporation led Airbus and Boeing to be more relying on Asia manufacturers, which aimed to lower down production cost. China publicly announced its intention to become a civil aircraft manufacturer with

[10] "An Analysis of the Airbus-Boeing Dispute from the Perspective of the Wto Process," Academia.edu, updated 10/04, 2010, https://www.academia.edu/1063739/An_Analysis_of_the_Airbus-Boeing_Dispute_From_the_Perspective_of_the_WTO_Process.

Boeing and Airbus, and promised to purchase Airbus and Boeing‘s aircraft firstly to attract Airbus and Boeing to move the aircraft manufacturing industry to Asia. Furthermore, Boeing CEO Jim McNerney predicted in 2006 that China would become the third aircraft manufacturer in the next few decades to compete with Boeing and Airbus.[11]

In 2005, japan had become an important first-tier of Boeing. Japan learned ways from basic part manufactured to aircraft design and assembled, which implied that Japan would eventually enter the market as a fully-fledged producer of commercial aircraft.[12] At the present, China and Japan both have one passenger aircraft manufacturer, which respectively COMAC and Mitsubishi to research and develop their own passenger aircraft. New competitors established are potential threats to Airbus and Boeing.

China Aviation Development

China had started civil commercial aircraft development since 1966. Since China had some experienced workers on maintenance of military aircraft so that China government planned to develop its civil commercial aircraft. China’s aviation development was separated into four steps. Firstly, China imitated to produce aircraft in 1966 to 1970. Secondly, China started to produce the first passenger aircraft, Y-10 in 1970 to 1980, but due to undeveloped technology halted production halfway of producing the aircraft model. Thirdly, China began international cooperation with McDonnell Douglas to produce MD-80 and corporate foreign manufacturers to learn aircraft technology in 1978 to 1998. However, McDonnell Douglas merged with

[11] Ibid.
[12] Alan MacPherson and David Pritchard, "Boeing’s Diffusion of Commercial Aircraft Technology to Japan: Surrendering the Us Industry for Foreign Financial Support," *J Journal of Labor Research* 28, no. 3 (2007).

Boeing in 1997 and stopped the corporation with China. Lastly, China's ambition in the passenger aircraft market was demonstrated in their research and development of its passenger aircraft since 2000[13], and hence in its establishment of COMAC in 2008.

In the past 50 years, China has learned technology of producing aircraft, but China is still in shortage of technology and in lack development of aviation industry. In the aspect of technology development, China aviation manufacturers had cooperated with foreign-advanced aircraft manufacturers to produce aircraft. However, China aviation manufacturers highly overlap in the industry, and also lack people researching and developing in aviation technology. Moreover, the aspect of China aviation industry development is also hard to cluster all aviation manufacturers.[14] Therefore, China aviation development is still immature so that COMAC is facing one of challenges to research and develop its passenger aircraft in the future.

Structure-Conduct- Performance Paradigm

The revelation regarding the forecasting demand of passenger aircraft and passenger aircraft market development. From the perspective of industry, market demand for aircraft and China's passenger aircraft manufacturers are the main areas that reflect the competition and development of Boeing, Airbus, and COMAC in China passenger aircraft market. Thus, the Structure-Conduct-Performance (SCP) paradigm can be used to inspect the development of aircraft manufacturers in China's passenger aircraft market.

[13] 丁松, "我國大型客機的產業集聚與空間布局研究"（南京航空航天大學, 2015). 16- 17.
[14] Ibid 23-24.

The SCP paradigm is a casual relationship among industrial structure, companies' conduct and performance. The original SCP paradigm was the one-way relationship from structure through conduct and then performance.[15] However, some studies have different arguments. For example, Scherer deliberated that the companies' conduct could influence industrial structure and then affect corporate's performance.[16] This deliberation tried to show that conduct played much more important role in an specific business. Moreover, the structure, conduct, and performance are interlinked hence influence one another. Certainly, external factor of government policy impacts in structure, conduct, and performance, especially the conduct can also influence the government policy.[17]

In the SCP paradigm, the market structure refers to the number of buyers and sellers, market barriers, the degree of product differences, and the degree of vertical integration, etc. The companies' conduct involves of price making, investment, advertisement, cooperation strategy, and so on. On the aspect of performance, it implicates profit, product quality, and technological development, etc. Besides, there are some external factors which will affect the structure, conduct and performance, such as the government policies, governmental subsidy, and taxation, etc. As above, these sorted elements in the paradigm will help the researcher to have further clear understanding of China's aviation market.

The SCP paradigm was used in different researches, such as food industry, and games industry. In the food industry, the paper written by Wang and Shen employed the SCP paradigm to analyze the global rice market.[18] They concluded that

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[15] J. S Bain, "Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936–1940," *The Quarterly Journal of Economics* 65, no. 3 (1951).

[16] 鍾憲瑞, *產業分析精論 多元觀點與策略思維*（前程文化事業有限公司, 2013). 頁 81

[17] Ibid, 頁 83

[18] 王曉凌、沉萌, "世界稻米產業的結構，行為與表現," *世界農業* (2012). 頁 13-17。

the global rice market was an oligopoly market since the concentration ratio of rice exporters (suppliers) was quite high, mainly Thailand (29.21%), Vietnam (16.68%), India (14.01%) United States (11.30%).[19] This oligopoly market structure deeply affected the imported market so that the protection measure was always the first priority of imported state government conduct. As a result, the world rice price, one of indicator of performance, was fluctuated due to the influence of external factors.[20] In addition, scholars used SCP paradigm to study agricultural industry in China and Taiwan respectively.[21] Shen's paper found that there were some problems in China's agricultural development, such as low intensive degree, low degree of differential products, surplus labor forces, low agricultural profit rate, and low industrial contribution rate. Hsieh and Tsao focused on Taiwan's rice noodle industry which grabbed public attention due to the food security problem. That paper analyzed the new government regulations, rice noddle labeling, and benefit to rice noodle enterprises. Their finding showed that the structure of rice noodle industry in Taiwan was a perfect competition market and manufacturers' conduct depended on the market demand and the price competitiveness. Moreover, the new regulations caused loss for the mix rice noodle manufacturers and did not bring much benefit to them.[22] As to the research on Taiwan E-sports industry, Wu used a one-way relationship to analyze that the structure of the main four elements, which are e-sports game firms, electronic devices, the event and live platforms and the sponsors, impact the conduct and performance in the industry. The finding showed that the scale of E-sport in Taiwan is

[19] The percentage indicated the country's share of total rice export globally. Ibid, 頁 15。
[20] Ibid, 頁 17。
[21] 沈立早, "基於 scp 范式的我國農業產業化分析," *安徽農業科學* 39, no. 20 (2011). 頁 12419-12421。Ren-Her Hsieh and Shuling Tsao, "Structure-Conduct-Performance Analysis of the Rice Noodle Industry: A Case Study of Taiwan's Smes," *Int. J. International Journal of Agriculture Innovation, Technology Globalisation* 1, no. 2 (2019).
[22] Ren-Her Hsieh and Shuling Tsao, op cit.

more diverse and competitive, and also reduced the cost of the corporation with foreign game industry. [23] Therefore, the SCP paradigm enabled the inspection the causal relationship on different kind of industries. The researcher would like to employ this paradigm to analyze China's aviation market and to figure the development of aircraft manufacturers in China's passenger aircraft market.

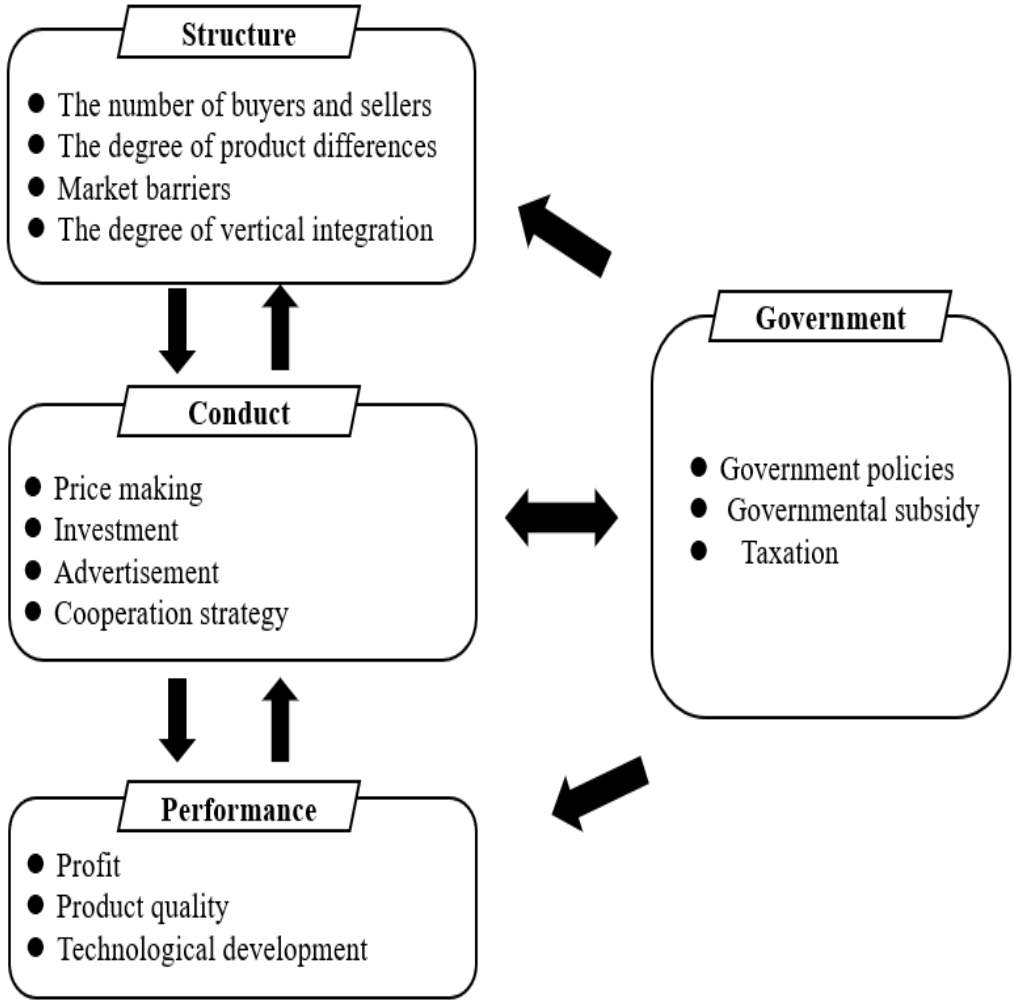

Figure 1. SCP paradigm 1990

[23] Yi Ting Wu, "An Applicantion of Structure- Conduct-Performance Paradigm to the Taiwan E-Sports Industry " (Wenzao Ursuline University of Languages 2017).

METHODOLOGY

Research Process

The purpose of this paper is to analyze the traits of China passenger aircraft market and the aircraft manufacturing providers with the structure-conduct-performance paradigm. Besides, the research is a qualitative analysis. Thus, the research is following the order that reading literature review, collecting second-handing data, analyzing data with SCP paradigm and then to the conclusion.

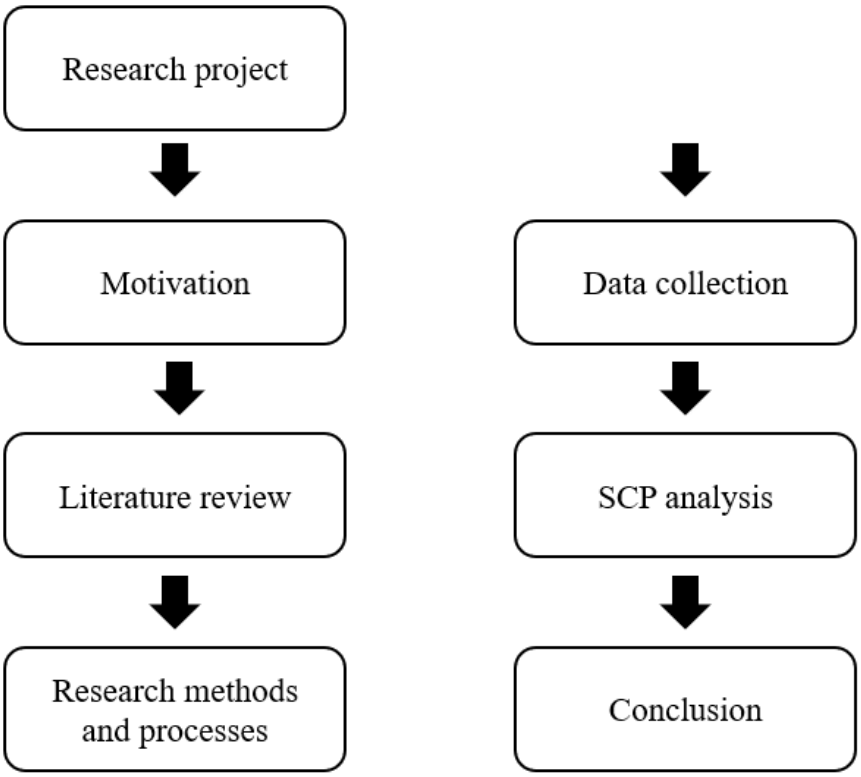

Figure 2. Research process

Research Design

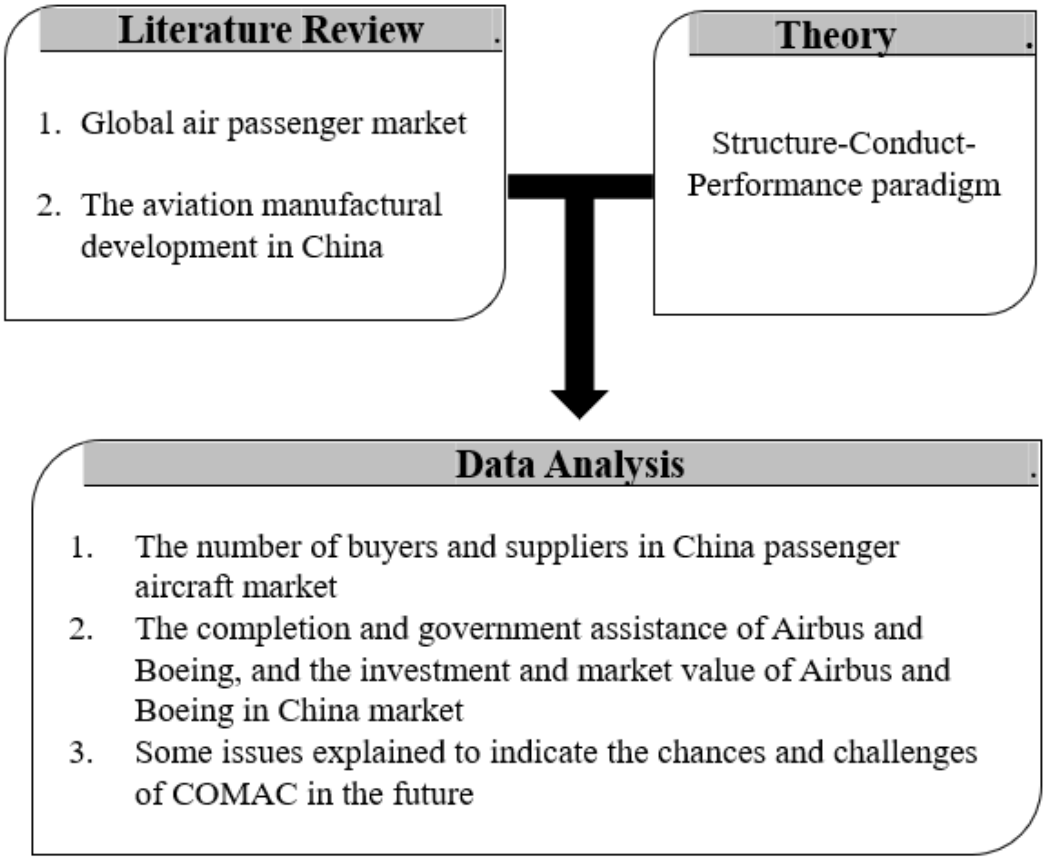

Figure 3. Research design

The literature review is about the development of passenger aircraft market and SCP paradigm. The data analysis is to analyze the structure about the number of buyers and suppliers in China. In the aspect of conduct and performance, Boeing competition responding to the global demands, government assistance to Airbus and Boeing, investment and market value of Airbus and Boeing in China aviation market. Lastly, some issues explained about COMAC orders from China buyers, B737 MAX incidents, the application of flying certificate, and substitution effect from high-speed rail bring chances and challenges to COMAC in the future.

Sources of Data

The purpose is to analyze the China passenger aircraft market. The populations of aircraft mutators are Airbus, Boeing, and COMAC in China passenger aircraft market. Therefore, the researcher collected data from official website and annual report of Airbus, Boeing, COMAC, CAAC to analyze the China passenger aircraft market in SCP paradigm. such as the market value, the amount of aircraft, 737 orders, and C919 orders, etc. Some data are form social media news, aviation news, literature articles, such as, 737MAX events ,and the discount price of aircraft ,and scale of fleet in China, etc.

Brief Introduction of Airbus, Boeing, and COMAC

Boeing Company

Boeing is a private American company established in 1916 and it is one of the largest aerospace manufacturers in the world. Boeing produce different kinds of aircraft, such as helicopter, decency, commercial aircraft (passenger aircraft and freighter), and space. In passenger aircraft market, Airbus is the main competitor to Boeing.

Airbus SE

Airbus established in 1970 by the EU and the main shareholders are German, France, England, and Spain. It is the other one of the largest aerospace manufacturers in the world. Airbus also has different kinds of aircraft, which are almost same with Boeing.

Commercial Aircraft Corporation of China Ltd (COMAC)

COMAC is a stated- own company in China and it was established in 2008, and also it is one plan of five-year plans, which is to produce aircraft rather than buy aircraft. COMAC is aimed to make its own big and safe aircraft.

DATA ANALYSIS

The Structure of Air Passenger Market in China

China's Passenger Traffic 2014-2018

The number of passengers taking airplanes in China are increasing stably year by year. According to the statistics from Civil Aviation Administration of China (CAAC) from 2014 to 2018, the passenger traffic in China airport grew from 800 million to 1.2 billion.

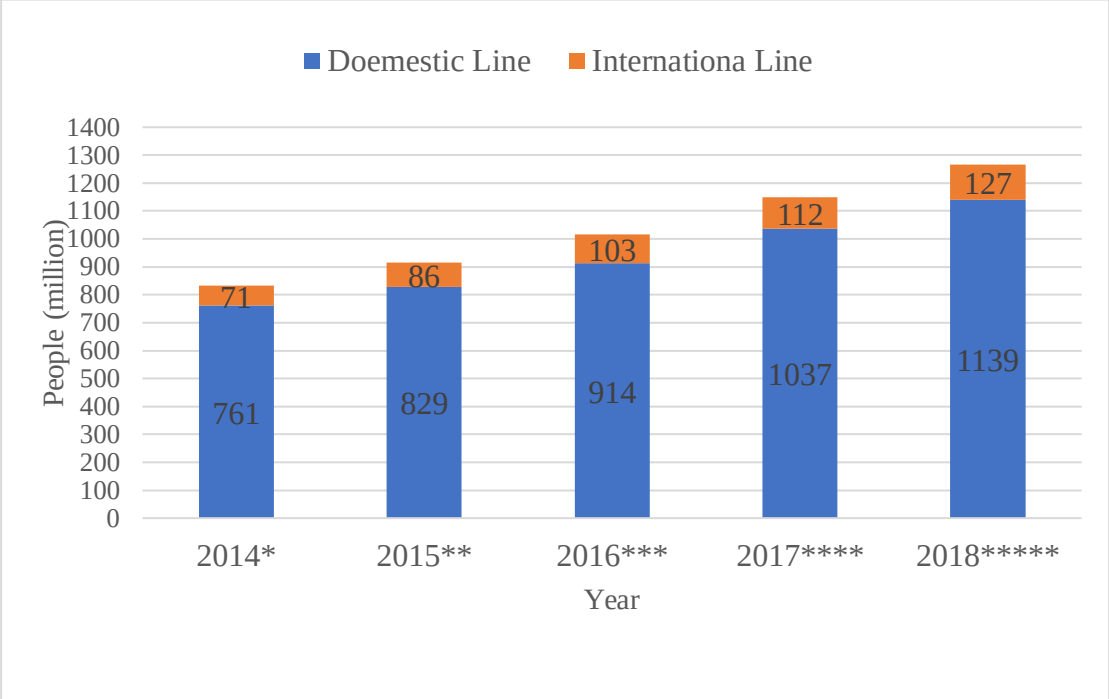

Figure 4. The passenger traffic in China 2014-2018

Source:
* "Bulletin of Statistics on Civil Aviation Airport Production in 2014" (Civil Aviation Administration of China) http://www.caac.gov.cn/XXGK/XXGK/TJSJ/201511/t20151102_8866.html
** "Bulletin of statistics on Civil Aviation Airport Production in 2015." (Civil Aviation Administration of China) http://www.caac.gov.cn/XXGK/XXGK/TJSJ/201603/t20160331_30105.html
*** "Bulletin of statistics on Civil Aviation Airport Production in 2016." (Civil Aviation Administration of China) http://www.caac.gov.cn/XXGK/XXGK/TJSJ/201702/t20170224_42760.html
**** "Bulletin of statistics on Civil Aviation Airport Production in 2017." (Civil Aviation Administration of China)http://www.caac.gov.cn/XXGK/XXGK/TJSJ/201803/t20180307_55600.html
***** "Bulletin of statistics on Civil Aviation Airport Production in 2018." (Civil Aviation Administration ofChina)http://www.caac.gov.cn/XXGK/XXGK/TJSJ/201903/t20190305_194972.html

The Figure 4 shows that the average of flow was growing about 100 million, which the domestic lines were much more than international lines. With the growing number of people taking airplanes, airlines need more and more aircraft.

The Number of Aircraft Buyers and Passenger Aircraft in China

The Leasing Groups

Passenger aircraft in aviation market are usually purchased by leasing groups and airlines. At present, there are many leasing groups in China with many businesses around the world.

Table 2 The Fleet of 4 Leasing Groups of China in 2018

Leasing group	ICBC Leasing*	BOC Aviation**	CDB Leasing***	BoCom Leasing****
Owned and managed	670	322	231	236
On the ordered	100	183	196	–

Source:
* "ICBC Leasing and China Commercial Aircraft signed a framework agreement for the purchase of 55 C919 large passenger aircraft in Beijing. The total number of orders for ICBC Leasing C919 aircraft reached 100." (ICBC Leasing, December 5, 2017) https://l.icbcleasing.com/node/136
** "Operating Information to 2018." BOC Aviation, https://www.bocaviation.com/zh-CN/Investors/~/media/FAAF77ADD7924FA58E1A36F70BE8BEE5.ashx
*** " Report in 2018: Aircraft leasing." CDB Leasing, p 40. http://www.cdb-leasing.com/Uploads/Uploads/2019-04-27/5cc32c01d2b5b.pdf
**** "Bank of Communications 2019 first half report." (Bank of Communications), p16. http://pdf.dfcfw.com/pdf/H2_AN201908271345188558_1.pdf

The table 2 shows that there are 4 leasing groups in China and they are owned or affiliated by four biggest state-owned banks , which are ICBC Leasing(工銀金融租賃), BOC Aviation(中銀航空租賃), CDB Leasing(國銀金融租賃), and BoCom Leasing(交银金融租赁). Each leasing groups have more than 200 aircraft. Besides, each leasing groups will purchase more than 100 aircraft in the future.

Theses leasing groups rent aircraft to domestic airlines and to foreign airlines. Through May of 2018, ICBC Leasing rented aircraft to airlines was about 325[24]. The ICBC revenue of aircraft renting to China accounted for 31 percent. BOC Aviation rented aircraft to airline in China was account for about 30 percent[25], which are about 96 aircraft. With these data, the leased aircraft in China may not have a significant impact on the total number of aircraft serviced in airline in China.

The Airlines

By the early 2019, there were about 50 airlines in China Airlines were mainly established by government. Some of them are joint ventures which invested by PRC government and private companies. The airlines market of China is mainly shared by Air China, China Eastern Airlines, China Southern Airlines, and Hainan Airlines. These four airlines also invested other airlines and become their main shareholders. For instances, Air China is the main shareholder of Air Macau, Dalian Airlines, Shenzhen Airlines, Shandong Airlines, Cathay Pacific, and Tibet Airlines. China Eastern Airlines is the main shareholder of China United Airlines, and Shanghai Airlines. China Southern Airlines is the main shareholder of Xiamen Air and Chongqing Airlines. Hainan Airlines is the shareholder of Air Chang'an, Beijing Capital Airlines, Fuzhou Airlines, Grand China Air, Lucky Air, West air, Tianjin Airlines, and Urumqi Air. For these airlines which are subsidiaries, some of them become one of main investors or shareholders of other airlines. Such as, Xiamen Air invested in Jiangxi Air and Hebei Airlines. Cathay Pacific invested in Cathay Dragon, and Hong Kong Airlines, HK Express and Air Hong Kong.

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[24] "Fleet Portfolio," 2018, accessed 07/30, 2019, https://www.icbcleasing.com/aviation.html.

[25] "截 至 2018 年 12 月 3 1 日止第四季度及年度營運資料," 中銀航空租賃有限公司, 2019, https://www.bocaviation.com/zhCN/Investors/~/media/FAAF77ADD7924FA58E1A36F70BE8BEE5.ashx.

In airlines market, airlines are classified into tradition airlines and budget airlines or low-cost carrier (LCC). In China, LCC began in 2007 when the government deregulated its domestic aviation market, which private airlines can enter the market. However, the number of tradition airlines are much more than LCCs.

Table 3 List of 50 Airlines in China

Tradition airlines (49 airlines)	Air China, Air Macau, Dalian Airlines, Shenzhen Airlines, Shandong Airlines, Tibet Airlines, Cathay Pacific, Cathay Dragon, Hong Kong Airlines, Air Hong Kong,
	China Eastern Airlines, Shanghai Airlines,
	China Southern Airlines, Xiamen Air, Chongqing Airlines, Hebei Airlines,
	Hainan Airlines, Air Chang'an, Fuzhou Airlines, Grand China Air, Tianjin Airlines,
	Beijing Airlines, Sichuan Airlines, Air Guilin, Air Travel, China Express Airlines, Donghai Airlines, Suparna Airlines Genghis Khan Airlines, Guangxi Beibu Gulf Airlines, Juneyao Airlines, Kunming Airlines, Longjiang Airlines, Loong Air, Okay Airways, Qingdao Airlines, Ruili Airlines,
Budget airlines (11 airlines)	Spring Airlines, Beijing Capital Airlines, Lucky Air, Chengdu Airlines, China United Airlines, West air, 9 Air, Urumqi Air, Jiangxi Air, Colorful Guizhou Airlines, HK Express, Joy Air

All LCCs are invested from other domestic airlines, except Spring Airlines which is a full- private owned airline in China. In the operation of China market, tradition airlines with governmental investment has got support from government, which means private airlines are hard to enter the traditional airlines market. Therefore, these 50 airlines in China are mainly having investment from government and some of them are subsidiaries to powerful airlines which means they have direct and indirect connections with each other.

The Aircraft Amount of China 7 Listed Airlines

At present, there are 7 listed airlines in China: Air China, China Eastern Airlines, China Southern Airlines, Hainan Airlines, Cathay Pacific, Juneyao Airlines, and Spring Airlines. The former 6 are tradition airlines and the latter one is LCC.

Table 4 The Aircraft Amount of 6 Listed Airlines in 2018

Airline company	Owned aircraft	Rental aircraft	Total aircraft	Rate of aircraft*	On the orders
Air China	276	388	664	58 %	72
China Eastern Airlines	230	450	680	66 %	60
China Southern Airlines	273	553	826	67 %	114
Hainan Airlines	146	317	463	68 %	11
Cathay Pacific	80	53	133	40 %	9
Juneyao Airlines	22	68	90	75 %	6
Spring Airlines	40	41	81	50 %	15

Source:
"Air China Annual Report 2018" 中國國際航空股份有限公司, 2018, p12.
http://pdf.dfcfw.com/pdf/H2_AN201904251322613150_1.pdf.
"Annual Report 2018" 中國東方航空, 2018, p13.
http://pdf.dfcfw.com/pdf/H2_AN201904251322648582_1.pdf.
"年度報告." 中國南方航空, 2018,p 19.
http://pdf.dfcfw.com/pdf/H2_AN201903291311520441_1.pdf.
"2018 年年度报告." 海南航空控股股份有限公司, 2018, page 17.
https://www.hnair.com/guanyuhaihang/tzzgx/cwbg/201905/P020190522481985413636.pdf.
"二零一八報告書." 國泰航空公司, 2018, p15.
https://www.cathaypacific.com/content/dam/cx/about-us/investor-relations/interim-annual-reports/sc/2018_annual_report_sc.pdf.
"2018年度報表." 吉祥航空, 2018, p29.
http://www.juneyaoair.com/pages/invester/pdf/H2_AN2018_0.pdf.
"2018 年年度报告."春秋航空股份有限公司 2018, p25.
* calculated by the researcher

In 2018, there were about 3479 aircraft in China after 311 passenger aircraft delivered to China. According to the Table 4, Air China had 664 aircraft, which consisted of 276 owned aircraft and 388 rental aircraft. China Eastern Airline had 680 aircraft, which consisted of 230 owned aircraft and 450 rental aircraft. China Southern Airline had 826 aircraft, which consisted of 273 owned aircraft and 553 rental aircraft. Hainan Airline had 463 aircraft, which consisted of 146 owned aircraft and 317 rental aircraft. Cathay Pacific had 133 aircraft, which consisted of 80 owned aircraft and 53

rental aircraft. Juneyao Airline had 90 aircraft, which consisted of 22 owned aircraft and 68 rental aircraft. Spring Airline had 81 aircraft, which consisted of 40 owned aircraft and 41 rental aircraft. The fleet of these 7 airlines mostly rented aircraft which count for more than half amount of their aircraft from domestic and foreign leasing groups.

In 2019, these airlines will increase the amount of their aircraft individually: Air China is 72, China Eastern Airlines is 60, China Southern Airlines is 114, Hainan Airlines is 11, Cathay Pacific is 9, Juneyao Airlines is 6, and Spring Airlines is 15. From the statistics of these 7 airlines, each airline has a huge fleet and their demand of aircraft are increasing. Also, after calculating the demand of these seven airlines for passenger aircraft, the demand of aircraft for these airlines in 2019 is close to the increased number of aircraft in 2018. It can be predicted that China needs more aircraft for carrying lots of passengers in the future.

The Market Shares of Passenger Aircraft in China

In 2015, there were about 2795 passenger aircraft servicing in China (involving Hong Kong and Macau). Those aircraft ware mainly produced by Airbus and Boeing; few aircraft were produced by Embraer S.A.(巴西航空製造商) and Bombardier Aerospace(龐巴迪). The main narrow-body aircraft were B737-800 and A320-200, which the number were 853 and 681 respectively. The main wide-body aircraft were A330 and B777, which the number were 245 and 170 respectively. The main regional jets were (Embraer S.A.) ERJ 145 and (Bombardier Aerospace) CRJ900, which the number of regional jets were 27 and 20 respectively.[26]

[26] 鄧智亮, "2015 年中國地區民航機隊發展," *中國市場* 13, no. 上海飛機設計研究院市場研究中心 (2017).

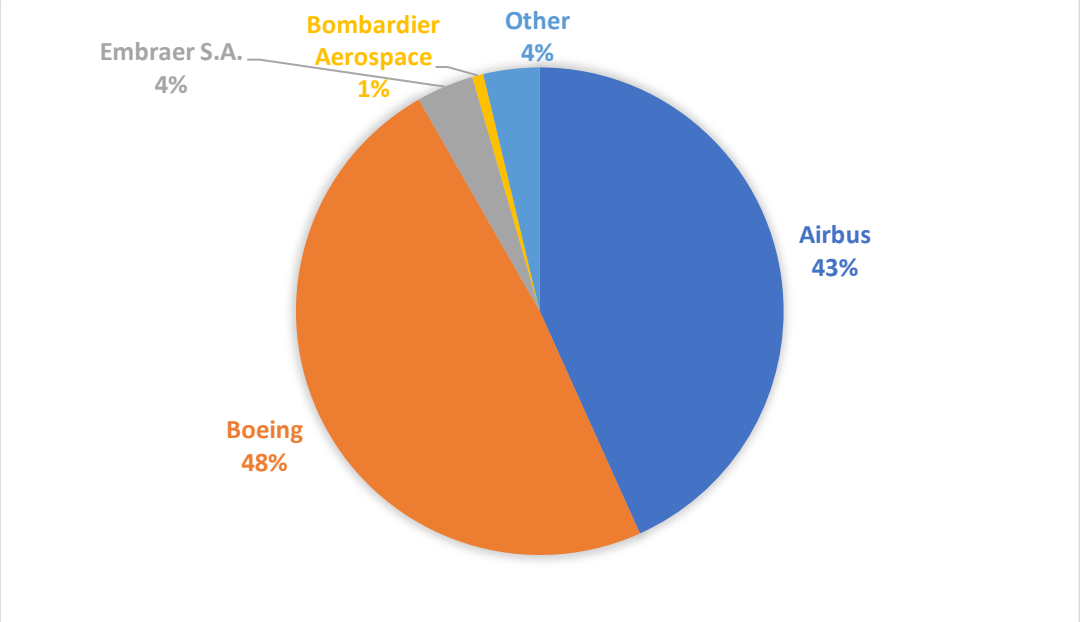

Figure 5. The scale of fleet in China 2015
Source: 鄧智亮. "2015年中國地區民航機隊發展." *中國市場* 13, no. 上海飛機設計研究院市場研究中心 (2017): 314-15.

Airbus and Boeing dominated China's market and they counted for 91 percent of the market. Form the view point of Four-firm Concentration Rate (CR4), Airbus and Boeing turn into duopoly in the market, which is hard for new competitors to enter the market. In the same year, the airlines in China ordered three types of passenger aircraft, especially narrow-body aircraft and wide-body aircraft, which are 107 and 31, the regional jet are 47 involved 27 ARJ21 produced by Commercial Aircraft Corporation of China (COMAC).

737MAX starts being produced in 2017 and it was one of the popular aircraft to many airlines. After the events of B737 MAX-8 crashed in late 2018 and early 219, airlines stop taking the series of 737 MAX in service and the events caused Boeing to lose many orders.

Table 5 The Amount of 737 MAX Through 2019 in China

Company	Ordered	Delivered	Unfilled
Air China	16	16	0
China Eastern Airlines	14	14	0
China Southern Airlines	50	16	34
Hainan Airlines	7	7	0
Xiamen Airlines	10	10	0
Donghai Airlines	25	0	25
Ruili Airlines	36	0	36
9 Air	1	1	0
WestJet Airlines	55	12	43
Shandong Airlines	7	7	0
Shenzhen Airlines	5	5	0
ICBC Leasing	5	5	0
CDB Financial Leasing	1	1	0
BOC Aviation	87	8	79
CALC Leasing（中國飛機租賃）	50	0	50
China Development Bank Fin.（國家開發銀行）	78	1	77
737 MAX Total of China	447	103	344
Global 737 MAX Total	4931	387	4544
737 MAX Ratio of China*	9%	27%	8%

Source: Boeing customer reports of current model series 737 MAX
http://www.boeing.com/commercial/#/orders-deliveries
* Ratio of 737 MAX from China were calculated by the researcher.

However, the Table 5 shows that the global orders of 737 MAX is up to 4931, which there had been already delivered about 387. At present, there are about 16 buyers of China demand about 447, which there had been already delivered about 103. Boeing got the orders of 737MAX from China is accounted for 9 percent of the global orders; while the amount of 737MAX delivered to China is accounted for about 27 percent of the world. The events caused airlines in China have 103 aircraft but all of them cannot take in service and lose many incomes from the 737MAX.

While Boeing promises 737 MAX will soon return to the market, there are still 4544 undelivered B737 MAX globally. Furthermore, Boeing owes China 344 B737MAX. Therefore, the bright side of the list shows that airlines and leasing groups still believe that B737 MAX will be able to re-operate in the market soon .

The Suppliers of Passenger Aircraft in China Market

Boeing has entered China aviation market for many years since Boeing set up a subsidiary in Shanghai to sell aircraft to China in 1935. However, Boeing and China did not have much connection in between until president of the United State, Richard Nixon, visited China in 1972. After1972, China was getting to purchase more and more aircraft. Boeing helped China to improve its aviation via technologically training to drive Boeing aircraft, moving some parts of aircraft produced in China, and cooperating with China aircraft relative manufacturers. Also, Boeing helped China get airport certificates in the industry. With the help from Boeing, China learned the ways to produce some parts of components and had opportunities to take part in the procedure of making aircraft, B737, B747, B767, and B787. Nowadays, China, to Boeing, is a place to produce aircraft components, assemble aircraft, and become one of a biggest market to sell Boeing aircraft.

Airbus is the biggest competitor to Boeing in the world. In 1985, Airbus entered into China aviation market when an A310 was the first delivered to China Eastern Airlines.[27] In 1994, Airbus established an official presence in China. Airbus not only sell its aircraft to China but also cooperated with China aircraft manufacturers.

[27] "China Signs for 102 Airbus Aircraft," 2010, accessed 08/20, 2019, https://www.airbus.com/newsroom/press-releases/en/2010/11/china-signs-for-102-airbus-aircraft.html.

By the end of 2005, there were half of Airbus aircraft components made in China. Furthermore, Airbus had trained 500 Chinese engineers. In provides, China had opportunities to take part in the procedure of making aircraft, A330 and A320.

Airbus and Boeing take the same strategies in China. Airbus and Boeing engaged into China aviation market and aimed to expand their markets and decrease costs of producing aircraft. In the wake of Airbus developing in China, airlines in China have the other choices to buy aircraft from Airbus instead of buy aircraft from Boeing. Also, at aspect of the politics, China government takes effects in the market as the power to negotiate with the United State and the EU. For instance, China successfully joined in WTO in 2001 because the world economy was depression. Boeing, as the pioneer, and other companies convinced the US government to vote for China to join WTO.[28] Also, China promises to buy 300 Airbus aircraft, worthy about EUR 30 billion in March 2019. According to social media and news reports, China aimed to stop the trade war of the US and China. Therefore, Airbus and Boeing do business in China but also as the bridges of China government between the United State government and the EU government.

China set up COMAC in 2008.COMAC is a new competitor to Airbus and Boeing in China. After few months of COMAC established, ARJ21, a regional jet, started the first flying test and then was delivered the first aircraft to Chengdu Airlines by the end of 2015. C919, a narrow -body aircraft, was produced in 2015 and it is still in the fly testing. C919 is thought as one of potential aircraft, which C919 has already got many orders from leasing groups and some airlines in China. There were many social medias around the world reported that COMAC would share passenger aircraft

[28] "For Company and for Country: Boeing and Us-China Relations," MacroPolo Decoding China's Economy Arrival, 2019 https://macropolo.org/analysis/boeing-us-china-relations-history/.

market with Airbus and Boeing, but it would not be easy to get into the oligopoly market. However, after two of B737 MAX-8 aircraft crashed, the events seemed providing COMAC a chance to get into the global aviation market.

China is a big market but all of aircraft in China need to be brought and imported from foreign manufacturers. China thinks it is costed to buy aircraft, hence, COMAC was established to manufacture its own big and safe passenger aircraft.

The Conduct and the Performance of Airbus and Boeing in China

Considerations of Airlines Purchasing Aircraft

In the competitive market, airlines generally consider several factors when they purchase aircraft, such as fuel economy, technology, safety, and aircraft price when they purchase aircraft. Firstly, aircraft need to consume plenty of petroleum and petroleum is unfixed cost to airlines. If the petroleum price grew, it would have an impact on the revenue of airlines. Secondly, airlines like advanced aircraft which urge aircraft manufacturers to improve the functions on aircraft. Purchasing advanced aircraft would give airlines efficient operations of aircraft and avoid risks of aircraft. Thirdly, safety is a very important consideration to airlines and manufacturers. If something happened, it would danger all of people on the aircraft. Lastly, when airlines buy a kind of aircraft that manufacturers offer similar aircraft, airlines would compare the aircraft price and purchase the cheaper ones.

The Competitive Conducts of Airbus and Boeing Response to Global Market Demands

Airbus and Boeing are competing various cases. According to the considerations of airlines buying aircraft, there are some instances of competition between Airbus and Boeing.

Fuel economy

Aircraft manufacturers make passenger aircraft more fuel economy. The aims are to reduce carbon emissions to avoid global warming and achieving airlines' expectations for fuel efficiency improvement and cost reduction. The two most fuel-efficient aircraft are B737 and A320. These years, Airbus launched A320neo series which are designed to be more fuel-efficient than their predecessors, reducing fuel burn by 20 percent.[29] While Boeing launched 737MAX and announced that fuel burn is expected to be 16 percent lower than its competitor's current offering. 737MAX would save about 85 million cost of fuel price to airlines every year.[30] Therefore, A320neo and B737 MAX were the last advanced aircraft and they both have progress on fuel economy and efficiency. Comparing these two aircraft, 737MAX is more popular to airlines and Boeing get more orders form airlines because 737MAX have meet which decrease the unfitted cost to airlines and decrease carbon emissions.

[29] Laura Ash, "Airbus Just Delivered Its 1,000th Airbus A320neo," *Simple Flying*, 10/10 2019.
[30] "Boeing Updates 737 Max Engine Configuration Status and Customer Commitments," 2011, accessed 08/01, 2019, https://boeing.mediaroom.com/2011-11-03-Boeing-Updates-737-MAX-Engine-Configuration-Status-and-Customer-Commitments.

Technology

When Airbus and Boeing manufacture aircraft, they improve the disadvantages of passenger aircraft, such as decreasing noise, increasing payload and technological innovation. A320neo added a big curved wingtip called a 'sharklet'. Although the installation of sharklets adds 200 kilograms to the aircraft weight, the wing area is increased generating more lift.[31] A320neo reduced 50 percent noise, compared to the previous A320, and made people comfort in aircraft and reduce noise pollution . According to Airbus issued "Airbus takes a concept of car which automate take-off and low-speed manoeuvres for vertical takeoff and landing(VTOL) and landing via image recognition on A320".[32]

Boeing improved the payload of 737 MAX which can carry more weight than A320 neo. Moreover, B737MAX deceased 40 percent noise, compared to the previous B737. Boeing is trying to design a device to decrease the impact of flow when an aircraft is flying in the air in the case of climate changed. The technology would be used on B797, a narrow- body aircraft and might be launched in 2020. Airbus and Boing produce advanced aircraft. They compete to improve foundations and problems on aircraft. Simultancously, Airbus and Boeing are developing new technologies to make aircraft more efficient, safer and more economical.

[31] Karolina Prokopovič, "Airbus A320: From Ceo to Neo," *Aviation Voice*, 08/02 2019.
[32] "Autonomous Skies
Airbus Is Working Towards a World of Self-Piloted Air Travel ", accessed 08/30, 2019, https://www.airbus.com/newsroom/stories/Autonomous-skies.html.

Safety

Airbus and Boeing had good records on producing safe passenger aircraft these years. In past years(2014 - 2017), fatalities of aircraft accidents decreased from 911 to 50 people and fatal accidents were mainly human factors.[33] However, fatalities grew up to 514 in 2018. Among these 514 people , there were 189 people dead on the A 737 MAX- 8 of Lion Air Flight 610 because the contradictory system setting of 737 MAX- 8 made the aircraft crashed. The same event happened on Ethiopian Airlines Flight 302 on March 10, 2019 and caused 157 people died. These events made 737 MAX series prohibited to fly until the problems fixed. Also, these events caused many airlines delayed and canceled 737MAX orders even more they trended to buy A320. For instance, Saudi Arabian budget carrier Flyadea canceled 50 order of 737MAX and made new 50 order of A320noe.[34] China was the first country to prohibited 737MAX flying, but there are still 344 order of 737 MAX undelivered to airlines in China.

Aircraft price

In the competition between Airbus and Boeing, they both make high price, then they offer big discount to buyers. Airbus aircraft are denominated in EUR while Boeing aircraft are denominated in USD. Their strategies are to avoid the impact of currency exchange rates and inspire airlines to purchase more aircraft. However, the price of the airline's purchasing aircraft can only be announced at the original or list price in the market. The preferential price given by the manufacturer cannot be issued public. In 2019, Airbus reveal a data that how many discounts did Airbus and Boeing offer to airlines in 2018.

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[33] "Accident Statistics," International Civil Aviation Organization, 2018, https://www.icao.int/safety/iStars/Pages/Accident-Statistics.aspx.

[34] Layan Odeh and Matthew Martin, "Boeing 737 Max Loses First Customer as Flyadeal Picks Airbus," *Bloomberg*, 07/07 2019.

Table 6 Average Price and Discount of Airbus and Boeing in 2018

(Unit: EUR /million)

	Boeing	List price	Market value	Discount	Airbus	List price	Market value	Discount
Wide-body aircraft*	B777-300ER	339.6	154.8	54%	A380	432.6	236.5	45%
	B787-9	264.6	142.8	46%	A350-900	308.1	150	51%
	B787-8	224.6	117.1	48%	A300-300	256.4	109.5	57%
					A300-200	231.5	86.6	63%
	Average**	276.2	138.2	48%	Average**	307.1	145.6	54%
Narrow- body aircraft*	B737-900ER	101.9	48.1	53%	A321	114.9	52.2	54%
	B737-800	96	46.5	52%	A320neo	107.3	48.5	55%
	B737-700	80.6	35.3	56%	A320	98	44.4	55%
					A319	89.6	37.3	58%
	Average**	92.8	43.3	54%	Average**	102.4	45.6	55.5%
	Total Average**	**184.6**	**90.8**	**52%**	**Total Average****	**204.8**	**95.6**	**55%**

Source: Cummins, Nicholas. " Airbus Reveals on Average Airlines Get 50% Off Airline List Prices." *Simple Flying*, 02/18 2019.
https://simpleflying.com/airbus-reveals-on-average-airlines-get-50-off-airline-list-prices/#comments
*sorted by the researcher
** calculated by the researcher

According to the Table 6, the average list price of Airbus aircraft is about EUR 205 million, higher than Boeing's, about EUR 185 million ; Airbus wide- body aircraft average about EUR 307 million and narrow- body aircraft average about EUR 102 million. Boeing wide- aircraft average about EUR 276 million and narrow- body aircraft average about EUR 93 million.

Airbus and Boeing sold aircraft at the 40 to 60 percent of the list price. The average discounts offered by Airbus, 55 percent, are more than Boeing's 52 percent.

After discounted, the average market price of Airbus aircraft, about EUR 96 million, is higher than Boeing's, about EUR 91 million; Airbus wide-body aircraft average about 146 USD million and narrow-body aircraft average about EUR 46

million. Boeing wide- aircraft average about EUR 138 million and narrow- body aircraft average about EUR 43 million.

Therefore, Airbus and Boeing are going to attract more orders from airlines so that they both offer almost 50 percent discounts to airlines. The general Airbus aircraft are more expensive than Boeing's. To balance the prices of aircraft, Airbus give more discount to airlines than Boeing does. Also, discount is to decrease the impact on airlines choosing aircraft due to the price.

US and EU Government Assistance to Airbus and Boeing

Government subsidizes domestic aircraft manufacturer, implements preferential policies on the market, and purchase aircraft which to help domestic aircraft manufacturer expand market and increase profit while government issues policies to protect domestic manufacturer, such as increasing tariffs, limiting the amount of aircraft purchased, etc.

With assistance from government, it causes conflicts in fair trade market. Airbus and Boeing have been in conflicts of over subsidies from governments for many years. According to the past cases, The EU government usually directly subsidized to Airbus while The US government usually indirectly subsidized to Boeing. Boeing got subsidies from NASA, Department of Defense (DoD), and Tax regulations. NASA and DoD took some parts of budget and technologies on civil aviation industry. Tax regulations were to help manufactures reduce the benefit of loans, and decrease or cut the taxes of taxes. To maintain development of the market, the US and the EU discussed about civil aircraft agreement. However, there is no effective agreement of the US and the EU by 2019.

On October of 2019, WTO adjudicated the case of Airbus and Boeing in 2006 that Boeing accused that Airbus got USD 22 billion over subsidies form EU government and the event caused Boeing lost income about USD 11 billion, estimated by Office of the United States Trade Representative(USTR). In the case, the United states found that Boeing lost some revenue of B787 and B747 because EU over subsidized billions on A350 and A380.[35] The United Stated sent the policy which to enhance 10 percent tariff on aircraft products by English, Spain, France, and German. The policy was admitted by WTO. Moreover, Airbus would accuse Boeing in 2020 that US government subsidies to Boeing caused lose to Airbus and Airbus want Boeing to more transparent and detail subsidy data.

Airbus and Boeing got subsidies from government which reduce the cost of researching and developing passenger aircraft. Airbus and Boeing enable to give big discounts to airlines. The cases of Airbus and Boeing were mainly about government subsidy for many years. They accused mutually and tried to reduce subsidies to their competitor. Moreover, they have not made clear regulations of government subsidies and have not detailed subsidies form their countries. Therefore, if there are no clear regulations of limited government subsidy, Airbus and Boeing enable to have extra money for investment, have price elasticity on aircraft, and develop advanced aircraft technology via government assistance. Although the conflicts of government assistance to Airbus and Boeing do not stop, the global passenger aircraft market is still dominated by Airbus and Boeing.

[35] "Ustr Proposes Products for Tariff Countermeasures in Response to Harm Caused by Eu Aircraft Subsidies," United States Trade Representative, 2019, https://ustr.gov/about-us/policy-offices/press-office/press-releases/2019/april/ustr-proposes-products-tariff.

The Investment Conduct of Airbus and Boeing in China Market

Airbus and Boeing cooperate with China aviation industrial companies to maintain business with China and help China develop aviation technology. Although Airbus and Boeing take the same strategies to develop in China, there is somewhat gap of development scale in the China passenger aircraft market.

A320 and A330 are popular in China so that Airbus has established some parts of A320 and A330 production line in China. Airbus signed the first sub-contracting agreement with Xi'an Aircraft Company (currently AVIC Aircraft Co.Ltd 中航飛機有限公司) on manufacturing and assembling access doors for Airbus A300 and A310 wide-body aircraft in 1985. Airbus and joint venture partner, China aircraft groups , set up Airbus Tianjin Final Assembly Company for final assembly line of A320 Family (A318, A319,A320, and A321) in 2008.[36] From 2008 to 2017, Airbus Tianjin Final Assembly Company has assembled 354 aircraft.[37] In 2016, Airbus Tianjin Final Assembly Company also became A330 Completion and Delivery Centre. Besides, Airbus have sub- contracting with China aviation industrial companies, such as a composite manufacturing center in Harbin and an engineering center in Beijing, to make some parts of A320 and A330. With deepening relationship of Airbus and China, the total value of industrial cooperation between Airbus and Chinese aviation industry grew from almost USD 600 to 900 million in 2017 and 2018.

[36] "First Airbus Final Assembly Line Outside Europe Inaugurated in Tianjin, China," 2008, accessed 08/26, 2019 https://www.airbus.com/newsroom/press-releases/en/2008/09/first-airbus-final-assembly-line-outside-europe-inaugurated-in-tianjin-china.html.
[37] "Airbus and Its Chinese Partners Strengthen Cooperation," 2018, accessed 08/26, 2019, https://www.airbus.com/newsroom/press-releases/en/2018/01/airbus-and-its-chinese-partners-strengthen-cooperation.html.

Boeing have cooperated with China aircraft industrial companies for many years since Boeing entered in China market. Boeing helps China aircraft industrial companies producing some parts of almost kinds of Boeing aircraft. In 1981, Boeing signed the sub- contracting with Xi'an Aircraft Company to produce B747 parts. In 1999, Boeing and joint venture partner AVIC Aircraft set up a Boeing Tianjin Composites company to produce aviation composite equipment. In these coming years, B73, B74, B767, B777, and B787 are involved in the production. In 2006, Boeing Shanghai is a joint venture between Boeing, Shanghai Airport Authorities and China Eastern Airlines. It provides a comprehensive range of services from engineering to 777 747 737 767. Through 2016, Boeing has already had 40 main aircraft parts suppliers in China.[38] In 2018, Boeing and COMAC, a joint venture partner, established 737 Completion and Delivery Centre in Zhoushan. With the increasing demand of aircraft, Boeing also have investment and training projects in Chain. Through 2018, the value of Boeing activity in China was more than USD 1 billion.[39]

Although the proportion of Airbus and Boeing aircraft components made in China are not high in the world, Airbus and Boeing have deepened their developments in China. They both have cooperated with China companies and improve China aviation technology market. In the aspect of manufacturing, almost all kinds of Boing aircraft have made some parts in China while Airbus have A330 and A320 produced some parts in China. In aspect of sales, China became one of places to assemble, deliver and complete A320, A330, and B737. Airbus and Boeing in China sell aircraft to airlines

[38] 孫立, "波音與中國航空工業開創全面航空生態系統合作," *航空維修與工程*, 11/06 2016.
[39] "Boeing Delivers Its 2,000th Airplane to China," 2018, accessed 08/29, 2019, https://investors.boeing.com/investors/investor-news/press-release-details/2018/Boeing-Delivers-Its-2000th-Airplane-to-China/default.aspx.

in china and even to the world. China has learned to produce aircraft components and assemble aircraft. The development scale of Boeing in China greater than Airbus but their activities values in China are more than USD 900 million.

The Performance of Airbus and Boeing in China Market

The amount of Airbus and Boeing passenger aircraft sold were close to each in the China aviation market from 2017 to 2018. As mentioned before, Airbus and Boeing not only help China developing aviation market but also maintain aircraft selling business with China. The amount of Airbus and Boeing passenger aircraft serviced in China grew stably.

Table 7 Airbus and Boeing Aircraft Delivery to China and World

(Unit: Number)

	Year	2016	2017	2018	Total delivery to China*****
Boeing	Total delivery*	748	763	806	-
	Delivery to China***	160	202	160	522
	Delivery rate to China*****	21%	26%	21%	23%
Airbus	Total delivery**	688	718	800	-
	Delivery to China****	153	176	200	529
	Delivery rate to China*****	22%	25%	25%	24%

Source:

* Boeing customer report of current year deliveries from 2016 to 2018
http://www.boeing.com/commercial/#/orders-deliveries

** A strong performance in 2016 positions Airbus Commercial Aircraft for the future
https://www.airbus.com/newsroom/news/en/2017/01/a-strong-performance-in-2016-positions-airbus-commercial-aircraft-for-the-future.html
Airbus Commercial Aircraft delivers record performance (issued in 2017)
https://www.airbus.com/newsroom/press-releases/en/2018/01/airbus-commercial-aircraft-delivers-record-performance.html
Airbus achieves new commercial aircraft delivery record in 2018
https://www.airbus.com/newsroom/press-releases/en/2019/01/airbus-achieves-new-commercial-aircraft-delivery-record-in-2018.html

***(following the order)
"First Large Chinese-Made Passenger Jet Makes Its Maiden Flight." Phys.org, 2017, https://www.google.com/search?q=phys&oq=phys&aqs=chrome.0.69i59j0l4j69i60l3.5447j0j7&sourceid=chrome&ie=UTF-8.
"Boeing Delivers Record High of 202 Aircraft to China in 2017." Xinhua News Agency, 2018, http://www.xinhuanet.com/english/2018-01/25/c_136924563.htm.
"Global Commercial Aircraft Deliveries Fell in 2016 as Boeing Again Outsold Airbus; 2017 to Be a Peak." CAPA - Centre for Aviation, 2017, https://centreforaviation.com/analysis/reports/global-commercial-aircraft-deliveries-fell-in-2016-as-boeing-again-outsold-airbus-2017-to-be-a-peak-321424
(President Trump has relatively indiscriminately attacked China on several fronts. Looking further ahead, into 2018, is subject to even more uncertainty, but the CAPA Fleet Database currently suggests that total delivery numbers will fall to levels similar to the numbers achieved in 2016.).

****(following the order)
"Boeing to Set up First Overseas Factory in China." The Economic Times, 2017, https://economictimes.indiatimes.com/news/international/business/boeing-to-set-up-first-overseas-factory-in-china/articleshow/57616845.cms.
"Boeing to Set up First Overseas Factory in China." The Economic Times, 2017, https://economictimes.indiatimes.com/news/international/business/boeing-to-set-up-first-overseas-factory-in-china/articleshow/57616845.cms.
"Airbus in China." Airbus 2018, https://www.airbus.com/company/worldwide-presence/china.html.

*****calculated by the researcher

The data do not involve Taiwan, Hong Kong, and Macao.

According to Table 7, Airbus and Boeing produced aircraft stably grew from 2016 to 2018. The total production of Airbus delivered to China has counted for 25 percent since 2017. Airbus delivered aircraft to China averaged about 24 percent of total production through 2018.

In 2016 and 2017, the amount of Boeing aircraft delivered to China were more than Airbus. However, Boeing reduce its production in 2018 because of the war trade of China and the USA and 737MAX events, Boeing aircraft delivered to China was reduced. Boeing delivered aircraft to China averaged 23 percent of total production through 2018.

Therefore, the 23 percent revenue of Airbus and Boeing in the past three years both came from the Chinese passenger aircraft market. Airbus and Boeing would earn about EUR 46 billion, which are respectively EUR 24 and 22 billion in the past three years (calculated in average narrow-body aircraft market piece of Table 6).

Chances and Challenges to COMAC

Chances of COMAC

C919 Orders

COMAC passenger aircraft is cheaper than Airbus and Boeing aircraft. Since C919, produced by COMAC, exhibited in Paris Air show in 2015, there have been many social media and news reported that A320neo, B737 MAX and C919 would compete in aviation market. In narrow body aircraft market, Airbus and Boeing sell passenger aircraft at more than EUR 100 million of the list prices in 2018. COMAC lists C919, the only one passenger aircraft, price at about USD 50 million. Obviously, C919 price is in a half of other aircraft prices, which is more attractive to many airlines.

At the present, C919 got orders about 920 aircraft and ARJ21 got about 596 aircraft. The orders of the two aircraft mainly many from China leasing groups and domestic airlines and leasing groups.

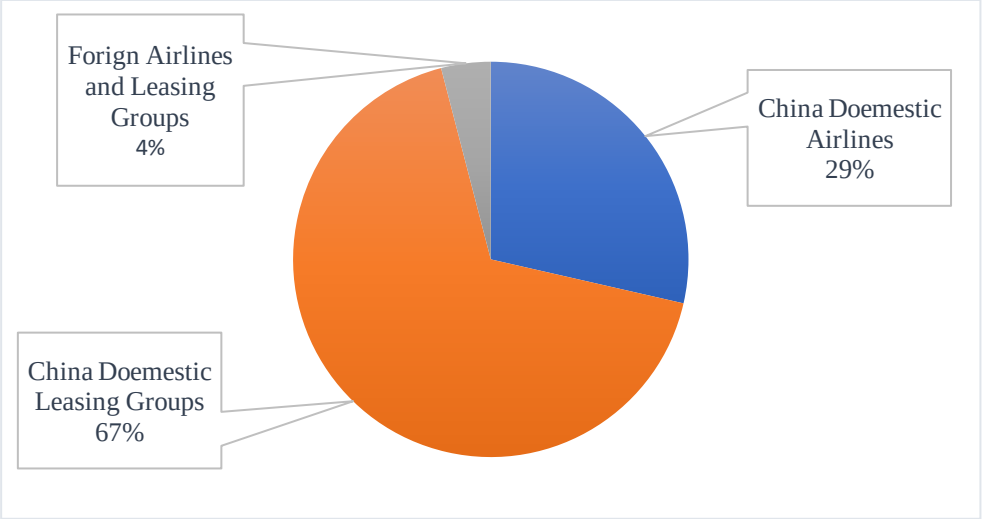

Figure 6. The C919 orders of 28 buyers in 2017
Source:
"Q5：C919 訂單情況？." 中國商飛公司新聞中心, 2017, http://www.comac.cc/zt/c919shoufei/zjdfj/201704/25/t20170425_5115893.shtml.
"Arj21 新增 105 架訂單，國航東航南航計畫各引進 35 架." 澎湃新闻, 2019, http://www.comac.cc/xwzx/mtjj/201909/02/t20190902_6868451.shtml.
* The data added 105 orders of C919 form Air China, China Eastern Airlines, China Southern Airlines in 2019.

The Figure 6 shows that the main orders were from China companies. China leasing groups and domestic airlines highly counted for 96 percent, which were consisted of leasing groups about 67 percent and airlines about 29 percent. The large orders of C919 were worth for about USD 44 billion.

COMAC is one of China 2025 plan goals in 2008 and China government helps COMAC selling aircraft. Most of the buyers (China leasing groups and domestic airlines) were state- owned companies, such as, Air China, China Eastern Airlines, China Southern Airlines, Hainan Airlines, ICBC Leasing, BOC Aviation, CDB Leasing, and BoCom Leasing. The main airlines and leasing groups would lead other domestic buyers in the market to order C919. COMAC would succeed to compete with Airbus and Boeing in China market.

The rest of 4 percent orders of C919 came by City airline in Thailand, GE Capital Aviation Services in the UAS , and Puren Airlines in German. COMAC might have chances to promote its aircraft to the world.

After 737MAX Crisis

Airbus got many 737 MAX orders from airlines. Boeing had gotten almost 9000 orders of 737 MAX. After 737 MAX events happened in late 2018 and early 2019, the orders of 737 MAX dropped to about 5000 aircraft. These 5000 seems like an expectation that 737MAX would back to service in the sky. However, some airlines turned down their orders so that Airbus got many Boeing ‘s orders. It was hard to calculate how many orders turn from Boeing to Airbus globally. If Boeing did not pass the flying test and solve the problem as soon as possible, Airbus would steal the greatest number of world passenger aircraft market.

Through the early 2019, there were about 350 undelivered orders of Chinese buyers. China would turn down 737 MAX orders and buy A320neo, C919, or ARJ 21 if Chinese buyers cannot wait for 737MAX problems fixed. Furthermore, China government has power to control China leasing groups and domestic airlines. COMAC would succeed in the China market. After the events of 737AMAX occurred, COMAC seems a reflection that Airbus successfully entered global market because Boeing had some aircraft producing problems in 1990s. China is promoting C919, the first narrow- body aircraft, in China and to the world. Although COMAC just set up a decade ago, COMAC has got many orders which is to compete and share China market with Airbus and Boeing. There are three aircraft manufacturers in China and the types of aircraft serviced in China will be produced by Airbus, Boeing, and COMAC. After a few more years, if COMAC had succeed to deliver C919 and ARJ21

to foreign buyers, especially, buyers in the US and EU, COMAC would have an opportunity to share global aviation market with Airbus and Boeing.

Challenges of COMAC

Flying Certificate Grant Needed for COMAC

Aircraft manufacturers produce aircraft need to have aircraft certificates from Civil Aviation Authority of the importing country. The two most influential certificates are from FAA (US) and EASA (EU) because most of aircraft are produced by Airbus and Boeing and they have great progress technology. If aircraft manufacturers want to sell aircraft worldwide, they need to have both certificates.

Through 2019, C919 and ARJ 21 still do not have the FAA and EASA certificates. COMAC had only ARJ 21 to get the aircraft certificate issued by CAAC in 2015, the amount of ARJ 21 in China is few in domestic market. The potential C919 will get certificate form CAAC in 2021. To the time which Boeing get into the troubles, COMAC needs to keep the timing, as social media and news reported about. If COMAC would success to compete witch Airbus and Boeing in China, COMAC and China need to get through the flying texts as soon as possible before 737MAX finishes the flying texts and regains the flying certificate. Otherwise, COMAC will lose some C919 orders and the great expectation will not meet then.

COMAC have assistance of China government sell aircraft not only in China but also to other countries. China would sell COMAC aircraft to undeveloped or low-developing countries by the one belt one road policy promote and diplomatic behaviors. In early 2019, Ghana airlines ordered for two ARJ 21. ARJ 21 would take fly in Ghana because the CAAC certificate admit by Ghana Civil Aviation Authority.

After established diplomatic ties between China and Kiribati, China committed to give Kiribati one B737 but China would like to offer one C919. In the result, Kiribati refuse C919. The cases show that ARJ 21 have CAAC flying certificate and aircraft would enable to sell other low- developing countries because low- developing countries do not have progress technology to test aircraft.

COMAC have applied for CAAC certificate while applying for FAA and EASA certificates. Through 2019, FAA and EASA certificates did not have a start to get over the tests to C919 and ARJ 21. According to many social media and news reports, the US and EU government would stop COMAC entre the global market which will make COMAC unable to compete with Boeing and Airbus. Thus, COMAC aircraft can fly to a country that has a flying certificate for COMAC aircraft or can be replaced by CAAC certificate. Airbus and Boeing have attempted to stop COMAC enter the passenger aircraft market.

The Backward Development of COMAC

The US and the EU have well-developed in the most advanced aviation industry. Airbus and Boeing have made different kinds of aircraft, such as defense aircraft, helicopter, and cargo aircraft. They both have successfully developed aviation market for many years. However, China have developed its own aviation industry just for about fifteen years. COMAC is the new company and only have devote into passenger aircraft production. In terms of passenger aircraft manufacturing, China's development of aircraft manufacturing is not yet mature so that COMAC needs to rely on more advanced technology from other aircraft manufacturers. Although China is a big passenger aircraft market, the production of COMAC aircraft is too less. From 2015 to 2019, there were only about 20 aircraft delivered from COMAC to China

leasing groups and domestic airlines. Thus, COMAC needs to enhance its production speed and expands its market scale, which would have good timely and advantage to share market value in China, and even in the world.

Substitution Effect of High- Speed Rail in China

Nowadays , the development of China high- speed rail (HSR) does not have much impact on airlines' income while HSR sometimes help airlines overcome over-arranged flight to carry many people. However, airlines and leasing groups would reduce the orders of regional jets because of the HSR development in China. Comparing time, the both transportations take almost the same time. The gap time is about an hour, to arrive the same destination while the HSR ticket price is cheaper than flight ticket price. For China aircraft buyers, they would buy big aircraft. Regional jets, such as ARJ21, would be not attractive to them. Moreover, China is trying to speed up the HRS and shorten the time of trips. In 2018, China has started to develop a super high- speed train, which enable to make train threating at 4000 kilometers and per hour.[40] With progress development of HSR, it seems that China would not need to buy so many aircraft to carry people move domestic area. Therefore, the development of China's high-speed rail will affect the types of aircraft bought by buyers. It would have impact on ARJ21 production since aircraft buyers would turn down the orders. In the future, the demand of passenger aircraft in China is getting down if the speed of high-speed rail has been increasing.
COMAC aircraft sales will be severely impacted in China regional domestic. Currently, China still need many passenger aircraft and China needs to take many years to achieve the goal of HSR.

[40] "陸超級高鐵來了 喊出時速 4000 公里," 中時電子報, 2017, https://www.chinatimes.com/newspapers/20170831000761-260309?chdtv.

CONCLUSION

According to the Chapter 4 DATA ANALYSIS, the researcher finds that passenger aircraft manufacturers' conduct depends on the market demand in the passenger aircraft market. The passenger aircraft manufacturers' conduct also will affect market structure, their financial performance, and government measures. Furthermore, the government assistances deeply influence the market structure, passenger aircraft manufacturers' conduct, and passenger aircraft manufacturers' performance in China passenger aircraft market. These findings are illustrated as Figure 7.

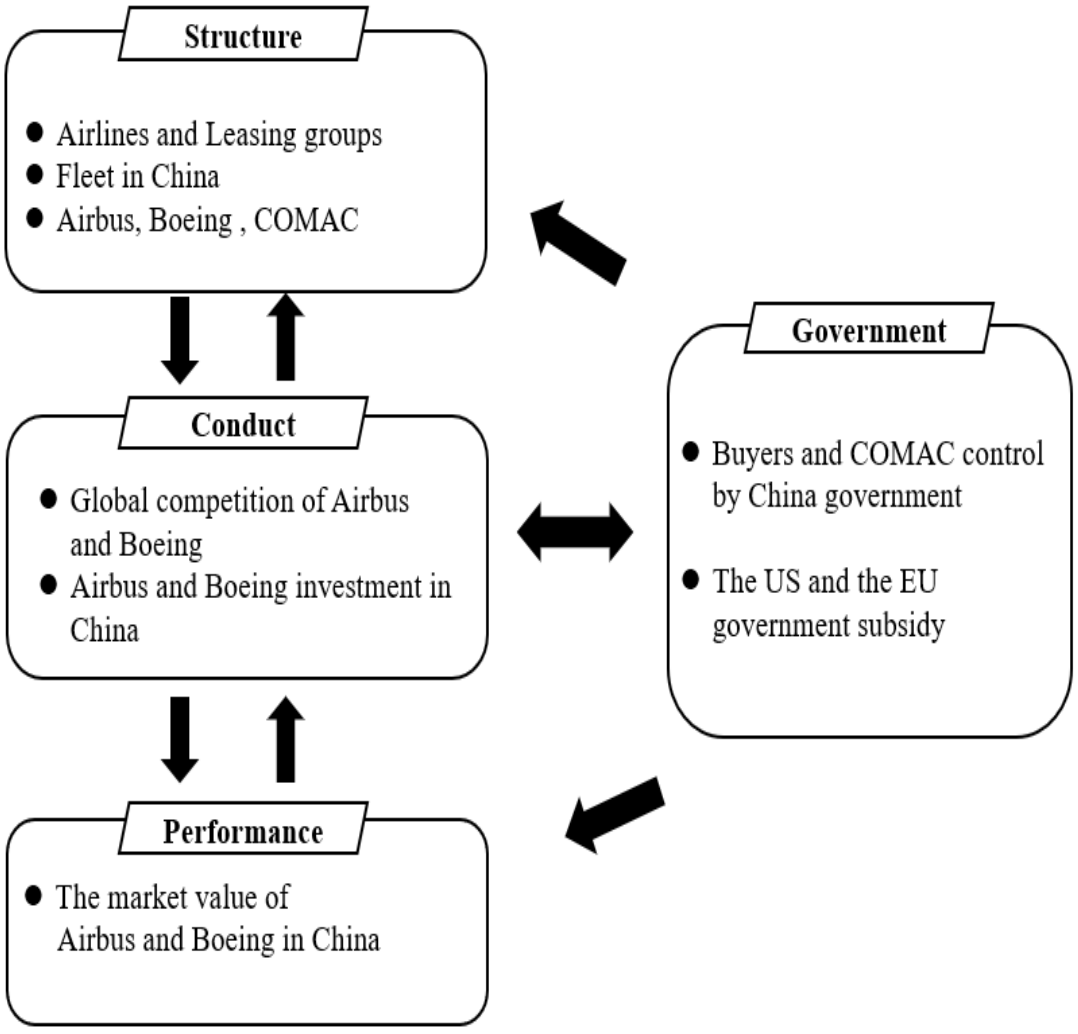

Figure 7. The SCP dynamic in China passenger aircraft market

We can find that there are many aircraft buyers in China in term of market structure. Since China passenger traffic is increasing, the airlines plan to purchase more aircraft for enlarging their share in this growing market. They are mostly established by government or joint ventures with State-owned enterprises investment. The fleet in China are mainly, up to 90%, produced by Airbus and Boeing. Among of the fleet, there are 103 737MAX delivered but Boeing still owes China 344 undelivered aircraft. But China buyers also ordered 27 ARJA21 in 2015, a product provided by COMAC, which were more than half of regional jet orders.
Besides, Airbus and Boeing, the main passenger aircraft supplier in China, have invested and cooperated with China government and enterprises for many years. Airbus and Boeing also become one of the indirect access of China to negotiate with the US and EU. Under the conditions of obtaining production technology from Airbus and Boeing, China established COMAC to produce its own passenger aircraft. This is what we are witnessing: Airbus, Boeing, and COMAC are competing in China passenger aircraft; furthermore, COMAC would be a potential competitor to Airbus and Boeing in China passenger aircraft market but it takes time.

In aspect of the conduct and performance, Airbus and Boeing competed in some dimensions, such as fuel economy, technology, safety, and aircraft price which respond to global market demands. Especially, Airbus and Boeing gave about 50 percent discount of list price to buyers and that is the way to attract buyers purchasing more aircraft. In China passenger aircraft market, Airbus and Boeing cooperated with China aviation manufacturers to produce some parts of aircraft. With the more demand of aircraft, Airbus and Boeing deepen the cooperation with China manufacturers. In 2018, the market value of Airbus and Boeing were respectively 900 million dollar and 1 billion dollar. The delivered aircraft by Airbus and Boeing to

global market were stably growing. From 2016 to 2018, aircraft delivered to China were up to about 1000 aircraft. The total production of Airbus and Boeing aircraft counts for more than 20 percent of aircraft delivered to China and t and the total revenue of Airbus and Boeing were about EUR 46 billion in China. With the big profit in China, Airbus and Boeing keep the business relationship with China and they still dominate the China passenger aircraft market.

In addition, governments supported their aircraft manufacturers. China government established and fully supported their airlines and COMAC. China government assisted COMAC to enter the domestic market and asked Chinese buyers to purchase C919 and ARJ 21 produced by COMAC. When I reviewed the development of Boeing and Airbus, the assistance of US government and EU government to these two giants were obviously visible. US and EU had ever negotiated and almost reached an agreement to reduce and limit the government subsidy to Boeing and Airbus respectively. They had signed an agreement in 1992 ,but the US dropped out the 1992 agreement in 2004.Then, the agreement is no effective.

Hence, there are directly and indirectly government subsidy to Airbus and Boeing which reduces the cost of Airbus and Boeing aircraft in research and development and enables to adjust in price, and even helps Airbus and Boeing expand their oversea market.

Airbus and Boeing have dominated passenger aircraft in the world as well as in China. As to COMAC, there are several chances to enter the aviation market. One is that COMAC aircraft price is much cheaper, up to 50%, than Airbus and Boeing. Another is that most of C919 and ARJ21 orders are mainly from China’s domestic buyers. The other is that 737 MAX security incidents. COMAC might get benefit

from order transfer phenomenon which is similar to Airbus entered the monopoly aviation market dominated by Boeing before.

Though there was a good beginning for COMAC to enter China's passenger aircraft market, it is still hard to share the global market. The main challenges for COMAC are: First, COMAC needs to get the flying certificates from CAAC, FAA, and EASA, especially CAAC certificate. Among COMAC aircraft, ARJ21 has gotten CAAC certificate. There are only few low-developing or undeveloped countries admitted CAAC certificate which helped COMAC to expand to few overseas markets. COMAC is immature in the market. Second, the production of ARJ 21 was not few, not enough to meet the order in the past years. COMAC had to rely on other aircraft manufacturers to enhance the efficiency of aircraft production. Third, there is a substitution effect from China's domestic high-speed rails which are quickly developing. For short trip travelers, they might rather take HSR than airline. With the speed of HSR growing, it would impact the demand of aircraft in China aviation market.

Therefore, the SCP paradigm adopted in this study helped reveal the traits of China's passenger aircraft market. The results of Airbus, Boeing, and COMAC in China and global passenger aircraft market show that it is a topic worthy of future observation and study.

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