

A Study on Evolution of Market Concentration in China Civil Aviation Airport Industry (2002-2022)

Jie Zhou^{1,*}, Wenjie Xu², Bixia Ma³, Jiao Chen⁴

glacia1205@163.com^{1,*}, nongmeix@163.com², 1571661531@qq.com³, 2250483875@qq.com⁴

School of Business and Tourism, Sichuan Agricultural University, Chengdu, 611830, China

Abstract. Under the background of globalization, airport is not only an important part of urban infrastructure, but also an important component of modern economic system. Taking airport localization reform in 2002 as the demarcation point, this paper analyzes the industrial concentration of China's civil aviation airports from 2002 to 2022. This paper uses CR and HHI, selects airport passenger throughput as measurement index, and observes the evolution process of concentration of civil aviation airports. The results show that after airport localization reform, the industrial concentration of China's civil aviation airport industry shows a trend of continuous decrease, no matter CR index or HHI index. Its market structure changed from a low to medium concentration oligopoly in 2002-2013 to a low concentration oligopoly in 2014-2016, and then to an atomic type after 2017. In addition, government policy intervention, regional socio-economic development, other alternative transportation development and social public events are found to be the main factors affecting the market concentration of the civil aviation airport industry.

Keywords: China Civil Aviation airport industry, Market Concentration Rate, Evolution process

1 Introduction

Report from International Air Transport Association (IATA) suggests that the center of gravity of global aviation will continue to shift eastward, market demand in the Asia-Pacific region will be the biggest driver for global aviation development, and China will be the world's largest aviation market by the mid-2020s^[1]. China's air passenger transport volume has been among the top two in the world for 18 consecutive years since 2005. In 2021, the proportion of civil aviation passenger turnover in the comprehensive transport system reached 33.1%, an increase of 18 percentage points over a decade ago^[2]. Moreover, the Chinese government has laid out nearly 80 airport-based Airport Economic Zone since 2013, 17 of which are national level. The civil aviation industry with airports as its core plays an increasingly prominent role in China's economic development and urban industrial structure transformation.

Since the implementation of the reform and opening policy in 1978, China's airport construction and management system has undergone three major reforms. The third round of reform focusing on airport localization in 2002 is the most thorough and profound reform since the establishment of civil aviation, and its important content is to carry out the localized management of airports, that is, to reform the management system of civil airports in accordance with the principle of separating government administration from enterprise management, which broke the previous

monopoly pattern and got rid of the management mode of government and enterprise integration, making the airport a new driving force for urban social and economic development.

The aviation industry reform initiated by the Chinese government in 2002 has not only had a significant impact on the production efficiency of airports, but also profoundly changed the competition pattern of civil airports. With the full implementation of the reform policy, how has the market concentration of China's civil aviation airports evolved? The objective of this study is to evaluate and analyze the concentration degree of China's civil aviation airports industry since 2002 by using the absolute index (CR) and composite index (HHI), so as to understand the competition situation of China's civil aviation airports industry after the reform of the aviation system in 2002. At the same time, the paper analyzes the influencing factors of this evolving pattern. The research conclusion of this paper will provide reference for government departments to better formulate airport management policies and optimize airport pattern.

2 Literature review

With the increasing status of air traffic in modernization and globalization, more scholars have paid attention to the research on air traffic. Through literature analysis, it is found that the existing airport-related researches are mainly carried out in airport congestion and pricing, airport regulation and privatization, as well as the airline alliances. Dender studied 55 samples of American airports from 1998 to 2002 and showed that the degree of competitive pressure between airports had a significantly negative impact on aviation fees ^[3]. Later, with the British airport privatization reform launched in 1987, privatization has become an important direction of global airport reform in the past 30 years. Pagliari assessed changes in airport competition in Lowland Scotland and found that there has been increasing competition between Edinburgh and Glasgow since the separation of ownership ^[4]. Since the localization reform of China in 2002, scholars have begun their study on China's airport industry. Yuen (2009) conducted a study on a sample of 25 airports in China and found that localization reform significantly improved airport efficiency, moreover, production efficiency of listed airports after the reform was statistically more significant than that of unlisted airports ^[5]. Some studies have also focused on the impact of airport localization reform on the economic development performance of the region where the airport is located, and found that the regional economic development level has been significantly improved after the airport is transferred to local management ^[6]. Some scholars have preliminarily discussed the market concentration degree of China's airport industry ^[7-9], Shi's study found that the level of competition in China's airport market was strengthened during 1987-2011, but the market structure had always been oligopolistic ^[8]. At present, the relevant research results remained before 2011 and did not involve the analysis of changes in the competitive pattern of China's airport industry after that.

However, the last decade has been a golden decade for China's rapid economic development and transportation construction. Statistics show that China has been the world's second largest economy since 2010. The development of social economy has created a greater demand for air traffic. In the past decade, CAAC has built or relocated a total of 82 transport airports and added more than 3,000 routes. In addition, as a large-scale transportation facility construction project, its construction and operation will take a long time. Therefore, it is not easy to see the impact of airport localization reform policy on airport competition pattern in the short term. In order to

make a diachronic analysis of the market concentration of Chinese airport industry in the last 20 years after the localization reform, and fills the gap of the lack of attention to the market concentration of airport industry in the existing studies, this paper comprehensively applies CR index and HHI index to study the market concentration of Chinese airport industry in the past 20 years after the airport localization reform, tries to clarify the changes of China's airport market pattern during this period, and analyzes the related influencing factors of this change.

3 Methods

Market concentration is an important index to measure industrial competition and investigate market structure [10]. Generally speaking, the higher the degree of concentration, the higher the degree of market monopoly; otherwise, the higher the level of competition. Determination methods include Concentration Ratio (CR_n), Herfindahl-Hirschman Index (HHI Index), Lorenz curve, Gini Coefficient and Entropy Index, etc. Among them, CR_n and HHI are the two most widely used methods in the study of market concentration.

3.1 Concentration Ratio

CR refers to the proportion of the relevant value (turnover, throughput, etc.) of the largest enterprises in the industry in the whole market [11]. The value of CR_n is between 0 and 1, with higher values indicating higher market concentration. The calculation formula is as follows.

$$CR_n = \frac{\sum_{i=1}^n X_i}{\sum_{i=1}^N X_i} \quad (1)$$

In which, n is the number of top n airports in the industry, N is the number of airports, X_i represents the passenger throughput of the ith ranked airport. The application of CR_n is usually reflected by the index share of n=4, 8 or 16 according to the actual situation. In this paper, n is calculated by taking 4 and 8 according to the current situation of airport throughput in China.

Bain has classified the market structure of the industry based on the CR index [12], as shown in Table 1. Bain's classification of industry concentration has been widely used in academic and industrial practice, and this paper will also analyze the airport industry with reference to Bain's classification standard.

Table 1. Bain's Market Structure classification criteria

Type	Oligopolistic I type Extremely oligopolistic	Oligopolistic II type High Concentrated oligopoly	Oligopolistic III type Middle and upper concentrated oligopoly	Oligopolistic IV type Middle and lower Concentrated oligopoly	Oligopolistic V type Low Concentrated oligopoly	Competitive Atomic type
CR ₄	CR ₄ ≥ 85	75 ≤ CR ₄ < 85	50 ≤ CR ₄ < 75	35 ≤ CR ₄ < 50	30 ≤ CR ₄ < 35	CR ₄ < 30
CR ₈		CR ₈ ≥ 85	75 ≤ CR ₄ < 85	45 ≤ CR ₄ < 75	40 ≤ CR ₄ < 45	CR ₄ < 40

3.2 Herfindahl-Hirschman Index

HHI is the most widely used index of comprehensive concentration. It reflects both the number and the relative scale of enterprises and considers the situation of all enterprises in the market. It is obtained by summing the square market shares of all enterprises in the same industry. The

higher the value of HHI, the higher the unevenness of manufacturer size distribution. The calculation formula is as follows.

$$HHI = \sum_{i=1}^n \left(\frac{X_i}{X} \right)^2 \quad (2)$$

In which, X is the total passenger throughput of the airport market, X_i is the throughput of the i th ranked airport, n is the number of airport.

Similarly, Japanese scholar Masu Uekusa classified the market structure according to the HHI index^[13], as shown in Table 2. The analysis of HHI index in this paper will refer to the classification standard of Masu Uekusa.

Table 2. Classification of market structure based on HHI

Market structure	Oligopoly				Competitive	
	High oligopoly type I	High oligopoly type II	Low oligopoly type I	Low oligopoly type II	Competitive type I	Competitive type II
HHI	$HHI \geq 3000$	$1800 \leq HHI < 3000$	$1400 \leq HHI < 1800$	$1000 \leq HHI < 1400$	$500 \leq HHI < 1000$	$HHI < 500$

4 Results

4.1 Results of market concentration measurement

According to the annual production statistics bulletin of civil aviation airports from 2002-2022 issued by CAAC. This paper selects passenger throughput as the index to measure market concentration. And the results of CR₄, CR₈ and HHI are shown in Table 3.

In addition to 2004, 2010 and 2022, CR₄ was slightly higher than last year, and the remaining years were lower than the previous year, and the market concentration showed an overall downward trend. With the exception of 2004, CR₈ and HHI all showed a downward trend, from 0.569 and 579 in 2002 to 0.303 and 215 in 2022, respectively. All indicators reflect the decline in the overall market concentration of China's civil aviation airport industry year by year.

By comparing the measurement results of the HHI and CR, it can be found that the two indicators show basically the same development trend for the market concentration of China's civil aviation airports, which both show that the market concentration of China's civil aviation airports is getting lower and lower, and the competition is gradually strengthening. HHI plays an auxiliary role in the reflection of market concentration degree. However, due to the influence of calculation method and division basis, the reflection of market structure is slightly different, but the results still show that there is a transition to a highly competitive market structure.

Table 3. Market concentration of China's airport industry from 2002 to 2022

Year	CR ₄	CR ₈	HHI	Airport's number	Year	CR ₄	CR ₈	HHI	Airport's number
2002	0.396	0.569	579	141	2013	0.290	0.451	379	193

2003	0.374	0.554	529	126	2014	0.277	0.440	360	202
2004	0.377	0.555	537	133	2015	0.271	0.434	348	210
2005	0.373	0.549	530	135	2016	0.262	0.421	332	218
2006	0.365	0.542	523	142	2017	0.245	0.397	304	229
2007	0.351	0.523	490	148	2018	0.235	0.381	286	235
2008	0.346	0.512	482	158	2019	0.226	0.369	270	238
2009	0.328	0.495	456	166	2020	0.184	0.335	237	241
2010	0.331	0.492	447	175	2021	0.168	0.312	219	248
2011	0.320	0.482	429	180	2022	0.174	0.303	215	254
2012	0.307	0.467	407	183					

4.2 Analysis of the evolution of market concentration

According to Bain and Masu Uekusa's classification criteria for market structure, China's civil aviation market can be divided into the following stages, as shown in Table 4 and 5.

Table 4. Market structure of China's civil aviation airport industry in different stage

Type	Middle and lower concentrated oligopoly	Low concentrate oligopoly	Atomic type
CR ₄	2002-2007	2008-2012	2013-2022
CR ₈	2002-2013	2014-2016	2017-2022

Table 5. Classification of market structure based on HHI

Type	Competitive type I	Competitive type II
CR ₈	2002-2006	2007-2022

Market capacity enlargement generally reduces the proportion of each company in the industry. And accordingly, the calculated market concentration will decrease. In industries with large market capacity, more large enterprises should be selected to calculate, otherwise, the degree of competition will be exaggerated. Therefore, according to CR₈, this paper divides the evolution process of China's civil aviation airport industry from 2002 to 2022 into three stages.

Oligopolistic stage of middle and lower concentration (2002-2013): The reform of the civil aviation industry in 2002 separated government administration from enterprise management and supported enterprises to expand their scale and become bigger and stronger. After deregulation, the competition among airports has intensified and the monopoly has decreased. As can be seen from Table 3, during the period from 2002 to 2013, CR₈ decreased slowly and continuously, from 56.9% to 45.1%. In terms of market structure, CR₈ in this period was in the range of 45%-75%, belonging to the oligopoly type of middle and lower concentration.

Oligopolistic stage of low concentration (2014-2016): From 2014 to 2016, with the development of regional economy, airports around the country have been booming, increasing routes, attracting passenger flow, and increasing runways and building terminals, the competition in the whole airport industry has been fierce. As can be seen from Table 3, during the period from 2014 to 2016, CR₈ continued to decline, from 45.1% in 2013 to 42.1% in 2016. In terms of market structure, CR₈ in this period was in the range of 40%-45%, belonging to the oligopoly type of middle and lower concentration.

Stage of atomic type (2017-2022): The period from 2017 to 2022 saw the gradual development of non-hub airports, the improvement of airport facilities in central and western regions and

border regions, and the steady growth of passenger traffic. CR_8 has decreased at a faster rate, from 42.1% to 30.3%, the descent rate in those six years was almost the same as in the previous decade. In terms of market structure, CR_8 was all less than 40%, belonging to atomic type.

5 Analysis of influencing factors of airport concentration evolution

After the reform of airport localization, the industrial concentration of civil aviation airports in China continues to decrease. Through analysis, it is found that the government's policy intervention, the development of regional social economy, the improvement of other transportation facilities and public emergencies all have an important impact on the concentration degree of the airport industry.

5.1 Policy implementation by government departments

The ability of the government to mobilize economic resources to influence market activities has always been strong^[14]. The impact of government policies on airport industry concentration is mainly in two aspects. First, Chinese government relaxes market access of the airport industry and intensifies market competition. The reform plan of civil aviation system of China approved by the State Council in 2002 marked the relaxation of market access. In 2016, CAAC explicitly proposed relaxing the restrictions on airports remaining state-owned or state-controlled, and held a positive attitude toward foreign and private capital entering the aviation and airport industry. It also intensified the competition in the airport market. Second, the government subsidy policy realizes the normal operation of small and medium-sized airports and reduces the bankruptcy and closure of airport enterprises. For example, CAAC granted 2,117.31 million yuan in subsidies to 190 small and medium-sized airports in 2022.

5.2 Balanced development of regional social economy

Regional social and economic development is an important guarantee for airport construction and operation. Before 2000, China's economic development was mainly concentrated in the coastal provinces, and the air traffic links between the coastal areas were the busiest. However, after 2000, the Chinese government implemented relatively balanced development policies to promote the economic development of central and western regions, which also made airport construction shifted from coastal areas to the vast inland areas, and from provincial capitals to small and medium-sized cities. Since then, the rank of airports in central and western regions had improved significantly. The development of airports in Sichuan Province is a case in point. With the rapid social and economic development of Sichuan Province, the construction of Sichuan airport industry has been greatly promoted. Chengdu Shuangliu Airport's passenger throughput ranking has climbed all the way, reaching the second place in 2020. There are 16 civil airports in Sichuan Province by 2022. Among them, seven airports were built after 2010.

5.3 Development of alternative modes of transportation

Other modes of transportation also affect the industrial concentration of airports in China, typically High-Speed Rail (HSR) with speeds of 250 km/h or more. With the opening of the country's first HSR in 2008, China officially entered the era of HSR. Due to the advantages of being punctual, fast, safe and cheap, HSRs are more advantageous for short - and medium-range

travel within 800 kilometers. The results of relevant empirical studies have confirmed that HSR has an obvious substitution effect on air traffic^[15]. With the improvement of HSR network in the eastern coastal areas of China, the passenger volume of civil aviation airports in the eastern region has been affected to some extent. For example, Hangzhou Xiaoshan Airport in the developed coastal areas has not entered the top 8 since 2008, largely for the improvement of HSR network in coastal areas has replaced air traffic.

5.4 Public emergency

Public emergencies also have a certain impact on the evolution of airport industry concentration. Typical public events between 2002 and 2022 were SARS, the Shanghai World Expo and the COVID-19 pandemic. As the city with the most severe SARS epidemic, the passenger throughput of Beijing Capital Airport was severely hit, which led to a substantial decrease in CR₄, CR₈ and HHI in 2003. After the SARS crisis in 2004, the passenger throughput was recovered and increased substantially, and the above indicators were increased simultaneously. The 2010 Shanghai World Expo has greatly increased the passenger throughput of Shanghai airport, which is reflected in the airport market CR₄ of China's airport market in 2010. Statistics show that the Shanghai World Expo has attracted a total of 73,0884,400 visitors to the Expo Park, and the passenger throughput of two airports in Shanghai increased by 27.12% and 24.80%, a much higher growth rate than in 2009, which made the absolute CR₄ increase in 2010. The outbreak of COVID-19 in 2020 has severely affected inter-country traffic, with inbound and outbound flights temporarily suspended at major international hub airports and a sharp decline in passengers. In particular, Beijing Capital International Airport and Shanghai Pudong International Airport saw their market shares decline from 7.40 percent and 5.63 percent in 2019 to 4.03 percent and 3.56 percent in 2020. However, other hub airports and non-hub airports with a relatively low proportion of international routes are less affected, which made the size distribution of airports becomes even and the concentration degree of airport market decreased.

6 Conclusions

The reform of the airport industry in 2002 changed the pattern of Chinese airports from complete monopoly to competition, and promoted the rapid development of China's air traffic in the past 20 years. The analysis of the industrial concentration of China's civil aviation airport industry after the reform is helpful to understand the current competitive situation of China's civil aviation airport industry more deeply. In this paper, CR index and HHI are used to analyze the industrial concentration degree of China's civil aviation airport industry with passenger throughput as the indicator. It is found that both CR index and HHI show a steady decline in the overall concentration degree of China's civil aviation airport industry. Based on Bain's classification criteria, its market structure has changed from middle and lower concentrated oligopoly (2002-2013) to low concentrated oligopoly (2014-2016), and then to an atomic type after 2017, indicating that competition in China's civil aviation airport industry has become increasingly fierce in the past decade, during which the market structure has changed from oligopoly to competition. At the same time, this paper analyzes the influencing factors of the evolution of industrial concentration in China's civil aviation airport industry, and concludes that the implementation of government policies, the balanced development of regional social

economy, the development of other alternative transportation modes, and social and public emergencies are the main influencing factors.

The contribution of this paper is to comprehensively analyze the changes of airport concentration in China's civil aviation airports under the background of rapid economic development after the localization reform, and to have a more profound understanding of the market competition pattern of China's civil aviation airports from the macro level, which makes up for the lack of attention to market concentration degree in the existing studies. In addition, how the relevant influencing factors affect the competition pattern of China's civil aviation airport industry remains to be further studied.

Reference

- [1] IATA. Air travel markets over the next two decades. (2016) <https://www.iata.org/en/iata-repository/publications/economic-reports/air-travel-markets-over-the-next-two-decades/>.
- [2] Liu Z. The new decade of China: from a large transportation country to a powerful transportation country. (2022) https://www.gov.cn/xinwen/2022-06/11/content_5695210.htm
- [3] Dender K. Determinants of fares and operating revenues at US airports. *Journal of Urban Economics*, 62(2), pp. 317-336 (2006)
- [4] Pagliari R, Graha A. Airport competition within the Scottish lowlands region[J]. *Research in Transportation Economics*, 79, pp. 100760-100760 (2019)
- [5] Yuen A, Zhang A. Effects of competition and policy changes on Chinese airport productivity: An empirical investigation. *Journal of air transport management*, 15(4), pp. 151-157 (2009)
- [6] Zou W, Liang P. Flying wings: airport decentralization reform and enterprise inventory. *Statistical Research*. 36(11), pp. 76-89 (2019)
- [7] Cai D. The impact of deregulation on China's airport industry. Master Thesis, Xiamen University. (2009)
- [8] Shi P, Jiang K, Zheng Y. Airport pricing strategy and its influencing factors under the framework of platform economics---based on empirical analysis of airports market structure in China. *Finance & Trade Economics*. 06, pp. 128-137 (2013)
- [9] Zhang L. Empirical analysis of airport industry concentration level in China. *Journal of Civil Aviation Flight University of China*. 25(02) pp. 77-80 (2014)
- [10] Wang Z, Xu C. Research on the market structure optimization of chinese real estate industry at present stage---empirical analysis based on market concentration. *Journal of Industrial Technological Economics*. 38(01), pp. 125-132 (2019)
- [11] Yang Gongpu, Xia Dawei. *Industrial Economics*. Shanghai University of Finance & Economics Press, Shanghai, pp. 158-159 (2000)
- [12] Bain J. *Industrial organization*. Joho, Wiley Sons Inc, New York, pp. 56-58 (1959)
- [13] Masu Uekusa. *Industrial Organization*. China Renmin University Press, Beijing (1988)
- [14] Yu L, Fu Q. Study on interaction between local administrative monopoly and industrial structure---based on panel data between provinces. *China Industrial Economics*. 06, pp. 56-66 (2008)
- [15] Zhang Q, Yang H, Wang Q, et al. Impact of high-speed rail on market concentration and Lerner index in China's airline market. *Journal of Air Transport Management*, 83(C), pp.101755-101755 (2020)