

## Research on Harmonious Relationship between Airport Economy and Urban Economy - Taking Guangzhou Baiyun Airport as an Example

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### Abstract

**This paper first analyzes the present situation of Guangzhou Baiyun Airport, and then uses entropy method to apply coupling degree model and coupling coordination degree model to study the coupling coordination state of Guangzhou airport economy and urban economy. The results show that the coupling coordination degree between Guangzhou airport economy and urban economy has changed from the initial disorder to the middle level coordinated development, and it has tended towards advanced coordinated development. Finally, some suggestions are given to promote the economic development of Guangzhou.**

### Keywords

**Coupling coordination degree, airport economy, urban economy, Guangzhou.**

### 1. Literature review

Guangzhou Baiyun Airport is one of the pillars of Guangzhou economic development. According to the August 2017 information, there are 3 runways and 1 terminal building in the airport. The long-term plan is 5 runways and 3 terminal buildings, with room for 202 passenger planes and 43 cargo planes (excluding FBO). T1 has a total building area of 523000 square meters; and T2, put into operation in April 2018, has a total building area of 880700 square meters. T1 has a total building area of 523000 square meters; and T2, put into operation in April 2018, has a total building area of 880700 square meters. In 2017, the passenger throughput of Guangzhou Baiyun International Airport was 65.8369 million, ranking 13th among airports in the world and the 3<sup>rd</sup> among airports in China.

In today's world based on knowledge economy, new products, tending to be small, lightweight and compact, require assembly and boast high added values. At the same time, under the competition of time directivity, global business and supply chain management have undergone tremendous change, and people have become increasingly dependent on fast and flexible air transport. At present, goods worth US \$6.4 trillion, accounting for 35% of all world trade, are transported by air.

Nearly 3 billion people are conducting activities related to business, tourism or leisure [1] through air transportation. Air transport has seriously affected the cross-border and cross-regional flow of "precious yet light" products and high-end talent. Regarding an airport as an agglomeration center of advanced production factors, the more prominent it is as a hub, the stronger its ability to agglomerate factors. According to the "fifth wave theory" put forward by Kasarda [2], the rise of a new metropolis is an important factor in relying on the airport, especially the large hub airport. Castells[3] redefines the geographical location of economic development. He thinks that the economic growth space is changing from the traditional Space of Places to the Spaces of Flows. In today's world marked by globalization, what really count are concentrations of people, logistics, information flow, capital flow and technology flow. The central Hub-and-Spoke aviation network helps people define the center - large hub airports, airports become Hubs of Flows, and expanding aviation. Expanding throughput will drive the airport from a hub of transport to a hub of urban economic operation and growth. Therefore, in the large transport infrastructure, the nature and role of the airport are undergoing a transformation of the root environment, and its status is becoming increasingly prominent. The relationship between an airport and urban economic growth deserves attention.

Air traffic has enhanced the connectivity between cities and promoted the Intercity Agglomeration Economies, thereby rendering it more convenient for knowledgeable talent to make face-to-face

contact between cities. The flow of knowledgeable talent in different spatial areas and interaction with surrounding groups is the main way of latent knowledge spillover, which has promoted the creation of new knowledge. On the other hand, the spread of knowledge among different groups has accelerated [5]; due to the dependence of advanced human capital and high value-added products on air transport modes, enterprises' headquarters, productive service enterprises and knowledge intensive enterprises tend to assemble in the location of an airport, thus forming corresponding industrial clusters, inducing urban agglomeration and achieving continuous self-reinforcement effect. Therefore, if we can effectively use the advantage of agglomerated key production factors, the airport will be an important knowledge "spillover pool" to promote the long-term economic growth of the city. However, despite the fact that the demand for air transportation will increase as the level of economic development rises, Charles and others [6] think there are many other factors that may restrict the development of airport economy in the future. For example, air transport is too dependent on hydrocarbons, and its sustainability is worrying. Part of the growing demand may be offset by high costs. It needs new management models to cope with complex and changeable decision-making environment such as security and aviation congestion in airports and surrounding areas; and whether there is enough space for development of air transportation depends on the level of regional economic development.

At present, most of the research focuses on the correlation between airport and economic development. For example, the correlation between airport economy and the development of urban services and high-tech industries, [7-10], the correlation between airport economy and the cost and productivity of urban manufacturing, [11], the correlation between airport economy and corporate headquarters [12]. There are few arguments about its coupling and coordination. Button and others [13] conducted causality tests on airports and urban employment and urban incomes. The results show that airports are the engines of regional economic development, but there are still some shortcomings in the verification of causality measurement methods. Scholars did not use specific data and appropriate models to explain the degree of coordinated development between airport economy and urban economy, and determine which index is most important in the process of airport and urban development. In view of this, this paper will analyze the coupling and coordination between airport and urban economic growth based on the data of Guangzhou Baiyun Airport Airport Economic Zone and Guangzhou 2001--2016, and illustrate the two problems with specific data with a view to understanding the long-term interaction between airport and urban economic growth, especially the positive impact of airport on urban development, and providing a realistic reference for airport planning and construction.

## 2. Index system and data source

### 2.1 The construction of evaluation index system

In order to accurately assess the degree of coupling coordination between airport economy and urban economic development in Guangzhou from 2001 to 2016, based on the analysis of the existing research results, we have located the index data that affect the urban economy and airport economy, and establish an evaluation index system respectively.

### 2.2 Data collection and processing

The data of airport economy and urban economy in Guangzhou from 2001 to 2016 are selected. The original data came from the *Guangzhou Statistical Yearbook* (2001 - 2016), *Guangzhou Statistical Bulletin of National Economy and Social Development* (2001 - 2016) and airport-related websites.

First, the data are standardized as follows:

$$X'_{it} = (X_{it} - X_{i\min}) / (X_{i\max} - X_{i\min}) \quad (1)$$

$$X'_{it} = (X_{i\max} - X_{it}) / (X_{i\max} - X_{i\min}) \quad (2)$$

$X_{it}$  is the original data of index I from 2001 to 2016. Formula (1) indicates that  $X_{it}$  has a positive effect and Formula (2) indicates that  $X_{it}$  has a negative effect.  $X'_{it}$  is the index I's standardized data after 2001 to 2016.  $X_{i\min}$  is the minimum value of I in T,  $X_{i\max}$  is the maximum value of I in t year, and the data of standardization of airport economy and urban economic system index from 2001 to 2016 are as follows.

Table 1 Standardization of Index Data of Guangzhou Airport Economic System

Particular year	Airport cargo throughput	Airport cargo throughput growth	Container throughput	Container throughput growth
2001	0.04	1.00	0.03	0.85
2002	0.09	0.82	0.08	1.00
2003	0.13	0.69	0.14	0.84
2004	0.19	0.69	0.20	0.74
2005	0.24	0.66	0.27	0.79
2006	0.34	0.96	0.36	0.76
2007	0.43	0.86	0.48	0.79
2008	0.52	0.56	0.54	0.35
2009	0.56	0.08	0.53	0.00
2010	0.64	0.39	0.65	0.59
2011	0.71	0.26	0.71	0.31
2012	0.80	0.31	0.81	0.41
2013	0.90	0.38	0.88	0.27
2014	0.95	0.00	0.94	0.26
2015	1.00	0.00	1.00	0.20
2016	1.03	0.00	1.01	0.21

Table 2 Standardization of Urban Economic System Indicators in Guangzhou

Particular year	GDP	Revenue	Fixed investment	Consumer goods retail price index	Total retail sales of consumer goods	Total imports and exports	Insurance revenue	Loan balance of financial institutions	Net export of Guangzhou port	Total industrial output value
2001	0.02	0.02	0.01	0.10	0.02	0.02	0.04	0.01	0.02	0.02
2002	0.05	0.02	0.02	0.19	0.07	0.05	0.05	0.04	0.04	0.04
2003	0.08	0.04	0.05	0.00	0.08	0.10	0.08	0.07	0.11	0.07
2004	0.13	0.05	0.12	0.11	0.09	0.19	0.11	0.09	0.23	0.13
2005	0.18	0.10	0.18	0.16	0.13	0.27	0.12	0.11	0.32	0.19
2006	0.25	0.16	0.20	0.23	0.18	0.36	0.17	0.17	0.39	0.25
2007	0.32	0.23	0.22	0.71	0.24	0.46	0.25	0.22	0.48	0.34
2008	0.40	0.28	0.18	0.90	0.32	0.58	0.36	0.28	0.65	0.44
2009	0.45	0.32	0.44	0.05	0.39	0.46	0.42	0.40	0.47	0.52
2010	0.55	0.40	0.44	0.50	0.46	0.63	0.59	0.50	0.67	0.60
2011	0.67	0.52	0.52	1.00	0.56	0.85	0.56	0.61	0.90	0.71
2012	0.75	0.64	0.62	0.55	0.66	0.87	0.62	0.71	0.89	0.83
2013	0.84	0.77	0.76	0.50	0.76	0.94	0.71	0.81	0.94	0.93
2014	0.93	0.88	0.87	0.65	0.88	0.97	0.82	0.89	0.85	0.96
2015	1.00	1.00	1.00	0.27	1.00	1.00	1.00	1.00	1.00	1.00
2016	1.10	1.12	1.12	0.28	1.13	0.99	1.07	1.11	1.03	1.04

### 3. Research methods

In this paper, entropy method and coupling degree and coupling coordination method were combined to calculate the weight of every index affecting the city and airport. Then the comprehensive evaluation model was established based on weight and each index, and finally the results of coupling

degree model and coupling coordination model were used to confirm the coupling coordination between the airport and urban economy.

### 3.1 Using entropy method to determine the weight of each index in the system

Entropy can be used to judge the discrete degree of an index; the greater the discrete degree of the index, the greater the impact of the index on the comprehensive evaluation. Then we used information entropy to calculate the weight.

Suppose that the dynamic state of Guangzhou airport economy and urban economy is evaluated from 2001 to 2016. The airport economic evaluation index system has 4 indicators, and the urban economic evaluation index system 10 indicators. First, the weight of each index in the airport economy can be calculated, and the following mathematical models can be established:

$$U = \{ U_1, U_2 \dots U_{16} \} \quad (3)$$

The airport economy consists of four indicators per year

$$U_i = \{ X_{i1}, X_{i2}, X_{i3}, X_{i4} \} \quad (4)$$

The original data matrix was obtained:

$$X = \{ X_{ij} \} 16 * 4 \quad (5)$$

The data were standardized as follows:

$$Y = \{ Y_{ij} \} 16 * 4 \quad (6)$$

Calculate the proportion of index J in the airport economy in the year I:

$$p_{ij} = y_{ij} / \sum_{i=1}^{16} y_{ij} \quad (j = 1, 2, 3, 4) \quad (7)$$

The entropy of item J index in the airport economy was calculated.

$$e_j = -k * \sum_{i=1}^{16} p_{ij} \quad (8)$$

$K = 1 / \log 16$  in type

Calculate the difference coefficient of item J index:

$$g_j = 1 - e_j \quad (9)$$

The bigger  $g_j$  is, the more important the index is.

Calculation  $w_j$  of item J in the airport economy

$$w_j = g_j / \sum_{j=1}^{16} g_j \quad (10)$$

The rating index for each year in the airport economy is calculated.

$$f_i = \sum_{j=1}^4 w_j * p_{ij} \quad (11)$$

In Eq. (3) - (11) entropy method was used to calculate the weight of each index in the airport economy, and for calculation of urban economy the above method was also used.

The difference is that calculation of the urban economy involves 10 indicators, and calculation of the airport economy only involves 4 indicators. The calculation method is the same, and it will not be repeated here.

$$f_i = \sum_{j=1}^4 w_j * p_{ij}$$

### 3.2 Establishing the Comprehensive Evaluation Model of Airport Economy and Urban Economy

(1) Establishing a comprehensive evaluation model of airport economy

$$f(x) = \sum_{i=1}^4 a_i x_i \quad (12)$$

Eq. (12)  $a_i$  denotes the weights of the indicators in the airport economy and  $x_i$  denotes the standardized values of the indicators in year I.

(2) Establishing a comprehensive evaluation model of urban economy

$$g(y) = \sum_{i=1}^{10} b_i y_i \quad (13)$$

Eq. (13)  $b_i$  is the weight of each index in the urban economy, and  $y_i$  indicates the standardized value of the index in year I.

### 3.3 Coupling degree and coupling coordination degree model

Coupling refers to the characteristic and law that complex systems interact with and influence each other through subsystems or elements, promote the process from disorder to order, and determine systems' phase transformation (9). The coupling coordination degree reflects the degree of coordination between the two systems. Compared with the coupling degree model, the coupling coordination degree model has higher stability and wider application scope [9].

(1) coupling degree model

$$C = \{f(x), g(x) / [0.5f(x) + 0.5g(x)]\} \quad (14)$$

In Eq. (14), C represents the coupling degree, K is the adjusting coefficient, and in general, the value range of K is [2, 5]. In this paper, we take  $K = 2$

(2) coupling coordination degree model

$$D = \sqrt{C * TT} = \alpha f(x) + \beta g(y) \quad (15)$$

Formula (15) D is the coupling coordination degree, C is the coupling degree, alpha is the weight of airport economic development level, and beta is the weight of urban economic development level. Because the airport economy and the urban economy are equally important, so here we take  $\alpha = \beta = 0.5$ .

According to the value of D, we can draw the coordination types of airport economy and urban economy from 2001 to 2015:  $D < 0.2$ , disorder and chaos;  $0.2 \leq D < 0.4$ , serious coordination recession;  $0.4 \leq D < 0.5$ , moderate maladjustment recession;  $0.5 \leq D < 0.6$ , mild maladjustment recession;  $0.6 \leq D < 0.7$ , primary coordinated development;  $0.7 \leq D < 0.8$ , intermediate coordinated development;  $0.8 \leq D < 0.9$ , advanced coordinated development;  $0.9 \leq D < 1$ , quality coordinated development.[9]

## 4. The results of the study

Based on the standardization of airport economic and urban economic indicators in Guangzhou from 2001 to 2016, the weights of various indicators affecting the airport economy and urban economy in Guangzhou from 2001 to 2016 are obtained by entropy method.

The weights of airport economic indicators are 21.38%, 34.11%, 36% and 23.15%.

The weights of the indicators of the urban economy are 9.26%, 12.34%, 11.42%, 8.72%, 10.41%, 8.58%, 9.98%, 11.47%, 7.98%, 9.84%.

The following table lists the airport and urban economic evaluation indices, coupling degree and coupling coordination degree of Guangzhou city for each year from 2001 to 2016.

Table 3 Coupling Degree and Coupling Coordination Degree of Airport Economy and Urban Economy

Particular year	Airport economic evaluation index	Urban economic evaluation index	Coupling degree	Coordination coupling degree	Type description
2001	0.5534	0.0262	0.0298	0.0929	Disordered and chaotic
2002	0.5463	0.0537	0.1062	0.1785	Disordered and chaotic
2003	0.4869	0.0671	0.1813	0.2241	Serious coordination recession
2004	0.4862	0.1202	0.4041	0.3500	Serious coordination recession
2005	0.517	0.1713	0.5591	0.4387	Moderate maladjustment
2006	0.6541	0.2255	0.5815	0.5057	Mild maladjustment decline
2007	0.6718	0.3301	0.7809	0.6255	Primary coordinated development
2008	0.4873	0.4165	0.9731	0.6709	Primary coordinated development
2009	0.2961	0.3926	0.9133	0.5442	Mild maladjustment decline
2010	0.5453	0.5265	0.9994	0.7318	Intermediate coordinated development
2011	0.4658	0.6701	0.9363	0.7292	Intermediate coordinated development
2012	0.5431	0.7071	0.9659	0.7770	Intermediate coordinated development
2013	0.5179	0.7924	0.9142	0.7739	Intermediate coordinated development
2014	0.4647	0.8718	0.8230	0.7416	Intermediate coordinated development
2015	0.4742	0.9375	0.7962	0.7497	Intermediate coordinated development
2016	0.4951	0.9764	0.8253	0.7568	Intermediate coordinated development

As can be seen from Table 3, the airport economic evaluation index has remained relatively stable. However, the slow growth of global economy and the significant decrease in import and export volume in 2008 led to considerable loss of airport economy. The airport economic evaluation index dropped from 0.4873 in 2008 to 0.2961 in 2009, and the coupling degree in 2008 was 0.9731. This shows that coupling degree sometimes can not accurately and dynamically reflect the degree of coordination between airport economy and urban economy. During the period from 2001 to 2008, Guangzhou attached great importance to the development of airport economy, and the airport economic evaluation index of Guangzhou was higher than the urban economic evaluation index. From 2001 to 2016, the degree of coupling and coordination maintained a steady growth, and there is a trend of continued growth. The index of urban economic evaluation shows that the economy of Guangzhou has been growing continuously. Because of its geographical advantages, Guangzhou has been incorporated not only into important links in accordance with Belt and Road Initiative, but also as a core city along Guangdong-Hongkong-Macau Greater Bay Area.

With the continuous improvement of technology, Guangzhou Baiyun Airport is constantly upgrading its own equipment, striving to be intelligent, introducing various advanced electronic equipment and improving efficiency. With the joint efforts of the government and Guangzhou citizens, the airport economy in Guangzhou will be further boosted; it tends towards advanced and coordinated development.

## **5. Suggestions on the development of Guangzhou airport economy**

### **5.1 Strengthen the policy support for the construction of Baiyun Airport in Guangzhou, give full play to its role as a leader, and raise its level of internationalization.**

"13th Five-Year Plan" is an important opportunity for the development of civil aviation industry in the Pearl River Delta. In order to speed up the development of the airport and civil aviation industry, lift the level of air transportation, seize the current national strategic and policy opportunities, focus on problem-solving, push forward reform in depth, and optimize the environment for development. Compared with other airports in the Pearl River Delta region, Guangzhou Baiyun International Airport has obvious advantages in terms of location, infrastructure, talent, capital and technology. Its operation mode is mature, and the input and output benefits are basically achieved at the existing level of technology and on its production scale. Therefore, in order to promote the economic development of Guangdong, Hong Kong and Macau, Baiyun Airport should play a leading role in promoting the further development of the airport economy through the establishment of the airport development alliance in the bay area. We need to further implement the overall planning of the airport, open up new international long-distance routes, build the base air services and develop international freight, and enhance the level of internationalization of Guangzhou airport.

As the "first window" in the region, Guangzhou Baiyun Airport should have more stringent requirements to consolidate the foundation of security and higher criteria for upgrading facilities and services. First of all, from the overall development of regional open economy, based on the positioning of Guangzhou as a large metropolis, we are supposed to seriously edit the overall planning of the airport, constantly expand our own development while serving the regional economic development to a greater extent; secondly, we should actively adapt to the needs of consumption upgrading, and further improve and enhance the air transport infrastructure. Thirdly, we should stress the importance of both passenger and cargo transportation, foster the growth of base airlines, open up domestic and international routes, especially international long-distance routes, accelerate the development of airport industry, promote economic construction of the airport as a focal point, make the airport an international gateway and hub, thus better playing the role of a supporter and driver of other airports in the region and boosting fast development of civil aviation industry in the region.

### **5.2 Cooperative development among the airports will enhance the comprehensive service capacity of the civil airports in the Pearl River Delta and increase the attraction of industries in surrounding areas.**

Guangzhou Baiyun Airport can cooperate with other airports. Their actual situations determine what kind of goods they are suitable for; and other airports may follow suit. A suitable airport may be chosen according to the type of goods. It can not only maximize the possibility of safe delivery of goods, but also save the cost of airports, maximize profits through mutual cooperation and promote regional economic development. In addition to strengthening the overall coordination and optimization management in the bay area, we should return to the airports at all levels, actively seek the niche market and bring the existing resources into full play, thus further stimulating the increase of passengers and freight traffic and the comprehensive service capability of the airport. It is important to push the flow of passengers and cargo at the airport. We should actively strengthen cooperation with the Southern Airlines as the base air company, encourage them to open up more routes, increase the density of flights, and improve the utilization of airspace resources in the Pearl River Delta.

The airport committee has actively coordinated to join tourism, logistics and other related industries through encouraging local travel agencies and logistics companies to develop by means of appropriate preferential measures, to expand passenger and freight traffic, and optimize the source structure of

passengers and cargo. The government should also optimize the transportation system around the airport, and strive to achieve seamless connection between the airport and the urban traffic, thereby enhancing the attraction of related industries in the surrounding areas.

### **5.3 Attention should be paid to the construction of aviation industrial park for purposes of establishment and improvement of service system, expansion of airport economic scale, and formation of aviation industry chain.**

Based on Baiyun Airport, we will vigorously develop the airport industry and establish sound a service system including catering, hotels, communications, finance and insurance. With the rise of the financial industry in recent years, especially the emergence of virtual economy, people are paying more and more attention to financial management. Guangzhou should also focus attention on development of airport-based financial settlement, insurance, customs declaration and other services.

In addition, Guangzhou should also lay emphasis on development of foreign trade. Guangzhou enterprises can cooperate with excellent foreign enterprises. The government can also formulate some measures to reduce import and export tariffs and increase the import and export volume of goods. The degree of development of import and export trade directly determines the scale and level of development of the airport economy. Guangzhou Baiyun Airport is vigorously expected to seek sourcing and develop new markets, which requires Guangzhou enterprises to go global and strengthen exchanges and cooperation with foreign enterprises, for joint development, mutual benefit and reciprocal victory.

At the same time, to develop the airport economy, developed ground transportation network is also indispensable. In addition, we must take into account the industrial structure of the city, the overall transport demand and many other factors. It does not suffice to boast only geographical advantages and spatial conditions. How to make the airport become the engine of urban economic growth also requires managers not only to operate air hubs as airports, but also to plan and design in accordance with the mode of airport city to meet the needs of passengers while meeting the needs of the development of airports around the region. Agglomeration and development convert the airport into a new "growth pole", "technology pole" and "innovation pole" in the city, forming a virtuous circle of the coordinated development of airport economy and urban economy.

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